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Changing Climate, Changing Wildlife

A Vulnerability Assessment of 400 Species of Greatest Conservation Need and Game Species in Michigan

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Executive Summary

Michigan's climate has been warming, and the warming trend is accelerating. The best available science indicates the acceleration is likely to continue, and warming in the next 40 years will be roughly 10 times as fast as the warming over the past 100 years in Michigan.

Michigan wildlife face myriad conservation challenges, including land use change and habitat loss, habitat fragmentation, competition from invasive exotic species, altered ecological processes, and a rapidly changing climate. This report focuses on the effect of a rapidly changing climate.

In 2010, the Michigan Natural Features Inventory (MNFI) received funding from the Michigan Department of Environmental Quality Coastal Management Program to assess vulnerability of 180 animal and plant species in the coastal zone using the Climate Change Vulnerability Index (CCVI) developed by NatureServe. MNFI assessed a total of 198 species including 131 animal species and 67 plant species. The Michigan Department of Natural Resources (DNR) Wildlife Division used State Wildlife Grants and Pittman-Robertson funds to assess vulnerability of 281 animal species using the same methods. Twelve animal species were assessed by both MNFI and the Michigan DNR. All resident terrestrial game species and all Species of Greatest Conservation Need (SGCN) (with enough life history data) were assessed. Vulnerable species are those expected to experience reductions in range extent or abundance by 2050 due to climate change.

The CCVI analysis suggests that 17% of terrestrial game species and 61% of terrestrial and aquatic Species of Greatest Conservation Need (SGCN) are vulnerable. Other conservation threats or programs aside, these species will likely experience range or population reductions due to climate change. Vulnerable species included important game species, such as moose (*Alces americanus*), American marten (*Martes americana*), snowshoe hare (*Lepus americanus*), and ruffed grouse (*Bonasa umbellus*). Vulnerable SGCN include conservation icons, such as the Karner blue butterfly (*Lycaeides melissa samuelis*) and common loon (*Gavia immer*). The full list of species' vulnerabilities is in the Appendices.

Other vulnerability analyses suggest that ecological communities in Michigan will change dramatically as species respond individually. Some characteristic northern species, such as spruce, fir, and birch may fade from the landscape. Quaking aspen (*Populus tremuloides*) is predicted not to regenerate and compete with the same health and vigor in a warmer and drier Michigan. Other species, such as red maple (*Acer rubrum*) and some oaks (*Quercus* spp.) and hickories (*Carya* spp.), are expected to do better in a warming climate. This analysis focuses on vulnerabilities of individual species, independent of changes in habitat or competitive interactions.

The CCVI predicts the strength and direction of the influence of a changing climate. Management action (or inaction) can offset or reinforce the climate influence. The CCVI is a useful first step in climate adaptation, but it is only one tool to use to develop climate adaptive management plans for species or habitats. Initial suggestions of management actions are provided to help managers begin thinking about how these adaptive plans can be formulated. However, adaptation (e.g., climate-smart management) will need to be context specific; it will depend on existing management goals, priorities, funds, and local site conditions.

Introduction

Imagine eating a woodland caribou (*Rangifer tarandus caribou*) steak in Marquette County; or finding freshly shed caribou antlers in Bad Axe; or trapping American marten in Allegan; or finding the broad tracks of Canada lynx (*Lynx canadensis*) in the deep snow of northern Ohio. Imagine lake ice that stretches to the horizon, linking islands to mainland, peninsula to peninsula, every winter. This is not a picture of a boreal Great Lakes shortly after the glaciers melted. This is Michigan at statehood, even up to the early 1900s, based on historical records (Baker 1983). Mean air temperatures have warmed 1 degree F over the past 100 years (Andresen 2012), and many species have responded. **In the next 40 years, temperatures are projected to rise 7 to 12 times as fast. These future climate change projections raise important questions for fish and wildlife managers. How might current Michigan species respond to 3 to 5 degrees F change by 2050?** Which species are most vulnerable? Which species might increase in abundance or expand their range? And what should we do now?

Vulnerability to climate change is the likelihood that climate-induced changes will have an adverse impact on a given species, habitat, or ecosystem (Glick et al. 2011). Vulnerability is a function of the ***sensitivity*** of a species or system to climate changes and ***exposure*** to those changes (Schneider et al. 2007, Williams et al. 2008). A species or system's ***capacity to adapt*** to climate changes also contributes to its vulnerability (Schneider et al. 2007, Williams et al. 2008). Sensitivity is a measure of whether and how a species or system is likely to be affected by a given change in climate (Schneider et al. 2007, Williams et al. 2008, Glick et al. 2011). Exposure is a measure of how much of a change in climate and associated impacts a species or system is likely to experience (Glick et al. 2011). Adaptive capacity refers to a species or system's ability to improve, minimize, or manage

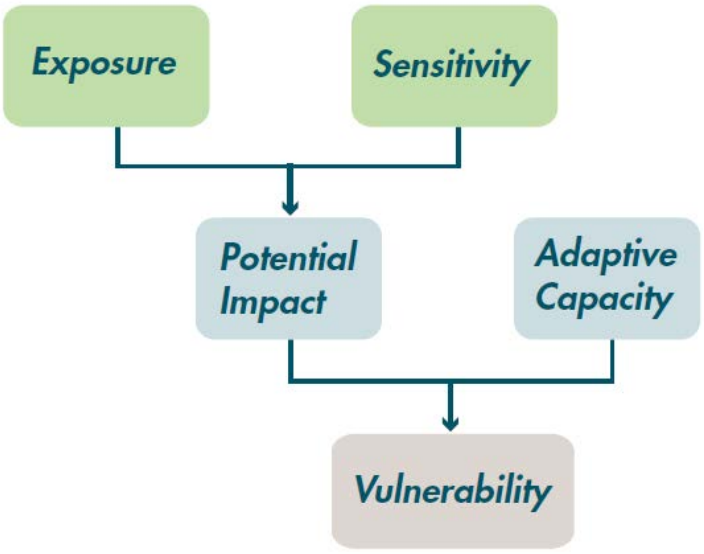

Figure 1. – The relationship of exposure, sensitivity, and adaptive capacity in determining vulnerability to climate change (Glick et al. 2011). All three elements were incorporated in the CCVI score.

its sensitivity or exposure to climate changes (Williams et al. 2008, Glick et al. 2011).

Vulnerability is like risk, and much can be learned from the field of risk management (Brooks 2003). **Risk management offers a different mental frame for understanding climate change and its potential to affect fish and wildlife resources.** Rather than seeking to control the threat, as a manager might control harvest levels or seasons, a more fruitful approach is to consider climate as a systemic stressor. Climate can be influenced by energy policies, but those are outside the decision-space of fish and wildlife managers. Instead, we should consider climate in the same category as other risks: new invasive species, new diseases, or demographic changes.

A vulnerability assessment is a first step in climate adaptation, just as a risk assessment is an early step in risk management. Risks are generally not eliminated, but rather they are managed by reducing exposure, decreasing sensitivity, or increasing adaptive capacity of a system. In the case of conservation, the systems are populations of species of fish and wildlife in the context of their habitats and ecosystems. First, we need to understand which species are most at risk. Then we need to understand why. Are they in a state or province where they could be exposed to more than average warming, or less? What makes them sensitive? Do they have limited dispersal abilities or require a narrow range of water temperatures? Once we know how climate threatens a species, then we can determine what can be done to manage those risks to reduce vulnerability. If feasible actions exist, they can then be prioritized and implemented.

A Climate Change Vulnerability Index (CCVI) score is a measure of the likelihood that climate change will cause a decrease in range or abundance of a species by 2050. The CCVI has been used in a number of states by a variety of agencies and organizations to conduct climate change vulnerability assessments including the natural resource departments and natural heritage programs in Nevada, West Virginia, Pennsylvania, New York, and Illinois (Byers and Norris 2011, Furedi et al. 2011, Schlesinger et al. 2011, Walk et al. 2011). The CCVI is designed to complement, and not duplicate, information contained in the NatureServe conservation status ranks (Master et al. 2012; see Appendix 1). Conservation status ranks are a standardized estimate of extinction risk. Species are ranked on a five point scale from 1 (critically imperiled) to 5 (secure) at the global (G) and the state (S) scale. The prairie vole, for example, is ranked G5 (secure) and S1 (critically imperiled). Managers can use output from the CCVI in conjunction with the conservation status ranks to identify priorities for adaptation efforts (Young et al. 2011). They may also use output from the CCVI to update future conservation status ranks to include the additional stressor of climate change (Byers and Norris 2011).

The CCVI focuses on changes in range or abundance. However, for game species, climate change adaptation is not only about avoiding extinction, but also about the effect that climate change may have on stakeholder values. As an example, ice fishermen create seasonal winter communities on larger lakes across the northern United States (Abbott 2005). The cultural heritage of these communities is likely threatened by ice loss: access may change even if the populations of fish on which they depend do not change. Similarly, **warmer temperatures will mean new or more virulent pests and diseases. Many diseases that could potentially occur in Michigan are limited by cold winter temperatures.** The link between Epizootic Hemorrhagic Disease (EHD) and weather has been well established (Ward 2005, Sleeman et al 2009, Xu et al. 2012). The 2012 outbreak of

EHD in Michigan was largely a function of the abnormally hot and dry weather. Climate is weather over time, and EHD is expected to respond strongly to climate change (Wittmann and Baylis 2000). The increased frequency of EHD outbreaks in the past decade is an example of wildlife impacts from Michigan's changing climate. Although EHD had an insignificant effect on the statewide deer harvest, some local deer populations were heavily impacted in 2012. To hunters in those areas, climate change has had a significant impact on their hunting and wildlife viewing opportunities. It is important to understand that a simple analysis like CCVI will not capture impacts to cultural values or local populations. CCVI is a statewide, first approximatation of vulnerability.

Finally, it should be noted that any assessment of vulnerabilities will have substantial uncertainty. Natural systems are dynamic and nonlinear. It is possible that some species will be less vulnerable than scored with this tool. However, the climate is changing faster than global climate models predicted. Global models of CO_2 rise, temperature rise, and sea level rise have under-predicted observed rates of change (Rahmstorf et al. 2007). Thus, it is likely that this assessment will more often underestimate than overestimate the climate risks to Michigan wildlife.

Methods

We assessed the vulnerability of 400 animal species to climate change using the Climate Change Vulnerability Index (CCVI) developed by NatureServe (Young et al. 2011). The CCVI provides natural resource managers a practical, easy-to-use tool for rapid and science-based assessment of species vulnerability to climate change. The CCVI uses a Microsoft Excel© platform, which allows users to enter numerical or categorical responses to a series of questions about risk factors related to a species exposure and sensitivity to climate change. We initially performed the calculations using the NatureServe CCVI version 2.01, and subsequently transferred all results to version 2.1 following its release in April 2011. The complete CCVI v2.1 tool and supporting guidance and documentation are available on NatureServe's website.

The CCVI tool determines the vulnerability of a species to climate change by assessing the exposure of the species to future projected climate change in the assessment area and the species sensitivity to climate change. Young et al. (2011) provides a more detailed summary and background on the CCVI. Adaptive capacity is incorporated under the sensitivity section of the CCVI tool.

CCVI classifies a species exposure to climate change as direct or indirect (Table 1). To measure direct exposure we examined the magnitude of predicted changes in temperature and moisture across the range of the species within the assessment area (Young et al. 2011). The direct exposure score is the percentage of the species' range within the assessment area that falls into categories of projected changes in temperature or moisture (Table 1). We downloaded projections for average annual temperature changes in Michigan for the year 2050 from The Nature Conservancy's Climate Wizard (Girvetz et al. 2009) and displayed these projections in a GIS format. We downloaded projections for changes in moisture by 2050 from NatureServe. These climate models or predictions represented a median of 16 global circulation models (GCMs) based on a "middle of the road" emissions scenario. Indirect exposure examines the species distribution relative to sea level rise, natural and

Table 1. Factors assessed with the NatureServe Climate Change Vulnerability Index tool developed by NatureServe (Young et al. 2011, Byers et al. 2011). Species had to be scored greatly increase, increase, slightly increase, neutral, slightly decrease, decrease, or unknown for each factor.

Aspect of Vulnerability	Factor	Description
Direct Exposure	Temperature Change	Predicted change in annual temperature by 2050, calculated over the range of the species in Michigan, ranged from 4.5 to >5.5^{o}F increase.
	Moisture Change	Predicted net change in moisture based on the Hamon AET:PET Moisture Metric, calculated over the range of the species in Michigan, net drying ranging from -0.028 to -0.096.
Indirect Exposure	Sea Level Rise	Not a factor in Michigan. Great Lakes level changes were incorporated as a Disturbance regime factor.
	Natural Barriers	Geographical features of the landscape that may naturally restrict a species from dispersing to inhabit new areas. The Great Lakes were a natural barrier for many species.
	Anthropogenic Barriers	Anthropogenically altered landscapes that may hinder the dispersal of a species. Examples include urban or agricultural areas for terrestrial species and dams or culverts for aquatic species.
	Land Use Changes from Climate Change Mitigation	Strategies designed to mitigate greenhouse gases, such as creating large wind farms, plowing new cropland for biofuel production, or converting large tracts of land and the species that use these areas in both positive and negative ways.

Table 1. continued

Aspect of Vulnerability	Factor	Description
Sensitivity	Dispersal/Movement	Populations of species with poor dispersal abilities may not be able shift geographic range fast enough to stay in a suitable climate.
	Historical Thermal Niche	Species populations that have historically experienced high variation in temperature are expected to be less sensitive to future change. Populations that have experienced a narrow range of historical temperatures are expected to be more sensitive.
	Physiological Thermal Niche	Species requiring specific temperature regimes may be less likely to find similar areas as climates change and previously-associated temperature patterns uncouple.
	Historical Hydrological Niche	Species populations that have historically experienced high variation in precipitation historically are expected to be less sensitive to future change. Populations that have experienced a narrow range of historical precipitation extremes are expected to be more sensitive.
	Physiological Hydrological Niche	Species requiring specific moisture regimes may be less likely to find similar areas as climates change and previously-associated precipitation patterns uncouple.
	Disturbance	Dependence on a specific disturbance regime likely to be impacted by climate change: Species dependent on habitats such as jack pine forests, floodplain forests, and riparian corridors that are maintained by regular disturbances (e.g., fires or flooding) are vulnerable to changes in the frequency and intensity of these disturbances caused by climate change.
	Ice/snow	Dependence on ice, ice-edge, or snow-cover habitats: for example, spawning under Great Lakes ice, dependence on snow for camouflage or escape.
	Rarity of Physical Habitat	Restriction to uncommon geological features or derivatives: species requiring specific substrates, soils, or physical features such as caves, cliffs, or sand dunes may become vulnerable to climate change if their favored climate conditions shift to areas without these physical elements.

Table 1. continued

Aspect of Vulnerability	Factor	Description
Sensitivity	Dependence on Other Species for Habitat	Dependence on other species to generate habitat; because species react idiosyncratically to climate change, those with tight relationships with other species may be threatened.
	Diet Specialization	Dietary versatility (animals only); because species will react idiosyncratically to climate change, those with tight relationships with other species may be threatened.
	Pollinators Specialization	Pollinator versatility (plants only); because species react idiosyncratically to climate change, those with tight relationships with other species may be threatened. This was not a factor in our analysis because we only evaluated animals.
	Dependence on Other Species for Dispersal	Because species react idiosyncratically to climate change, those with tight relationships regarding propagule dispersal with other species may be threatened. Larvae of some mussels attach only to one or a few fish host species, for example.
	Dependence on Any Other Species Interaction	Species react idiosyncratically to climate change. This category captures species dependence not covered by the preceeding four categories.
	Documented Genetic Variation	Measured genetic variation; because a species' ability to evolve adaptations to environmental conditions brought about by climate change is largely dependent on its existing genetic variation.
	Past Genetic Bottleneck	Occurrence of and recovery from bottlenecks in recent evolutionary history; because a species' ability to evolve adaptations to environmental conditions brought about by climate change is largely dependent on its existing genetic variation.

Table 1. continued

Aspect of Vulnerability	Factor	Description
Sensitivity	Documented Phenological Response	Phenology is the study of the timing of natural events. For example, recent research suggests that some species or populations are declining due to lack of response to changing annual temperature dynamics (earlier spring, longer growing season).
Documented or Modeled Response	Documented Response to Recent Climate Change	Although conclusively linking species declines to climate change is difficult, convincing evidence relating declines to recent climate patterns has begun to accumulate in a variety of species groups. This criterion incorporates the results of these studies.
	Modeled Change	This factor incorporates models of species vulnerability completed with other methods. This factor appeared to have a strong effect on the final score.
	Modeled Overlap with Current Range	A spatially disjunct predicted future range indicates the species will need to disperse in order to occupy the newly favored area, and geographical barriers or slow dispersal rates could prevent the species from getting there.
	Protected Areas in Modeled Range	For many species, future ranges may fall entirely outside of protected areas and therefore compromise their long-term viability. Because most protected area in Michigan is in the north, this factor was rarely scored high.

anthropogenic barriers to dispersal, and new land uses aiming to mitigate climate change (Table 1).

Sensitivity is based on a variety of factors, including dispersal capability; past climate regime and reliance on specific thermal and hydrological conditions; dependence on disturbance; dependence on snow or ice cover; restriction to certain geological types; reliance on interspecific interactions (e.g., herbivory and predator/prey relationships); genetic variation; and climate-related changes in phenology (Table 1). Each species is scored for each sensitivity factor from "decrease vulnerability" to "greatly increase vulnerability" (or a subset range of these categories), with three to six of these categories available for each factor. Some factors are optional, but a minimum number of factors in each group must be filled out to obtain a vulnerability score. We also incorporated documented or modeled responses to climate change from the peer-reviewed literature as a final factor (Table 1). "Adaptive capacity" was not considered separately in the CCVI. Instead, adaptive capacity

characteristics, such as genetic variation or historical population bottlenecks, were considered as aspects of sensitivity.

Our assessment area was the entire state of Michigan. For vulnerability assessment of listed or special concern species, we used the MNFI Natural Heritage Database, MNFI species abstracts, MNFI Rare Species Explorer, NatureServe Explorer, and other relevant literature and references (e.g., Michigan Breeding Bird Atlas, Michigan Fish Atlas) for species range, distribution and life history information. For listed species with few or no element occurrences in the MNFI database and for common or non-listed species, we relied on the NatureServe Explorer, Michigan GAP data, and other references and published literature for distribution information (e.g., Trautman 1981, Baker 1983, Brewer et al. 1991, Kurta 1995, Harding 1997, Scott and Crossman 1998, and Michigan Fish Atlas). When available we also used general habitat and life history descriptions from these references.

We obtained ranges of terrestrial gastropod species in Michigan from Hubricht (1985) and occurrence records in the Natural Heritage Database. We found additional taxa specific information for terrestrial and aquatic gastropods, including habitat preferences, in published literature (Burch 1988, Burch and Jung 1988, Burch and Jung 1993, and Nekola 1998). We estimated ranges of unionid mussels and aquatic gastropod species in Michigan using a GIS layer of occurrence records in the Natural Heritage Database. We overlaid species range distributions on the projected temperature and moisture maps/data layers and the historical precipitation variation data layer to rank the factors related to direct exposure and predicted sensitivity to temperature and moisture changes/niches. We also consulted with additional sources of information for the assessment including webinars (e.g., Ludsin 2011), theses, and dissertations.

After initial scores were calculated based on available literature, we interviewed a group of experts to ensure that the factors were scored accurately and that we did not miss any relevant literature or research results. Interviews were done on an individual basis, and not in a workshop setting. Most scores did not change after expert review. Those that did change usually increased in vulnerability. This suggests that for the CCVI tool there may be a bias toward underestimating climate vulnerability if expert opinion is not solicited.

Using CCVI we produced a climate change vulnerability score for each species along with a quantitative measure of confidence or uncertainty around the score. Young et al. (2011) provides a summary of how the vulnerability score and confidence measures were generated. Vulnerability scores, definitions, and abbreviations are provided below. Confidence scores range from low to very high (see Appendix 1).

- **Extremely Vulnerable (EV):** Abundance and/or range extent within geographical area assessed extremely likely to substantially decrease or disappear by 2050.
- **Highly Vulnerable (HV):** Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050.
- **Moderately Vulnerable (MV):** Abundance and/or range extent within geographical area assessed likely to decrease by 2050.
- **Not Vulnerable/Presumed Stable (PS):** Available evidence does not suggest that abundance and/or range extent within the geographical area assessed will change (increase/decrease) substantially by 2050. Actual range boundaries may change.

- **Not Vulnerable/Increase Likely (IL):** Available evidence suggests that abundance and/or range extent within geographical area assessed is likely to increase by 2050.
- **Insufficient Evidence (IE):** Available information about a species' vulnerability is inadequate to calculate a CCVI score.

Climate Vulnerability and Conservation Status Ranks

NatureServe and the Michigan Natural Features Inventory rank species by conservation status. Conservation status incorporates many measures of rarity and population trends. Until recently, threats were considered as one measure of all conservation threats facing a species (Master et al. 2003). Climate change was not mentioned as a threat category. The new methodology does incorporate climate change explicitly, but not with the thoroughness of the CCVI (Master et al. 2012). The conservation ranks listed in this report were calculated prior to 2012, and did not use climate change as a threat. Thus, the conservation status ranks in this report apply to rarity, population trends, and other conservation threats. **The CCVI scores and conservation status together provide a conservation index for the species incorporating rarity, population trends, other threats, and climate change.** Biologists should use the two measures in conjunction to give a full understanding of each species conservation status in a rapidly changing climate. For example, the moose has a state conservation rank of S4, meaning that it is apparently secure, uncommon, but not rare within Michigan. However, the CCVI rank is Highly Vulnerable, meaning that abundance is likely to decrease significantly by 2050. The mink frog (*Rana semptentrionalis*) has a conservation rank of S3, meaning it is vulnerable and at risk in Michigan, but has a ranking of Extremely Vulnerable, meaning it is likely to substantially decrease or disappear by 2050. At the opposite end of the spectrum, wild turkey (*Meleagris gallopavo*) is an S5 (secure in Michigan), with a CCVI of Increase Likely.

State conservation ranks and CCVI scores for each species are listed in Appendix A, where species are organized alphabetically by scientific name within taxonomic groups. The other appendices rank species from most vulnerable to least vulnerable. In these appendices species are considered in four broad categories: climate-vulnerable rare species (n=145, Appendix B), climate-vulnerable common species (n=49, Appendix C), climate-stable rare species (n=73, Appendix D), climate-stable common species (n=93, Appendix E). Within these categories, species are ranked from most vulnerable to least vulnerable and most imperiled (S-rank 1) to most secure (S-rank 5). Readers who want to find the CCVI for a particular species should consult Appendix A. Readers who want to see which species are most or least at-risk should consult Appendices B-E.

Climate-Vulnerable Rare Species

Most rare species (S3, S2, or S1) are also threatened by climate change (Moderately, Highly or Extremely Vulnerable). Some of these species already have recovery plans or conservation programs in place. Those programs may need to adapt to climate change, in addition to addressing other, existing conservation threats.

Climate-Vulnerable Common Species

Some common species are likely to be impacted by climate change. They are species that appear secure (S4 or S5), but climate may have a surprising negative impact by 2050. Further research in the sustainability of these species is needed, especially for game species. These may also be candidates for other conservation lists, such as the state threatened and endangered species list, MNFI's Species of Special Concern list, or Michigan's list of SGCN.

Climate-Stable Rare Species

Some rare species (S1, S2, and S3) have other conservation threats, but climate change may not be one of them (Stable or Increase Likely). In some cases, the climate may change to favor these species, but climate change may or may not offset other threats. Some rare prairie or savanna species in the southern part of the state are in this category.

Climate-Stable Common Species

Species that are common (S4 or S5), and not vulnerable to climate change (CCVI vulnerability is Stable or Increase Likely) are low priorities for conservation action. One possible exception would be overabundant species that are likely to increase with climate change. Another exception is discussed in the next section on geographic range shift.

Climate Vulnerability and Geographic Range Shift

The CCVI handles population increases or declines due to geographic range shift in a very particular way. It is not intuitive for managers who work within fixed jurisdictions (those in the federal refuge system, national forest system, or state agencies). A species may be scored Presumed Stable, or even Increase Likely, and become extirpated from the refuge, forest, or state by 2050. Alternatively, a species may be Extremely Vulnerable, with a globally decreasing population, and the population within a jurisdiction may increase. This is because the CCVI focuses on the health of the population, and not its location.

An example of a vulnerable species that could increase in population in Michigan is the eastern box turtle (*Terrapene carolina carolina*). Box turtles are vulnerable for several reasons: they disperse slowly, are sensitive to temperature extremes, and do well only in a relatively narrow range of disturbance (too much or too little disturbance causes habitat degradation or direct mortality). Yet this species is at the northern edge of its distribution in Michigan. Suitable climate will exist statewide in the foreseeable future, and we could see local population increases even as it is extirpated from much of its southern range. Globally, it is expected to do poorly. In Michigan, box turtle populations might respond particularly well, but only if other significant conservation threats are addressed. These species are listed in Table 2 and footnoted in the Appendices.

A good example of a stable species that is projected to do well, yet decline within Michigan, is ruffed grouse. The species has natural history characteristics that make their populations less vulnerable: good dispersal ability, no need for a narrow temperature or hydrological regime, etc. Yet the species is at the southern edge of its range in Michigan, and with warming it is likely (although not certain) that the edge of the range will shift north.

Thus, the ruffed grouse population will be able to adapt at the global or regional scale; however the numbers within Michigan are likely to decrease, especially if current trends in aspen decline continue as predicted (Worrall et al. *In Press*). The term “Presumed Stable” or “Increase Likely” are footnoted in the appendices where geographic range shift may cause reduced abundance as a stable or increasing population shifts out of Michigan. They are also listed in Table 3.

Table 2. The NatureServe Climate Change Vulnerability Index (CCVI) tool for these climate vulnerable species included the caveat that the "Species may expand range in assessment area." Populations of these species may decrease globally, but increase in Michigan if their populations shift northward. EV – Extremely Vulnerable, HV – Highly Vulnerable, MV – Moderately Vulnerable.

Species	English Name	CCVI	Confidence
Acipenser fulvescens	Lake sturgeon	HV	Moderate
Acris crepitans blanchardi	Blanchard's Cricket Frog	HV	Low
Alasmidonta marginata	Elktoe	HV	Low
Alasmidonta viridis	Slippershell	EV	Very High
Ambystoma opacum	Marbled salamander	HV	Low
Ammocrypta pellucida	Eastern sand darter	HV	Moderate
Amybstoma texanum	Smallmouth Salamander	EV	Moderate
Basilodes pepita	Gold moth	HV	Low
Calephelis mutica	Swamp metalmark	HV	Moderate
Catocala dulciola	Quiet underwing	MV	Moderate
Catocala illecta	Magdalen underwing	MV	Moderate
Cicindela lepida	Little white tiger beetle	HV	Moderate
Clemmys guttata	Spotted Turtle	HV	Low
Clonophis kirtlandi	Kirtland's Snake	HV	Low
Emydoidea blandingii	Blanding's Turtle	HV	Very High
Epioblasma torulosa rangiana	Northern riffleshell	EV	High
Epioblasma triquetra	Snuffbox	HV	Low
Erimyzon claviformis	Western creek chubsucker	HV	Moderate
Erimyzon sucetta	Lake chubsucker	MV	Low
Erynnis persius persius	Persius duskywing	MV	Moderate
Falco peregrinus	Peregrine Falcon	MV	Very High
Fixsenia favonius Ontario	Northern hairstreak	MV	Low
Glyptemys insculpta	Wood Turtle	MV	Moderate
Hemileuca maia	Barrens buckmoth	MV	Moderate
Hiodon tergisus	Mooneye	MV	Low
Ixobrychus exilis	Least Bittern	MV	Very High
Lampsilis fasciola	Wavy-rayed lampmussel	HV	Low
Lepisosteus oculatus	Spotted gar	HV	Moderate
Merolonche dolli	Doll's merolonche	MV	Moderate

Table 2. Range expanders…continued

Species	English Name	CCVI	Confidence
Meropleon ambifusca	Newman's brocade	HV	Moderate
Moxostoma duquesnei	Black redhorse	MV	Low
Moxostoma erythrurum	Golden redhorse	MV	Moderate
Myotis sodalist	Indiana bat	MV	Moderate
Necturus maculosus	Mudpuppy	MV	Moderate
Neonympha mitchellii mitchellii	Mitchell's satyr	EV	Very High
Nerodia erythrogaster neglecta	Copperbelly water snake	EV	Very High
Notropis photogenis	Silver shiner	HV	Low
Noturus flavus	Stonecat	MV	Moderate
Noturus miurus	Brindled madtom	MV	Moderate
Noturus stigmosus	Northern madtom	EV	Moderate
Nycticeius humeralis	Evening bat	MV	Very High
Obovaria olivaria	Hickorynut	HV	Low
Oecanthus laricis	Tamarack tree cricket	EV	High
Oecanthus pini	Pine tree cricket	MV	Low
Opsopoeodus emiliae	Pugnose minnow	HV	Moderate
Pachypolia atricornis	Three-horned moth	MV	Low
Papaipema cerina	Golden borer	MV	Moderate
Papaipema speciosissima	Regal fern borer	HV	Low
Pleurobema clava	Northern clubshell	EV	Very High
Pleurobema coccineum	Round pigtoe	HV	Low
Prosapia ignipectus	Red-legged Spittlebug	EV	Moderate
Pygarctia spraguei	Sprague's pygarctia	MV	Low
Scudderia fasciata	Pine katydid	HV	Low
Setophaga cerulean	Cerulean Warbler	MV	Very High
Somatochlora hineana	Hine's Emerald Dragonfly	EV	Very High
Spartiniphaga inops	Spartina borer moth	HV	Very High
Speyeria idalia	Regal fritillary	EV	High
Terrapene carolina carolina	Eastern Box Turtle	HV	Moderate
Toxolasma lividus	Purple lilliput	EV	Moderate
Venustaconcha ellipsiformis	Ellipse	EV	Moderate
Villosa fabalis	Rayed bean	HV	Low

Table 3. The NatureServe Climate Change Vulnerability Index (CCVI) tool for these climate stable species included the caveat that "Species range may shift and perhaps leave the assessment area." These species' populations may be stable globally, but may decrease in Michigan as populations shift across state/international boundaries. PS – Presumed Stable, IL – Increase Likely

Species	English Name	CCVI	Confidence
Accipiter gentilis	Northern Goshawk	PS	Very High
Aeshna canadensis	Canada darner	IL	Very High
Ammodramus leconteii	Le Conte's Sparrow	IL	High
Bombus terricola	Yellow banded bumble bee	PS	Very High
Bonasa umbellus	Ruffed Grouse	PS	Very High
Canis lupus	Gray Wolf	PS	Very High
Colaptes auratus	Northern Flicker	IL	Very High
Contopus cooperi	Olive-sided Flycatcher	IL	Very High
Falco columbarius	Merlin	PS	Very High
Martes pennanti	Fisher	PS	Very High
Mustela erminea	Ermine / Short-tailed Weasel	PS	Very High
Ophiogomphus anomalus	Extra-striped snaketail	PS	Very High
Oporornis agilis	Connecticut Warbler	PS	Moderate
Pandion haliaetus	Osprey	PS	Low
Perisoreus canadensis	Gray Jay	PS	Low
Picoides arcticus	Black-backed Woodpecker	IL	Very High
Poecile hudsonica	Boreal Chickadee	PS	Very High
Regulus calendula	Ruby-crowned Kinglet	PS	Very High
Setophaga caerulescens	Black-throated Blue Warbler	IL	Very High
Setophaga kirtlandii	Kirtland's Warbler	PS	Very High
Setophaga palmarum	Palm Warbler	PS	Very High
Tympanuchus phasianellus	Sharp-tailed grouse	PS	Moderate

Featured Species and Climate Change

The Michigan DNR, Wildlife Division maintains a list of featured habitat species. The list is comprised of those species that are highly valued by Michigan citizens and limited by habitat. This list of 42 species represents high priority species for habitat management. Suitable climate is a component of species habitat, and that component of habitat is projected to deteriorate for some featured species. Considering the featured habitat species together, a couple patterns emerge.

Populations of boreal species are unlikely to return to past levels. American marten scored Moderately Vulnerable and snowshoe hare, common loon, and moose scored Highly Vulnerable. It is likely that these four species will experience population declines due

to direct and indirect impacts from on-going climate change. Ruffed grouse populations were scored stable, but the tool noted that those populations may shift partly or entirely out of Michigan by 2050. These species vulnerability results are consistent with vulnerability analyses of ecological communities, which show moderate to high vulnerability for aspen and conifer ecological communities (Worrall et al. *In Press*, Lee et al. *In Prep*, Handler et al. *In Prep*).

Wildlife managers often assume that population declines are correlated with changes in the biotic aspects of habitat quality or quantity. However, suitable habitat is not just suitable vegetation, but also suitable climate. For climate vulnerable species, the biotic aspects of habitat will become less of a limiting factor as the climate changes. For climate vulnerable species, habitat management may not result in the desired population responses in a warming, drying climate. For example, snowshoe hare populations may not respond to aspen clear-cuts if snowfall becomes less predictable. Similarly, brook trout (*Salvelinus fontinalis*) may not respond to in-stream habitat improvements if the water temperatures rise. As climate changes, we should expect that the climate aspect of habitat will become the limiting factor for vulnerable species.

Some game species populations are likely to increase in a warming climate. Most common species will not experience climate-related population reductions in the next 40 years. For example, abundance and distribution of white-tailed deer (*Odocoileus virginianus*, Presumed Stable) are unlikely to change by 2050 because of climate. Regional ecological and economic impacts, however, may be significant, even if the statewide abundance of deer does not change. Local populations may see temporary significant declines from EHD further north and more widespread than previously. Milder or more severe winters in the Upper Peninsula could change deer migration patterns and seasonal habitat use, with impacts to both wintering complexes and forest regeneration outside those complexes.

Wild turkeys are another valuable species that is likely to benefit from winters that are less severe. Habitat management for turkeys in regions where turkey populations were historically marginal due to climate will increasingly result in a positive population response.

Most species of greatest conservation need (SCGN) are somewhat to extremely vulnerable to climate change by 2050. For example, both the federally endangered Karner blue butterfly and federal candidate eastern Massasauga rattlesnake (*Sistrurus catenatus catenatus*) scored Highly Vulnerable. Both species already face significant conservation challenges, and climate is likely to cause further population declines, especially in southern areas and away from the moderating effects of the Great Lakes.

The rare species that scored Presumed Stable or Increase Likely were species that reach their northern range limit in Michigan, such as the blue racer (*Coluber constrictor foxi*) or evening bat (*Nycticeius humeralis*), or are associated with grasslands and other dry habitats, such as the Henslow's sparrow (*Ammodramus henslowii*), prairie warbler (*Setophaga discolor*), and Kirtland's warbler (*Setophaga kirtlandii*). Habitat management for these species may make up for habitat lost at the southern extremes of their current range in North America.

Managing to Reduce Vulnerability

Identifying vulnerable species is a useful first step, but it is also important to understand why each species is vulnerable to climate change. **Why are 61% of Michigan's SGCN species likely to experience population decreases due to climate change by 2050? Why are important game species like snowshoe hare and ruffed grouse so vulnerable?** The CCVI can be used to identify which factors increase vulnerability for the most species.

In the NatureServe tool, each species was scored on 24 factors. Several factors were always scored as Neutral in Michigan, including Sea Level Rise and Pollinators. The factors that most often increased vulnerability were related to Hydrological Niche, Natural Barriers, and Climate Mitigation (Table 4). The factors most often scored to decrease vulnerability

Table 4. Number of species for which each factor was scored to increase, decrease or not affect vulnerability. Factors are ranked from those that increased vulnerability for most species to those that increased vulnerability for the fewest number of species.

Factor	Increase	Neutral	Decrease
Historical Hydrological Niche	399	1	0
Natural Barriers	207	192	0
Physiological Hydrological Niche	195	185	20
Climate Change Land Use	183	200	9
Anthropogenic Barriers	132	268	0
Disturbance Regime Change	127	208	65
Dispersal/Movement	89	96	215
Physiological Thermal Niche	75	296	22
Diet Specialization	64	276	43
Rarity of Physical Habitat	60	146	194
Dependence on Other Species for Habitat	22	372	0
Modeled change	21	6	27
Past Genetic Bottleneck	16	14	0
Dependence on Other Species for Dispersal	14	367	0
Ice/snow Dependence	12	385	0
Documented Genetic Variation	9	10	3
Modeled Overlap with Current Range	9	41	0
Documented Response to Recent Climate Change	5	2	4
Dependence on Any Other Species Interaction	2	358	0
Documented Phenological Response	1	7	1
Protected Areas in Modeled Range	1	18	0
Sea Level Rise	0	400	0
Historical Thermal Niche	0	400	0
Pollinators Specialization	0	0	0

were related to Dispersal Ability and Habitat Rarity (Table 4). The effect of factors varied across taxonomic groups (Figures 2 and 3). Birds, for example, can cross natural barriers, such as the Great Lakes, but half are more vulnerable to land use related to climate change mitigation policies, such as an increased dependence on wind towers for energy. The factors that most often increased or decreased vulnerability are discussed in detail in the next section.

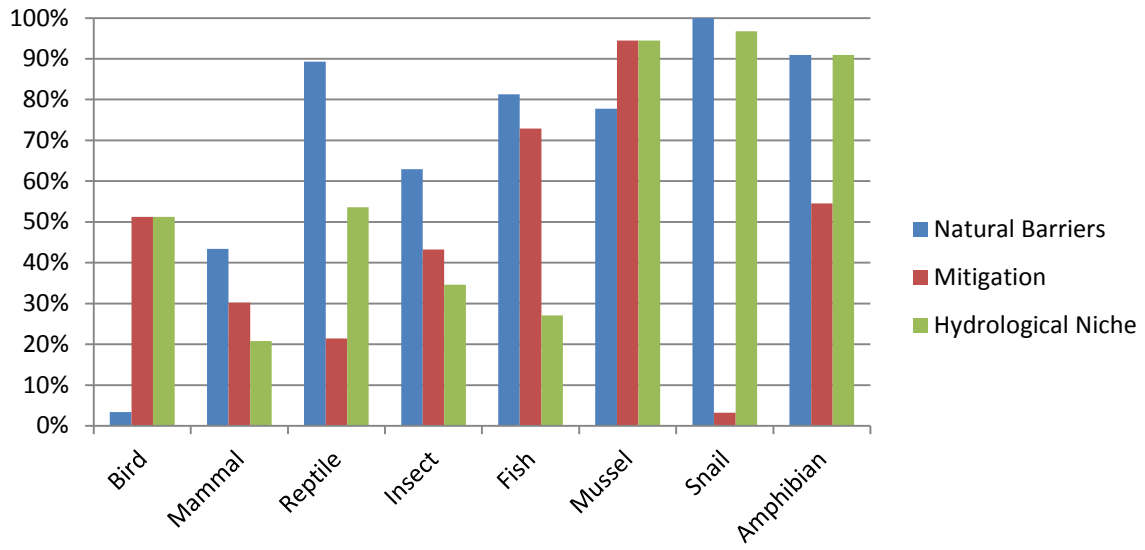

Figure 2. Percentage of each taxon ranked as more vulnerable to the top three factors that increased climate vulnerability for the most species.

Hydrological Niche

The CCVI tool has two factors related to the dependence of a species on hydrology. One is the width of the historical hydrological niche of the species in the assessment area. This factor measures the range of mean annual precipitation that the species has experienced in Michigan from 1951-2006. Compared to other parts of the world, species in Michigan have experienced relatively little variation year-to-year in precipitation, which makes them more susceptible to future change. The other factor is the physiological hydrological niche. This factor measures the dependence of the species on a relatively narrow precipitation regime. Because the prediction for Michigan was for drier conditions, wetland species were disproportionately affected. Some prairie/barrens dependent species benefited, but the effect was negative for most species.

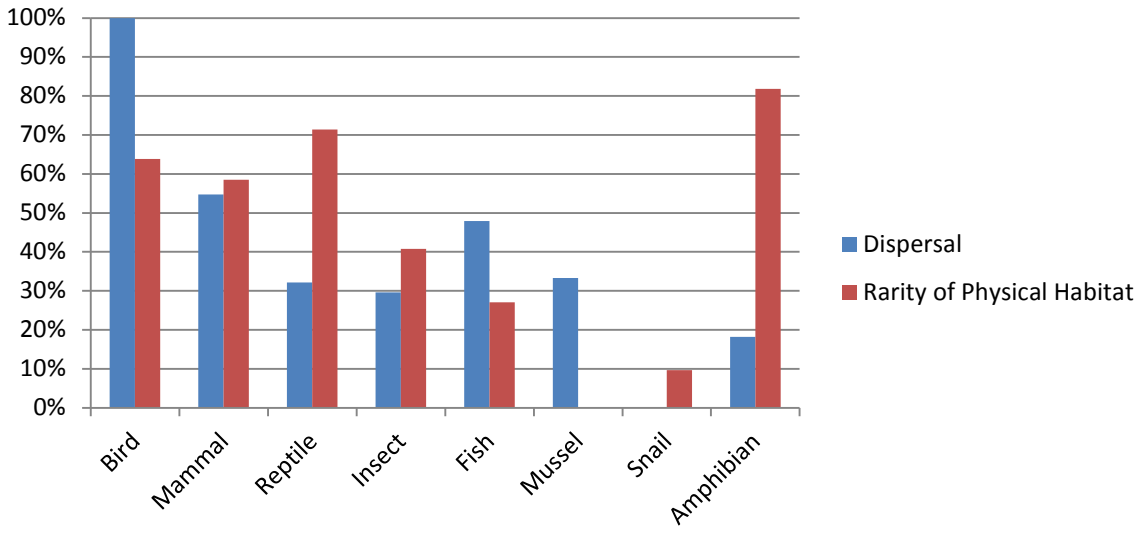

Figure 3. Percentage of each taxon ranked as less vulnerable to the top two factors that reduced vulnerability for the most species.

The CCVI results are based on one hydrological map, which is effectively one future scenario: the average of multiple models and moderate fossil fuel emissions. In this scenario, the slight increase in precipitation is offset by increased evaporation from soils for a drier future. However, the average hides significant variation among models: some models predict dryer, others predict wetter. In the face of uncertainty of this type, the most tempting response is to delay management actions. However, this uncertainty is unlikely to be reduced in the foreseeable future. Thus, delay may not be the best option. The best course of action is scenario planning, in which **management options that are robust under multiple scenarios are given preference over an option that is optimal in any single scenario**. The details of scenario planning are beyond the scope of this report. However, the importance of hydrology in CCVI scores and the variation among models suggest that future adaptation planning should stress scenario planning.

Potential hydrological adaptation strategies:

- Scenario planning to find optimum wetland protection and restoration strategies for a range of future precipitation regimes
- Preferentially monitor climate sensitive species in wetlands rather than in uplands
- Protect/restore wetlands that provide habitat to vulnerable species in drought and flood (e.g., watershed with intact floodplains and few impervious surfaces, groundwater maintained wetlands)
- Maintain ability to manage water levels at managed waterfowl areas and other important wetland complexes.

Natural Barriers

As temperature regimes shift northward, many species will need to shift geographic distribution accordingly, if they can (Francl et al. 2010, Burrows et al. 2011). If geographic range shift is significantly blocked, populations south of the barrier will be more vulnerable. This factor "assesses the degree to which natural (e.g., topographic, geographic, or ecological) barriers limit a species' ability to shift its range in response to climate change" (Young et al. 2011). If the species is not blocked and can disperse, then that species will be much less vulnerable to climate change.

Barriers vary by species and by geography. **The Great Lakes form a barrier to most terrestrial species in Michigan.** Furthermore, Michigan is oriented such that new competitors can enter either peninsula, either from the south or southwest, but existing populations are blocked to the north by Lake Michigan, Lake Huron, or Lake Superior. A small proportion of a population may be able to cross either the Straits of Mackinac or the St. Mary's River, but most individuals of most populations are bounded by a wide lake. Temperature isotherms are shifting northward. In the Great Lakes, average January temperature isotherms will be shifting at a rate of 2.5 kilometers per year by 2020-2049, increasing to 4.5 kilometers per year by the end of the century (Francl et al. 2010). Another study using different climate variables and models estimated climate shifts of 2 – 5 kilometers per year (Burrows et al. 2011). At the rate of 2.5 kilometers per year, the isotherms in Michigan will have shifted 100 kilometers (60 miles) by 2050. The Upper Peninsula is less than 200 kilometers (125 miles) wide north-south in most places, and the Lower Peninsula is about 500 kilometers (300 miles) wide north-south. Because it is much narrower north-south, the Upper Peninsula will experience the effects of the Great Lakes as a natural barrier before the southern peninsula.

Aquatic species also face numerous natural and anthropogenic barriers, but the temperature gradients are different from terrestrial systems. Within large lakes, colder water is deeper than warmer water, at least during the stratified period. As lakes warm, the stratified period lasts longer, but the depth for optimum temperatures also increases. Inland lakes of moderate depths may experience oxygen depletion and anoxic thermoclines during stratification. As seasonal heating increases, there will be limited or no available thermal refugia. Cisco (lake herring) and northern pike would be vulnerable in these conditions. Small, shallow lakes may no longer stratify during ice-free periods. Within networks of streams and rivers, headwaters are colder than lower reaches of the watershed. As the entire system warms, cooler and colder water regimes migrate upstream. In both cases, temperature regimes shift away from hydrological connections.

Potential natural barrier adaptation strategies:

- Manage relocations by restricting movement of aggressive, often damaging species, while facilitating movement of ecologically or economically valuable species. Managed relocation has been the focus of heated discussion in the scientific literature (Schwartz et al. 2012).
- Continue to discourage or prohibit movement of firewood and other materials that transport invasive exotics between Michigan's peninsulas

Climate Mitigation Driven Land Use

Climate change affects the landscape through ecological changes, but it also affects how humans use landscapes. In Michigan, concerns over fossil fuel use and influence on climate have resulted in development of more wind energy facilities, which impact some species of bats and birds. These same concerns are increasing demands for more ethanol (and other biofuels), which raises corn prices, which results in conversion of wetlands, old fields, and hedgerows to intensive agriculture. This intensification of agricultural land use has negative implications for wildlife that use grasslands, wetlands, or edge habitats, especially in southern Michigan. **These climate-driven land use trends are underway, and we expect them to increase in intensity as society attempts to shift away from the production of greenhouse gases.**

Potential adaptation strategies to minimize the impacts of climate mitigation:

- Work with wind energy facilities to reduce impacts to bats and birds through wise site selection, operation, and monitoring.
- Modify incentives in the Farm Bill to keep pace with commodity prices, tiling practices, etc.
- Emphasize large landscapes of grasslands, wetlands, and other important habitat elements on state lands
- Create incentives and regulations to improve water quality in urban and agricultural landscapes.

Dispersal Ability

The ability of a species to disperse improves its adaptive capacity to respond to climate change. In the CCVI tool, species are assessed separately on barriers and on dispersal ability. Barriers aside, most species we assessed can disperse and shift geographic range at the pace of climate change. Migratory birds or butterflies can expand their range quickly. Some species will not be able to disperse quickly. Earthworms and snails, for example, expand their range slowly. **In a perfectly connected world, most species that we assessed could theoretically shift geographic distributions to keep pace with climate change through 2050.** In reality, Michigan is fragmented by natural and human-caused barriers that will prevent populations from dispersing at their theoretical maximum speed.

Potential adaptation strategies to capitalize on dispersal abilities:

- Protect additional acres of linear corridors of natural vegetation, perhaps through partnerships with trails advocates. Manage linear corridors to discourage northward expansion of damaging invasive species.
- Protect “stepping stones” of natural areas across the full range of abiotic factors that correlate with current ecological communities.
- Restore and connect corridors, especially where relatively short corridors can connect large patches of natural vegetation and potential wildlife habitat.
- Protect funnel points for dispersing wildlife near edges of both peninsulas, especially near the Straights of Mackinac, the St.Clair River, St. Mary’s River, and along Great Lakes coastlines.

Rarity of Physical Habitat

Another factor that works in favor of many (not all) conservation concern species in Michigan is that they are not specialists dependent on rare habitats. The factor is both the degree to which a species is restricted to a particular geological or landscape feature, and how rare that feature is on the landscape.

Although many species in Michigan are restricted to a certain habitat or landscape feature at some point in their life cycle, those features usually are not so rare to constitute climate vulnerability. Scoring of this factor often suggested a reduction in vulnerability, especially for vertebrate taxa.

Michigan is biologically-diverse. If the goal is to maintain diversity, the challenge will be to focus on many ecological communities rather than a small number. The many landscape features and ecological communities that occur throughout Michigan should be recognized as an asset to be protected.

Potential adaptation strategies to capitalize on existing habitat:

- Maintain or increase the amount of conservation land managed for sustainable natural resources on public and private property.
- Protect the diversity of landscape features and ecological communities throughout their ranges in Michigan.

Comparing SGCN and Game Species

We attempted to apply the CCVI to all of the animal species that are targets of conservation in Michigan. This includes all game species (except game fish, which are defined and regulated differently than vertebrate wildlife), all Species of Greatest Conservation Need, and all statewide DNR Featured Habitat Species. Overall, data were insufficient to assess 158 game species and SGCN. Most often the Most important was a lack of information on a species' geographic distribution.

Assessing game species and SGCN with the same tool was a useful exercise. Overall, the pattern was that rare species were more vulnerable (61% MV, HV, or EV) than the more common game species (17% MV, HV, or EV). This is not surprising. The natural history traits that make harvest of game species sustainable are similar to those that reduce climate vulnerability: habitat generalists with high reproductive rates and robust population sizes. **That we identified nearly one-fifth of game species as vulnerable is noteworthy and cause for management concern.**

The CCVI scores for game species only indicate if climate change is a threat to the viability of that population by 2050. The CCVI is a poor tool to assess other climate impacts, which might include impacts to:

- access (e.g., changes in space or time of waterfowl migration),
- health (diseases that have local or highly visible impacts, such as EHD), or
- method of take (the disintegration of ice fishing communities, lack of snow for tracking).

Similarly, vulnerability scores do not capture significant shifts in indirect impacts caused by wildlife species. For instance, white-tailed deer were assessed as Presumed Stable. However, when snow persists for fewer days on average, deer in the Upper Peninsula will likely

migrate shorter distances and spend less time in coniferous wintering complexes. This could significantly impact forestry and hunting, not to mention tourism, agriculture, and the forest products industry.

Finally, a quirk of the CCVI approach is that some vulnerable species could increase in the assessment area (Table 2), and some stable species may leave the assessment area (Table 3). Considering the scores themselves, there are no vulnerable game birds and only three vulnerable game mammals (moose, American marten, and snowshoe hare). However, **the CCVI tool has an additional note on three other game species: fisher (*Martes pennati*), ermine (*Mustela erminea*), and ruffed grouse. The note states that although these species are scored as Stable, they "may shift and perhaps leave the assessment area."** Presumably, the species are adaptable, but populations may not persist in Michigan.

Comparing Taxa

In the CCVI tool, the same factors are considered in the same way across taxonomic groups. This allows managers to compare the relative vulnerabilities of birds to fish to plants. **In Michigan, amphibians, mollusks, fish, and insects are the most vulnerable groups; mammals are among the least vulnerable (Figure 3).** Penskar (2013) has conducted a similar analysis for plants in Michigan, but those results are not included in this report.

Vulnerability of migratory birds is not captured well by the CCVI. This analysis only shows vulnerability for Michigan, but many migratory species spend most their life cycle outside Michigan. This assessment for migratory species is at best overly optimistic, and at worst misleading. These results apply to Michigan and vulnerability to climate change while in Michigan. Migratory birds and bats should be considered over their entire life cycle, which may require a revision of this tool or the creation of an entirely new tool.

Migratory birds and bats aside, some patterns are evident when comparing taxa. **Taxa associated with water were more vulnerable** than fully terrestrial species or species associated with sand and other xeric landscapes. Also, **ectotherms (cold-blooded species) were more vulnerable** than endotherms (warm-blooded species.)

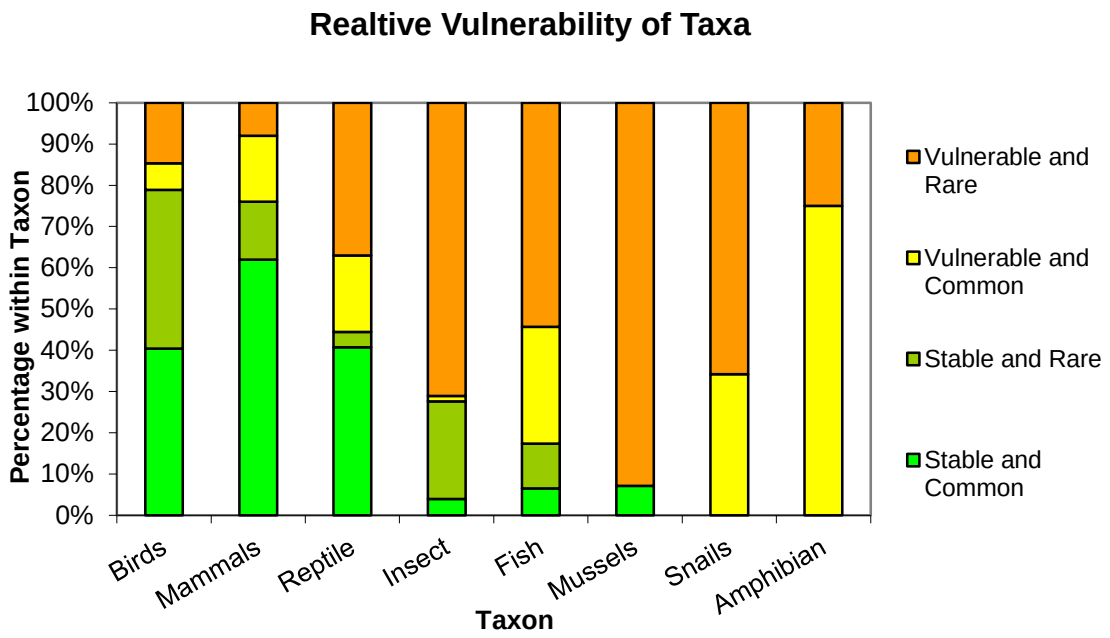

Figure 3. The relative climate vulnerability of 400 game and SCGN in Michigan, organized by taxa groups, using NatureServe CCVI.

The Many Uses of a Vulnerability Assessment

Vulnerability assessments are useful in a variety of contexts. They provide a common language for discussions of species vulnerability across multiple states. If a SGCN in one state (for example, Franklin's ground squirrel, *Poliocitellus franklinii*, in Illinois) is predicted to potentially leave that state, states or provinces to the north should be aware.

The CCVI scores and other factors could be useful in prioritizing scarce conservation staff and money. Between 15% and 37% of all species globally may be in danger of extinction because of climate change (Thomas et al. 2004). Without significant increases in conservation funding, agencies may have to decide which suites of recovery programs are likely to minimize the number of extinctions. Implicit in that decision is determining which species are too rare and too vulnerable to conserve in their current range in Michigan. Similarly, the data in the tool on vulnerability, geographic range position, dispersal ability, and conservation status are all potential inputs when assessing the wisdom or need to translocate species over natural or anthropogenic barriers.

CCVI vulnerability is a measure of the likelihood that climate change will cause a decrease in range or abundance of a species. It can be used when revising lists of SGCN for State Wildlife Action Plans, when amending state or federal lists of threatened or endangered species, or whenever conservation groups need to create a list of priority conservation species for a forest, park, sanctuary or easement.

Similarly, **CCVI scores can help managers prioritize which game management plans or species recovery plans need revision to include information on climate threats.** Given the significant amount of time and energy needed to revise species plans, it is

important to start with those most vulnerable to projected climate change. That does not mean that most resources should go to managing the most climate vulnerable species. The plan may be revised to put fewer resources toward very vulnerable species, especially if available staff and funding are no longer expected to be sufficient to meet long-term conservation goals. However, the plans for the most vulnerable are those plans that need to be reviewed and revised most urgently.

Finally, the CCVI scores can be useful in raising awareness of the impacts of climate change in Michigan. The prediction of a several degree temperature increase by 2100 is academic to most people. Impacts by 2050 are more immediate. The loss of opportunity to hunt grouse, fish through ice, or hear loons while "up north" makes the impact more tangible to those who most value fish, wildlife, and natural places.

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Appendix A. NatureServe Climate Change Vulnerability Index (CCVI) scores for Michigan game species and Species of Greatest Conservation Need (SGCN). G rank and S rank are conservation status derived from rarity, population trends, and threats other than climate change at the global and state scale, respectively. Ranks range from five (secure) to one (critically imperiled.) In this Appendix, species are sorted by taxa and scientific names.

Mammals

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Alces americanus	Moose	HV	Very High	5	4
Canis latrans	Coyote	IL	Very High	5	5
Canis lupus	Gray Wolf	PS[b]	Very High	4	3
Castor canadensis	American Beaver	PS	Very High	5	5
Cervus elaphus	Elk	PS	Very High	5	3
Cryptotis parva	Least shrew	PS[a]	Very High	5	1
Didelphis virginiana	Virginia Opossum	IL[a]	Very High	5	5
Glaucomys sabrinus	Northern flying squirrel	MV[b]	Very High	5	5
Glaucomys volans	Southern flying squirrel	PS[a]	Very High	5	5
Lasionycteris noctivagans	Silver-haired bat	PS	Very High	5	4
Lasiurus borealis	Red bat	PS	Very High	5	5
Lasiurus cinereus	Hoary bat	PS	Very High	5	3
Lepus americanus	Snowshoe hare	HV	Very High	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Mammals… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Lontra canadensis	Northern River Otter	PS	Very High	5	4
Lynx canadensis	Lynx	HV[b]	Very High	5	1
Lynx rufus	Bobcat	IL	Very High	5	4
Marmota monax	Woodchuck	IL	Very High	5	5
Martes americana	American marten	MV	Low	5	3
Martes pennanti	Fisher	PS[b]	Very High	5	4
Mephitis mephitis	Striped Skunk	IL	Very High	5	5
Microtus orchrogaster	Prairie vole	PS[a]	Very High	5	1
Microtus pinetorum	Woodland vole	PS[a]	Very High	5	3
Mustela erminea	Ermine / Short-tailed Weasel	PS[b]	Very High	5	5
Mustela frenata	Long-tailed Weasel	PS[a]	Very High	5	5
Mustela nivalis	Least Weasel	PS	Very High	5	5
Myodes gapperi	Southern red-backed vole	MV[b]	Very High	5	5
Myotis septentrionalis	Northern bat or Northern myotis	PS	Very High	4	NR
Myotis sodalis	Indiana bat	MV[a]	Moderate	2	1
Napaeozapus insignis	Woodland jumping mouse	MV[b]	High	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Mammals… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Neotamias minimus	Least chipmunk	MV[b]	Very High	5	5
Neovison vison	American Mink	PS	Very High	5	5
Nycticeius humeralis	Evening bat	MV[a]	Very High	5	NA
Odocoileus virginianus	White-tailed deer	PS	Very High	5	5
Ondatra zibethicus	Muskrat	PS	Very High	5	5
Perimyotis subflavus	Eastern pipistrelle or Tri-colored bat	PS[a]	Very High	5	2
Peromyscus maniculatus	Deer mouse	PS	Very High	5	5
Procyon lotor	Raccoon	IL	Very High	5	5
Puma concolor	Cougar	IL	Very High	5	H
Sciurus carolinensis	Eastern Gray Squirrel	PS[a]	Very High	5	5
Sciurus niger	Eastern Fox Squirrel	PS[a]	Very High	5	5
Sorex arcticus	Arctic shrew	PS	Moderate	5	5
Sorex fumeus	Smoky shrew	HV	Very High	5	1
Sorex hoyi	American pygmy shrew	MV	Low	5	5
Sorex palustris	Water shrew	MV	Very High	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Mammals… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Spermophilus tridecemlineatus	Thirteen-lined Ground Squirrel	PS[a]	Very High	5	5
Sylvilagus floridanus	Eastern Cottontail	PS	Very High	5	5
Synaptomys cooperi	Southern bog lemming	PS	Very High	5	5
Tamias striatus	Eastern chipmunk	PS[a]	Very High	5	5
Tamiasciurus hudsonicus	Red Squirrel	PS	Very High	5	5
Taxidea taxus	American Badger	PS[a]	Very High	5	4
Urocyon cinereoargenteus	Gray Fox	PS[a]	Very High	5	4
Ursus americanus	Black bear	PS	Very High	5	5
Vulpes vulpes	Red Fox	IL	Very High	5	5

Birds

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Accipiter cooperii	Cooper's Hawk	PS[a]	Very High	5	3
Accipiter gentilis	Northern Goshawk	PS[b]	Very High	5	3
Actitis macularia	Spotted Sandpiper	MV	Moderate	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Birds… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Aix sponsa	Wood Duck	PS	Moderate	5	5
Ammodramus henslowii	Henslow's sparrow	PS[a]	Very High	4	2
Ammodramus leconteii	Le Conte's Sparrow	IL[b]	High	4	1
Ammodramus savannarum	Grasshopper Sparrow	PS[a]	Moderate	5	3
Anas acuta	Northern Pintail	PS	High	5	NRN
Anas americana	American Widgeon	PS	Very High	5	1
Anas clypeata	Northern Shoveler	PS	Very High	5	NRN
Anas crecca	Green-winged Teal	PS	Very High	5	3
Anas discors	Blue-winged Teal	PS	Very High	5	5
Anas platyrhynchos	Mallard	PS	Very High	5	5
Anas rubripes	American Black Duck	PS	Very High	5	3
Anas strepera	Gadwall	PS	Very High	5	NRN
Ardea herodias	Great Blue Heron	PS	Moderate	5	5
Asio flammeus	Short-eared Owl	PS	Moderate	5	1
Asio otus	Long-eared Owl	PS	High	5	2
Aythya affinis	Lesser Scaup	MV	Moderate	5	NRN

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
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Appendix A. Birds… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Aythya americana	Redhead	MV	Very High	5	3
Aythya collaris	Ring-necked Duck	MV	Low	5	4
Aythya marila	Greater Scaup	MV	Moderate	5	NRN
Aythya valisineria	Canvasback	MV	Very High	5	NRN
Bartramia longicauda	Upland Sandpiper	IL[a]	Very High	5	4
Bonasa umbellus	Ruffed Grouse	PS[b]	Very High	5	5
Botaurus lentiginosus	American Bittern	MV	Very High	4	3
Branta canadensis	Canada Goose	MV	Very High	5	5
Branta hutchinsii	Cackling Goose	PS	Very High	5	U
Bucephala clangula	Common Goldeneye	PS	Very High	5	3
Buteo lineatus	Red-shouldered Hawk	PS[a]	Very High	5	3
Butorides virescens	Green Heron	PS[a]	Low	5	5
Caprimulgus vociferus	Whip-poor-will	IL[a]	Low	5	5
Cardellina canadensis	Canada Warbler	MV[b]	Moderate	5	5
Charadrius melodus	Piping Plover	MV	Moderate	3	1
Charadrius vociferus	Killdeer	IL	Moderate	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Birds… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Chilodonias niger	Black tern	MV[b]	Very High	4	3
Chordeiles minor	Common Nighthawk	IL	Moderate	5	5
Circus cyaneus	Northern Harrier	MV	Moderate	5	3
Cistothorus palustris	Marsh Wren	PS	Very High	5	3
Cistothorus platensis	Sedge Wren	PS	Low	5	4
Coccothraustes vespertinus	Evening Grosbeak	IL	Very High	5	5
Coccyzus americanus	Yellow-billed Cuckoo	IL[a]	Very High	5	5
Coccyzus erythropthalmus	Black-billed Cuckoo	IL	Low	5	5
Colaptes auratus	Northern Flicker	IL[b]	Very High	5	5
Colinus virginianus	Northern Bobwhite	IL[a]	Very High	5	4
Contopus cooperi	Olive-sided Flycatcher	IL[b]	Very High	5	4
Corvus brachyrhynchos	American Crow	IL	Very High	5	5
Coturnicops noveboracensis	Yellow rail	MV[b]	Moderate	4	1
Cygnus buccinator	Trumpeter Swan	MV[b]	High	4	3
Dolichonyx oryzivorus	Bobolink	IL	Very High	5	5
Dryocopus pileatus	Pileated woodpecker	PS	Moderate	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Birds… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Empidonax minimus	Least Flycatcher	MV	Moderate	5	5
Empidonax virescens	Acadian Flycatcher	IL[a]	Low	5	3
Falcipennes canadensis	Spruce grouse	MV	Very High	5	2
Falco columbarius	Merlin	PS[b]	Very High	5	1
Falco peregrinus	Peregrine Falcon	MV[a]	Very High	4	1
Fulica americana	American Coot	PS	Very High	5	3
Gallinula galeata [G. chloropus]	Common Gallinule [Common Moorhen]	PS[a]	Very High	5	3
Gavia immer	Common Loon	HV[b]	Very High	5	3
Grus canadensis	Sandhill crane	PS	Very High	5	4
Haliaeetus leucocephalis	Bald Eagle	IL	Moderate	5	4
Helmitheros vermivorus	Worm-eating Warbler	PS[a]	Very High	5	NA
Hylocichla mustelina	Wood Thrush	IL	Low	5	4
Icteria virens	Yellow-breasted Chat	IL[a]	Very High	5	3
Ixobrychus exilis	Least Bittern	MV[a]	Very High	5	2
Lanius ludovicianus migrans	Migrant Loggerhead Shrike	PS[a]	Very High	5	1
Lophodytes cucullatus	Hooded Merganser	PS	Very High	5	3

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Birds… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Loxia curvirostra	Red Crossbill	PS	Very High	5	3
Loxia leucoptera	White-winged Crossbill	PS	Very High	5	2
Melanerpes erythrocephalus	Red-headed Woodpecker	IL[a]	Very High	5	5
Meleagris gallopavo	Wild Turkey	IL[a]	Moderate	5	5
Mergus merganser	Common Merganser	PS	Very High	5	3
Mimus polyglottos	Northern Mockingbird	IL[a]	High	5	4
Nycticorax nycticorax	Black-crowned Night-heron	IL[a]	Moderate	5	2
Oporornis agilis	Connecticut Warbler	PS[b]	Moderate	4	2
Oxyura jamaicensis	Ruddy Duck	PS	Low	5	NRN
Pandion haliaetus	Osprey	PS[b]	Low	5	4
Parkesia motacilla	Louisiana Waterthrush	PS[a]	Very High	5	2
Passerculus sandwichensis	Savannah Sparrow	IL	Low	5	5
Perisoreus canadensis	Gray Jay	PS[b]	Low	5	4
Phalaropus tricolor	Wilson's Phalarope	PS	Very High	5	2
Phasianus colchicus	Ring-necked Pheasant	PS[a]	Low	5	SNA
Picoides arcticus	Black-backed Woodpecker	IL[b]	Very High	5	2

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Birds… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Pipilo erythrophthalmus	Eastern Towhee	IL[a]	Moderate	5	5
Podilymbus podiceps	Pied-billed Grebe	PS[a]	Very High	5	4
Poecile hudsonica	Boreal Chickadee	PS[b]	Very High	5	3
Pooecetes gramineus	Vesper Sparrow	IL	High	5	5
Porzana carolina	Sora	MV	Moderate	5	4
Progne subis	Purple Martin	PS[a]	Very High	5	5
Protonotaria citrea	Prothonotary Warbler	IL[a]	Low	5	3
Rallus elegans	King Rail	PS[a]	Very High	4	1
Rallus limicola	Virginia Rail	PS	Moderate	5	3
Regulus calendula	Ruby-crowned Kinglet	PS[b]	Very High	5	4
Scolopax minor	American Woodcock	IL	Low	5	5
Setophaga americana	Northern Parula	PS	Very High	4	2
Setophaga caerulescens	Black-throated Blue Warbler	IL[b]	Very High	5	3
Setophaga cerulea	Cerulean Warbler	MV[a]	Very High	4	3
Setophaga citrina	Hooded Warbler	PS[a]	Very High	5	3
Setophaga discolor	Prairie Warbler	IL[a]	Very High	5	1

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Birds… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Setophaga dominica	Yellow-throated Warbler	IL[a]	Moderate	5	1
Setophaga fusca	Blackburnian Warbler	MV[b]	Moderate	5	5
Setophaga kirtlandii	Kirtland's Warbler	PS[b]	Very High	1	1
Setophaga palmarum	Palm Warbler	PS[b]	Very High	5	1
Sialia sialis	Eastern bluebird	PS[a]	Very High	5	5
Spiza americana	Dickcissel	IL[a]	Very High	5	3
Spizella pusilla	Field Sparrow	IL[a]	Moderate	5	5
Sterna forsteri	Forster's Tern	MV	Very High	5	2
Sternia caspia	Caspian Tern	MV	Moderate	5	2
Sternia hirundo	Common Tern	MV[b]	Moderate	5	2
Sturnella magna	Eastern Meadowlark	PS[a]	Very High	5	5
Sturnella neglecta	Western Meadowlark	PS	Very High	5	4
Toxostoma rufum	Brown Thrasher	IL	Very High	5	4
Tympanuchus phasianellus	Sharp-tailed grouse	PS[b]	Moderate	4	3
Tyrannus tyrannus	Eastern Kingbird	IL	Very High	5	4
Tyto alba	Barn Owl	PS[a]	Very High	5	1

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Birds… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Vermivora chrysoptera	Golden-winged Warbler	IL[a]	Low	4	5
Vermivora pinus	Blue-winged Warbler	IL[a]	Very High	5	5
Vireo griseus	White-eyed Vireo	IL[a]	Very High	5	4
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	MV	Very High	5	2

Reptiles

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Apidoscelis sexlineatus	Six-lined racerunner	HV	Very High	5	U
Chelydra serpentina serpentina	Snapping Turtle	PS	Very High	5	5
Chrysemys picta	Painted Turtle	PS	High	5	5
Clemmys guttata	Spotted Turtle	HV[a]	Low	5	2
Clonophis kirtlandi	Kirtland's Snake	HV[a]	Low	2	1
Coluber constrictor foxi	Blue racer	PS	Very High	5	5
Diadophis punctatus edwardsii	Northern Ring-necked Snake	HV	Very High	5	5
Elaphe vulpina vulpina	Western fox snake	PS	Very High	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Reptiles… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Emydoidea blandingii	Blanding's Turtle	HV[a]	Very High	4	3
Eumeces fasciatus	Five-lined skink	MV	Low	5	3
Glyptemys insculpta	Wood Turtle	MV[a]	Moderate	3	2
Graptemys geographica	Common map turtle	PS[a]	Very High	5	5
Heterodon platirhinos	Eastern Hognose Snake	MV	Moderate	5	3
Lampropeltis triangulum	Eastern milk snake	PS	Very High	5	5
Liochlorophis vernalis	Smooth green snake	PS	Low	5	5
Nerodia erythrogaster neglecta	Copperbelly water snake	EV[a]	Very High	5	1
Nerodia sipedon sipedon	Northern water snake	PS[a]	Very High	5	5
Pantherophis gloydi	Eastern Fox Snake	MV	Low	3	2
Pantherophis spiloides	Gray Ratsnake/ Central Ratsnake	PS[a]	Moderate	5	3
Regina septemvittata	Queen Snake	EV	Moderate	5	4
Sistrurus catenatus catenatus	Eastern Massasauga	HV	High	3	3
Sternotherus odoratus	Common musk turtle	MV	Low	5	5
Storeria dekayi	Brown snake	PS	Moderate	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Reptiles… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Storeria occipitomaculata occipitomaculata	Northern red-bellied snake	PS	Very High	5	5
Terrapene carolina carolina	Eastern Box Turtle	HV[a]	Moderate	5	2
Thamnophis butleri	Butler's garter snake	MV	Low	4	4
Thamnophis sauritus septentrionalis	Northern ribbon snake	MV	Low	5	5
Thamnophis sirtalis sirtalis	Eastern garter snake	PS	Very High	4	4

Amphibians

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Acris crepitans blanchardi/ Acris blanchardi	Blanchard's Cricket Frog	HV[a]	Low	5	2
Ambystoma opacum	Marbled salamander	HV[a]	Low	5	1
Amybstoma laterale	Blue-spotted Salamander	EV	Very High	5	5
Amybstoma maculatum	Spotted Salamander	HV	Low	5	5
Amybstoma texanum	Smallmouth Salamander	EV[a]	Moderate	5	1
Anaxyrus fowleri/ Bufo fowleri	Fowler's Toad	MV	Moderate	5	5
Bufo americanus americanus	Eastern American toad	MV	Low	5	NR

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Amphibians… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Hemidactylium scutatum	Four-toed Salamander	EV	High	5	5
Hyla chrysoscelis	Cope's gray treefrog	MV	Moderate	5	5
Hyla versicolor	Eastern gray treefrog	MV	Low	5	5
Lithobates pipiens	Northern Leopard Frog	HV	Very High	5	5
Lithobates sylvaticus	Wood Frog	HV	Moderate	5	5
Necturus maculosus	Mudpuppy	MV[a]	Moderate	5	5
Notophthalmus viridescens louisianensis	Central newt	HV	Very High	5	5
Notophthalmus viridescens viridescens	Red-spotted newt	HV	Low	5	5
Plethodon cinereus	Redback Salamander	HV	Very High	5	5
Pseudacris crucifer crucifer	Northern spring peeper	MV	Low	5	5
Pseudacris maculata	Boreal Chorus Frog	EV	Very High	5	1
Pseudacris triseriata triseriata	Western chorus frog	MV	Low	5	5
Rana palustris	Pickerel frog	MV	Moderate	5	5
Rana septentrionalis	Mink frog	EV	Moderate	5	3
Siren intermedia nettingi	Western lesser siren	EV	Moderate	5	H

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Fish… continued

Fish

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Acipenser fulvescens	Lake sturgeon	HV[a]	Moderate	3	2
Ameiurus nebulosus	Brown bullhead	IL	Moderate	5	4
Ammocrypta pellucida	Eastern sand darter	HV[a]	Moderate	3	1
Aphredoderus sayanus	Pirate perch	PS[a]	High	5	4
Clinostomus elongatus	Redside dace	EV	High	3	1
Coregonus artedi	Lake herring	MV	Low	5	3
Coregonus bartlettii	Siskiwit lake cisco	EV	Very High	3	H
Coregonus hubbsi	Ives lake cisco	EV	Low	1	1
Coregonus kiyi	Kiyi	EV	Moderate	3	3
Coregonus zenithicus	Shortjaw cisco	EV	Low	3	2
Cottus cognatus	Slimy sculpin	HV	Very High	5	5
Cottus ricei	Spoonhead sculpin	HV	Moderate	5	3
Erimyzon claviformis	Western creek chubsucker	HV[a]	Moderate	5	1
Erimyzon sucetta	Lake chubsucker	MV[a]	Low	5	4
Esox americanus	Grass pickerel (redfin pickerel)	MV	Low	5	5
Etheostoma flabellare	Fantail darter	HV	Moderate	5	4

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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Appendix A. Fish… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Etheostoma microperca	Least darter	MV	Moderate	5	5
Etheostoma spectabile	Orangethroat darter	HV	Moderate	5	3
Etheostoma zonale	Banded darter	MV	Moderate	5	1
Fundulus dispar	Starhead topminnow	PS	Very High	4	2
Hiodon tergisus	Mooneye	MV[a]	Low	5	2
Hybognathus hankinsoni	Brassy minnow	EV	High	5	2
Hypopthalmichthys nobilis	Big head carp	PS[a]	Very High	5	
Ictiobus niger	Black buffalo	PS[a]	Very High	5	3
Lepisosteus oculatus	Spotted gar	HV[a]	Moderate	5	2
Luxilus chrysocephalus	Striped shiner	MV	Moderate	5	5
Macrhybopsis storeriana	Silver chub	EV	Moderate	5	2
Minytrema melanops	Spotted sucker	PS[a]	High	5	3
Moxostoma carinatum	River redhorse	PS[a]	Very High	4	1
Moxostoma duquesnei	Black redhorse	MV[a]	Low	5	3
Moxostoma erythrurum	Golden redhorse	MV[a]	Moderate	5	4
Myoxocephalus thompsonii	Deepwater sculpin	HV	Low	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Fish… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Nocomis micropogon	River chub	MV	Moderate	5	4
Notropis anogenus	Pugnose shiner	HV	Moderate	3	3
Notropis dorsalis	Bigmouth shiner	MV	Moderate	5	4
Notropis photogenis	Silver shiner	HV[a]	Low	5	1
Noturus flavus	Stonecat	MV[a]	Moderate	5	4
Noturus gyrinus	Tadpole madtom	PS[a]	Low	5	5
Noturus miurus	Brindled madtom	MV[a]	Moderate	5	2
Noturus stigmosus	Northern madtom	EV[a]	Moderate	3	1
Opsopoeodus emiliae	Pugnose minnow	HV[a]	Moderate	5	1
Percina copelandi	Channel darter	HV	Moderate	4	1
Percina shumardi	River darter	HV	Moderate	5	1
Phoxinus erythrogaster	Southern redbelly dace	MV	Low	5	1
Phoxinus neogaeus	Finescale dace	EV	Moderate	5	5
Prosopium coulterii	Pygmy whitefish	EV	Low	5	4
Sander canadensis	Sauger	HV	Low	5	1

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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Appendix A. Mussels… continued

Mussels

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Alasmidonta marginata	Elktoe	HV[a]	Low	4	2
Alasmidonta viridis	Slippershell	EV[a]	Very High	4	2
Anodontoides ferussacianus	Cylindrical papershell	PS	Moderate	5	4
Cyclonaias tuberculata	Purple wartyback	MV	Low	5	2
Dreissena polymorpha	Zebra mussel	PS	Very High	5	SNA
Epioblasma torulosa rangiana	Northern riffleshell	EV[a]	High	2	1
Epioblasma triquetra	Snuffbox	HV[a]	Low	3	1
Lampsilis fasciola	Wavy-rayed lampmussel	HV[a]	Low	5	2
Lasmigona compressa	Creek heelsplitter	HV	Moderate	5	SNR
Ligumia nasuta	Eastern pondmussel	MV	Low	4	NSR
Obliquaria reflexa	Threehorn wartyback	EV	High	5	NSR
Obovaria olivaria	Hickorynut	HV[a]	Low	4	2
Pleurobema clava	Northern clubshell	EV[a]	Very High	1	1
Pleurobema coccineum	Round pigtoe	HV[a]	Low	4	2

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Mussels… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Simpsonaias ambigua	Salamander mussel	EV	High	3	1
Toxolasma lividus	Purple lilliput	EV[a]	Moderate	2	1
Venustaconcha ellipsiformis	Ellipse	EV[a]	Moderate	3	2
Villosa fabalis	Rayed bean	HV[a]	Low	2	1

Snails

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Acella haldimani	Spindle lymnaea	EV	Moderate	3	3
Anguispira kochi	Banded globe	EV	Moderate	NR	U
Appalachina sayana	Spike-lip crater	HV	Low	4	U
Catinella exile	Pleistocene catinella	EV	Moderate	2	2
Discus patulus	Domed disc	EV	Moderate	5	U
Euconulus alderi	a land snail	EV	Moderate	4	2
Fontigens nickliniana	Watercress snail	EV	Very High	5	SU
Gastrocopta holzingeri	Lambda snaggletooth	EV	Very High	5	1
Guppya sterkii	Sterki's granule	HV	Low	5	1

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Snails… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Helisoma anceps	Two-ridge rams-horn	MV	Moderate	5	SU
Hendersonia occulta	Cherrystone drop	EV	Low	4	1
Mesodon elevatus	Proud globe	HV	Moderate	5	SU
Mesomphix cupreus	Copper button	HV	Moderate	5	U
Philomycus carolinianus	Carolina mantleslug	PS	Moderate	5	U
Planogyra asteriscus	Eastern flat-whorl	EV	Low	4	3
Planorbella smithi	aquatic snail	HV	Low	5	2
Pomatiopsis cincinnatiensis	Brown walker	HV	Low	4	SU
Potamopyrgus antipodarum	New Zealand mudsnail	MV	Low	5	SU
Pupilla muscorum	Widespread column	MV	Low	5	U
Pyrgulopsis letsoni	Gravel pyrg	HV	Low	5	U
Stagnicola contracta	Deepwater pondsnail	HV	Very High	1	1
Vallonia gracilicosta albula	terrestrial snail	HV	Moderate	4	1
Vertigo bollesiana	Delicate vertigo	HV	Moderate	4	2
Vertigo cristata	Crested vertigo	EV	High	5	3
Vertigo elatior	Tapered vertigo	HV	Moderate	5	3

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Snails… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Vertigo hubrichti	Hubricht's vertigo	EV	Moderate	3	2
Vertigo modesta parietalis	a land snail	EV	High	5	1
Vertigo morsei	Six-whorl vertigo	EV	Low	3	2
Vertigo nylanderi	Deep-throat vertigo	EV	Moderate	3	1
Vertigo paradoxa	Mystery vertigo	HV	Low	4	3
Vertigo pygmaea	Crested vertigo	MV	Low	5	U

Insects

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Acronicta falcula	Corylus dagger moth	MV	Low	U	2
Aeshna canadensis	Canada darner	IL[b]	Very High	5	NR
Appalachia arcana	Secretive locust	MV	Very High	2	2
Atrytonopsis hianna	Dusted skipper	MV	Low	4	2
Basilodes pepita	Gold moth	HV[a]	Low	4	1
Battus philenor	Pipevine swallowtail	PS[a]	Low	5	1

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
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Appendix A. Insects… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Boloria freija	Freija fritillary	HV	Low	5	3
Boloria frigga	Frigga fritillary	HV	Low	5	3
Bombus affinis	Rusty-patched bumble bee	PS[a]	Very High	U	NR
Bombus terricola	Yellow banded bumble bee	PS[b]	Very High	U	NR
Brachionycha borealis	Boreal fan moth	PS	High	4	1
Brychius hungerfordi	Hungerford's crawling water beetle	HV	Very High	1	1
Calephelis mutica	Swamp metalmark	HV[a]	Moderate	3	1
Callophrys henrici	Henry's elfin	PS	Moderate	5	2
Callophrys irus	Frosted elfin	HV	Moderate	3	2
Catocala amestris	Three-staff underwing	EV	Very High	4	1
Catocala dulciola	Quiet underwing	MV[a]	Moderate	3	1
Catocala illecta	Magdalen underwing	MV[a]	Moderate	5	2
Catocala robinsonii	Robinson's underwing	PS[a]	Very High	4	2
Chlosyne gorgone carlota	Gorgone checkerspot	HV	High	5	2
Cicindela lepida	Little white tiger beetle	HV[a]	Moderate	4	4
Cicindela limbalis	a tiger beetle	PS[a]	Very High	5	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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Appendix A. Insects… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Cicindela macra	a tiger beetle	PS[a]	High	5	5
Cordulegaster erronea	Tiger spiketail	PS[a]	Very High	4	1
Dorydiella kansana	Leafhopper	HV	Very High	NR	1
Eacles imperialis pini	Pine imperial moth	MV[b]	Low	5	2
Erebia discoidalis	Red-disked alpine	MV[b]	Low	5	2
Erora laeta	Early hairstreak	MV	Low	U	2
Erynnis baptisiae	Wild indigo duskywing	PS[a]	Low	5	2
Erynnis persius persius	Persius duskywing	MV[a]	Moderate	5	3
Euchloe ausonides	Large marble	EV	Very High	5	1
Euxoa aurulenta	Dune cutworm	PS	Very High	5	1
Fixsenia favonius ontario	Northern hairstreak	MV[a]	Low	4	1
Flexamia delongi	Leafhopper	PS	Very High	NR	1
Flexamia huroni	Huron River leafhopper	EV	Very High	NR	1
Flexamia reflexus	Leafhopper	PS	Very High	NR	1
Gomphus lineatifrons	Splendid clubtail	PS[a]	Very High	4	2
Gomphus quadricolor	Rapids clubtail	PS[a]	Very High	3	2

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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Appendix A. Insects… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Hemileuca maia	Barrens buckmoth	MV[a]	Moderate	5	2
Hesperia ottoe	Ottoe skipper	MV	Moderate	3	1
Heterocampa subrotata	Small heterocampa	MV	Very High	4	1
Heteropacha rileyana	Riley's lappet moth	HV	Moderate	4	1
Lepyronia angulifera	Angular spittlebug	EV	Very High	3	1
Lepyronia gibbosa	Great plains spittlebug	HV	Moderate	3	1
Liodessus cantralli	Cantrall's bog beetle	MV	Low	NR	1
Lycaeides idas nabokovi	Northern blue	HV	Very High	5	2
Lycaeides melissa samuelis	Karner blue	HV	Very High	5	2
Merolonche dolli	Doll's merolonche	MV[a]	Moderate	3	1
Meropleon ambifusca	Newman's brocade	HV[a]	Moderate	3	1
Neonympha mitchellii mitchellii	Mitchell's satyr	EV[a]	Very High	2	1
Oarisma poweshiek	Poweshiek skipperling	EV	Very High	2	1
Oecanthus laricis	Tamarack tree cricket	EV[a]	High	1	1
Oecanthus pini	Pine tree cricket	MV[a]	Low	NR	1
Oeneis macounii	Macoun's arctic	EV	Moderate	2	1

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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Appendix A. Insects… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Oncocnemis piffardi	Three-striped oncocnemis	HV	Moderate	4	1
Ophiogomphus anomalus	Extra-striped snaketail	PS[b]	Very High	4	1
Ophiogomphus howei	Pygmy snaketail	PS[a]	Very High	3	1
Pachypolia atricornis	Three-horned moth	MV[a]	Low	3	1
Papaipema aweme	Aweme borer	MV[b]	Moderate	1	H
Papaipema cerina	Golden borer	MV[a]	Moderate	4	2
Papaipema speciosissima	Regal fern borer	HV[a]	Low	4	2
Phyciodes batesii	Tawny crescent	PS	Low	4	4
Polygonia gracilis	Hoary comma	HV[b]	Low	5	3
Prosapia ignipectus	Red-legged Spittlebug	EV[a]	Moderate	1	1
Proserpinus flavofasciata	Yellow-banded day-sphinx	HV[b]	Moderate	5	3
Pygarctia spraguei	Sprague's pygarctia	MV[a]	Low	5	2
Schinia indiana	Phlox moth	EV[b]	Very High	2	1
Schinia lucens	Leadplant flower moth	HV	Very High	4	1
Scudderia fasciata	Pine katydid	HV[a]	Low	NR	1
Somatochlora hineana	Hine's Emerald Dragonfly	EV[a]	Very High	2	1

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix A. Insects… continued

Species	English Name	Climate Vulnerability	Confidence	G Rank	S Rank
Somatochlora incurvata	Incurvate emerald	MV	Very High	4	1
Spartiniphaga inops	Spartina borer moth	HV[a]	Very High	3	1
Speyeria idalia	Regal fritillary	EV[a]	High	3	H
Stenelmis douglasensis	Douglas stenelmis riffle beetle	EV	Low	1	1
Stylurus amnicola	Riverine snaketail	PS	Very High	4	1
Stylurus laurae	Laura's snaketail	PS[a]	Very High	4	1
Stylurus notatus	Elusive snaketail	PS[a]	Very High	3	1
Stylurus plagiatus	Russet-tipped clubtail	PS[a]	Very High	5	1
Tachopteryx thoreyi	Grey petaltail	PS[a]	Moderate	4	1
Trimerotropis huroniana	Lake Huron locust	MV	Very High	2	2
Williamsonia fletcheri	Ebony Boghaunter	MV[b]	Low	4	1

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
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Appendix B. Climate-vulnerable (EV, HV, and MV) rare (S1, S2, and S3) species. NatureServe Climate Change Vulnerability Index (CCVI) scores for Michigan game species and Species of Greatest Conservation Need (SGCN). S rank is conservation status derived from rarity, population trends, and threats other than climate change at the state scale. Ranks range from five (secure) to one (critically imperiled.) Relative vulnerability is a combination of rarity, other conservation threats and climate vulnerability. Species with the same rank order are tied (same S-rank and same CCVI).

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Amybstoma texanum	Smallmouth Salamander	1	EV[a]	1
Catocala amestris	Three-staff underwing	1	EV	1
Clinostomus elongatus	Redside dace	1	EV	1
Coregonus hubbsi	Ives lake cisco	1	EV	1
Epioblasma torulosa rangiana	Northern riffleshell	1	EV[a]	1
Euchloe ausonides	Large marble	1	EV	1
Flexamia huroni	Huron River leafhopper	1	EV	1
Gastrocopta holzingeri	Lambda snaggletooth	1	EV	1
Hendersonia occulta	Cherrystone drop	1	EV	1
Lepyronia angulifera	Angular spittlebug	1	EV	1
Neonympha mitchellii mitchellii	Mitchell's satyr	1	EV[a]	1
Nerodia erythrogaster neglecta	Copperbelly water snake	1	EV[a]	1
Noturus stigmosus	Northern madtom	1	EV[a]	1
Oarisma poweshiek	Poweshiek skipperling	1	EV	1

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix B. Climate vulnerable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Oecanthus laricis	Tamarack tree cricket	1	EV[a]	1
Oeneis macounii	Macoun's arctic	1	EV	1
Pleurobema clava	Northern clubshell	1	EV[a]	1
Prosapia ignipectus	Red-legged Spittlebug	1	EV[a]	1
Pseudacris maculata	Boreal Chorus Frog	1	EV	1
Schinia indiana	Phlox moth	1	EV[b]	1
Simpsonaias ambigua	Salamander mussel	1	EV	1
Somatochlora hineana	Hine's Emerald Dragonfly	1	EV[a]	1
Stenelmis douglasensis	Douglas stenelmis riffle beetle	1	EV	1
Toxolasma lividus	Purple lilliput	1	EV[a]	1
Vertigo modesta parietalis	a land snail	1	EV	1
Vertigo nylanderi	Deep-throat vertigo	1	EV	1
Alasmidonta viridis	Slippershell	2	EV[a]	2
Catinella exile	Pleistocene catinella	2	EV	2
Coregonus zenithicus	Shortjaw cisco	2	EV	2
Euconulus alderi	a land snail	2	EV	2
Hybognathus hankinsoni	Brassy minnow	2	EV	2

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix B. Climate vulnerable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Macrhybopsis storeriana	Silver chub	2	EV	2
Venustaconcha ellipsiformis	Ellipse	2	EV[a]	2
Vertigo hubrichti	Hubricht's vertigo	2	EV	2
Vertigo morsei	Six-whorl vertigo	2	EV	2
Acella haldimani	Spindle lymnaea	3	EV	3
Coregonus kiyi	Kiyi	3	EV	3
Planogyra asteriscus	Eastern flat-whorl	3	EV	3
Rana septentrionalis	Mink frog	3	EV	3
Vertigo cristata	Crested vertigo	3	EV	3
Ambystoma opacum	Marbled salamander	1	HV[a]	4
Ammocrypta pellucida	Eastern sand darter	1	HV[a]	4
Basilodes pepita	Gold moth	1	HV[a]	4
Brychius hungerfordi	Hungerford's crawling water beetle	1	HV	4
Calephelis mutica	Swamp metalmark	1	HV[a]	4
Clonophis kirtlandi	Kirtland's Snake	1	HV[a]	4
Dorydiella kansana	Leafhopper	1	HV	4
Epioblasma triquetra	Snuffbox	1	HV[a]	4

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

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[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix B. Climate vulnerable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Erimyzon claviformis	Western creek chubsucker	1	HV[a]	4
Guppya sterkii	Sterki's granule	1	HV	4
Heteropacha rileyana	Riley's lappet moth	1	HV	4
Lepyronia gibbosa	Great plains spittlebug	1	HV	4
Lynx canadensis	Lynx	1	HV[b]	4
Meropleon ambifusca	Newman's brocade	1	HV[a]	4
Notropis photogenis	Silver shiner	1	HV[a]	4
Oncocnemis piffardi	Three-striped oncocnemis	1	HV	4
Opsopoeodus emiliae	Pugnose minnow	1	HV[a]	4
Percina copelandi	Channel darter	1	HV	4
Percina shumardi	River darter	1	HV	4
Sander canadensis	Sauger	1	HV	4
Schinia lucens	Leadplant flower moth	1	HV	4
Scudderia fasciata	Pine katydid	1	HV[a]	4
Sorex fumeus	Smoky shrew	1	HV	4
Spartiniphaga inops	Spartina borer moth	1	HV[a]	4
Stagnicola contracta	Deepwater pondsnail	1	HV	4

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix B. Climate vulnerable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Vallonia gracilicosta albula	terrestrial snail	1	HV	4
Villosa fabalis	Rayed bean	1	HV[a]	4
Acipenser fulvescens	Lake sturgeon	2	HV[a]	5
Acris crepitans blanchardi/ Acris blanchardi	Blanchard's Cricket Frog	2	HV[a]	5
Alasmidonta marginata	Elktoe	2	HV[a]	5
Callophrys irus	Frosted elfin	2	HV	5
Chlosyne gorgone carlota	Gorgone checkerspot	2	HV	5
Clemmys guttata	Spotted Turtle	2	HV[a]	5
Lampsilis fasciola	Wavy-rayed lampmussel	2	HV[a]	5
Lepisosteus oculatus	Spotted gar	2	HV[a]	5
Lycaeides idas nabokovi	Northern blue	2	HV	5
Lycaeides melissa samuelis	Karner blue	2	HV	5
Obovaria olivaria	Hickorynut	2	HV[a]	5
Papaipema speciosissima	Regal fern borer	2	HV[a]	5
Planorbella smithi	aquatic snail	2	HV	5
Pleurobema coccineum	Round pigtoe	2	HV[a]	5
Terrapene carolina carolina	Eastern Box Turtle	2	HV[a]	5

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix B. Climate vulnerable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Vertigo bollesiana	Delicate vertigo	2	HV	5
Boloria freija	Freija fritillary	3	HV	6
Boloria frigga	Frigga fritillary	3	HV	6
Cottus ricei	Spoonhead sculpin	3	HV	6
Emydoidea blandingii	Blanding's Turtle	3	HV[a]	6
Etheostoma spectabile	Orangethroat darter	3	HV	6
Gavia immer	Common Loon	3	HV[b]	6
Notropis anogenus	Pugnose shiner	3	HV	6
Polygonia gracilis	Hoary comma	3	HV[b]	6
Proserpinus flavofasciata	Yellow-banded day-sphinx	3	HV[b]	6
Sistrurus catenatus catenatus	Eastern Massasauga	3	HV	6
Vertigo elatior	Tapered vertigo	3	HV	6
Vertigo paradoxa	Mystery vertigo	3	HV	6
Catocala dulciola	Quiet underwing	1	MV[a]	7
Charadrius melodus	Piping Plover	1	MV	7
Coturnicops noveboracensis	Yellow rail	1	MV[b]	7
Etheostoma zonale	Banded darter	1	MV	7

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix B. Climate vulnerable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Falco peregrinus	Peregrine Falcon	1	MV[a]	7
Fixsenia favonius ontario	Northern hairstreak	1	MV[a]	7
Hesperia ottoe	Ottoe skipper	1	MV	7
Heterocampa subrotata	Small heterocampa	1	MV	7
Liodessus cantralli	Cantrall's bog beetle	1	MV	7
Merolonche dolli	Doll's merolonche	1	MV[a]	7
Myotis sodalis	Indiana bat	1	MV[a]	7
Oecanthus pini	Pine tree cricket	1	MV[a]	7
Pachypolia atricornis	Three-horned moth	1	MV[a]	7
Phoxinus erythrogaster	Southern redbelly dace	1	MV	7
Somatochlora incurvata	Incurvate emerald	1	MV	7
Williamsonia fletcheri	Ebony Boghaunter	1	MV[b]	7
Acronicta falcula	Corylus dagger moth	2	MV	8
Appalachia arcana	Secretive locust	2	MV	8
Atrytonopsis hianna	Dusted skipper	2	MV	8
Catocala illecta	Magdalen underwing	2	MV[a]	8
Cyclonaias tuberculata	Purple wartyback	2	MV	8

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix B. Climate vulnerable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Eacles imperialis pini	Pine imperial moth	2	MV[b]	8
Erebia discoidalis	Red-disked alpine	2	MV[b]	8
Erora laeta	Early hairstreak	2	MV	8
Falcipennes canadensis	Spruce grouse	2	MV	8
Glyptemys insculpta	Wood Turtle	2	MV[a]	8
Hemileuca maia	Barrens buckmoth	2	MV[a]	8
Hiodon tergisus	Mooneye	2	MV[a]	8
Ixobrychus exilis	Least Bittern	2	MV[a]	8
Noturus miurus	Brindled madtom	2	MV[a]	8
Pantherophis gloydi	Eastern Fox Snake	2	MV	8
Papaipema cerina	Golden borer	2	MV[a]	8
Pygarctia spraguei	Sprague's pygarctia	2	MV[a]	8
Sterna forsteri	Forster's Tern	2	MV	8
Sternia caspia	Caspian Tern	2	MV	8
Sternia hirundo	Common Tern	2	MV[b]	8
Trimerotropis huroniana	Lake Huron locust	2	MV	8
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	2	MV	8

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix B. Climate vulnerable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Aythya americana	Redhead	3	MV	9
Botaurus lentiginosus	American Bittern	3	MV	9
Chilodonias niger	Black tern	3	MV[b]	9
Circus cyaneus	Northern Harrier	3	MV	9
Coregonus artedi	Lake herring	3	MV	9
Cygnus buccinator	Trumpeter Swan	3	MV[b]	9
Erynnis persius persius	Persius duskywing	3	MV[a]	9
Eumeces fasciatus	Five-lined skink	3	MV	9
Heterodon platirhinos	Eastern Hognose Snake	3	MV	9
Martes americana	American marten	3	MV	9
Moxostoma duquesnei	Black redhorse	3	MV[a]	9
Setophaga cerulea [Dendroica cerulea]	Cerulean Warbler	3	MV[a]	9

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix C. Climate-vulnerable (EV, HV, and MV) common (S4 and S5) species. NatureServe Climate Change Vulnerability Index (CCVI) scores for Michigan game species and Species of Greatest Conservation Need (SGCN). S rank is conservation status derived from rarity, population trends, and threats other than climate change at the state scale. Ranks range from five (secure) to one (critically imperiled.) Species ranked from most vulnerable to least vulnerable. Relative vulnerability is a combination of rarity, other conservation threats and climate vulnerability. Species with the same rank order are tied (same S-rank and same CCVI).

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Prosopium coulterii	Pygmy whitefish	4	EV	10
Regina septemvittata	Queen Snake	4	EV	10
Amybstoma laterale	Blue-spotted Salamander	5	EV	11
Hemidactylium scutatum	Four-toed Salamander	5	EV	11
Phoxinus neogaeus	Finescale dace	5	EV	11
Alces americanus	Moose	4	HV	12
Cicindela lepida	Little white tiger beetle	4	HV[a]	12
Etheostoma flabellare	Fantail darter	4	HV	12
Amybstoma maculatum	Spotted Salamander	5	HV	13
Cottus cognatus	Slimy sculpin	5	HV	13
Diadophis punctatus edwardsii	Northern Ring-necked Snake	5	HV	13
Lepus americanus	Snowshoe hare	5	HV	13
Lithobates pipiens	Northern Leopard Frog	5	HV	13
Lithobates sylvaticus	Wood Frog	5	HV	13
Myoxocephalus thompsonii	Deepwater sculpin	5	HV	13
Notophthalmus viridescens louisianensis	Central newt	5	HV	13
Notophthalmus viridescens viridescens	Red-spotted newt	5	HV	13

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix C. Climate vulnerable, common species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Plethodon cinereus	Redback Salamander	5	HV	13
Aythya collaris	Ring-necked Duck	4	MV	14
Erimyzon sucetta	Lake chubsucker	4	MV[a]	14
Moxostoma erythrurum	Golden redhorse	4	MV[a]	14
Nocomis micropogon	River chub	4	MV	14
Notropis dorsalis	Bigmouth shiner	4	MV	14
Noturus flavus	Stonecat	4	MV[a]	14
Porzana carolina	Sora	4	MV	14
Thamnophis butleri	Butler's garter snake	4	MV	14
Actitis macularia	Spotted Sandpiper	5	MV	15
Anaxyrus fowleri/ Bufo fowleri	Fowler's Toad	5	MV	15
Branta canadensis	Canada Goose	5	MV	15
Setophaga fusca	Blackburnian Warbler	5	MV[b]	15
Empidonax minimus	Least Flycatcher	5	MV	15
Esox americanus	Grass pickerel (redfin pickerel)	5	MV	15
Etheostoma microperca	Least darter	5	MV	15
Glaucomys sabrinus	Northern flying squirrel	5	MV[b]	15
Hyla chrysoscelis	Cope's gray treefrog	5	MV	15

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix C. Climate vulnerable, common species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Hyla versicolor	Eastern gray treefrog	5	MV	15
Luxilus chrysocephalus	Striped shiner	5	MV	15
Myodes gapperi	Southern red-backed vole	5	MV[b]	15
Napaeozapus insignis	Woodland jumping mouse	5	MV[b]	15
Necturus maculosus	Mudpuppy	5	MV[a]	15
Neotamias minimus	Least chipmunk	5	MV[b]	15
Pseudacris crucifer crucifer	Northern spring peeper	5	MV	15
Pseudacris triseriata triseriata	Western chorus frog	5	MV	15
Rana palustris	Pickerel frog	5	MV	15
Sorex hoyi	American pygmy shrew	5	MV	15
Sorex palustris	Water shrew	5	MV	15
Sternotherus odoratus	Common musk turtle	5	MV	15
Thamnophis sauritus septentrionalis	Northern ribbon snake	5	MV	15
Cardellina canadensis	Canada Warbler	5	MV[b]	15

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix D. Climate-stable, (PS and IL) rare (S1, S2, and S3) species. NatureServe Climate Change Vulnerability Index (CCVI) scores for Michigan game species and Species of Greatest Conservation Need (SGCN). S rank is conservation status derived from rarity, population trends, and threats other than climate change at the state scale. Ranks range from five (secure) to one (critically imperiled.) Species ranked from most vulnerable to least vulnerable. Relative vulnerability is a combination of rarity, other conservation threats and climate vulnerability. Species with the same rank order are tied (same S-rank and same CCVI).

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Anas americana	American Wigeon	1	PS	16
Asio flammeus	Short-eared Owl	1	PS	16
Battus philenor	Pipevine swallowtail	1	PS[a]	16
Brachionycha borealis	Boreal fan moth	1	PS	16
Cordulegaster erronea	Tiger spiketail	1	PS[a]	16
Cryptotis parva	Least shrew	1	PS[a]	16
Setophaga kirtlandii	Kirtland's Warbler	1	PS[b]	16
Setophaga palmarum	Palm Warbler	1	PS[b]	16
Euxoa aurulenta	Dune cutworm	1	PS	16
Falco columbarius	Merlin	1	PS[b]	16
Flexamia delongi	Leafhopper	1	PS	16
Flexamia reflexus	Leafhopper	1	PS	16
Lanius ludovicianus migrans	Migrant Loggerhead Shrike	1	PS[a]	16
Microtus orchrogaster	Prairie vole	1	PS[a]	16

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix D. Climate stable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Moxostoma carinatum	River redhorse	1	PS[a]	16
Ophiogomphus anomalus	Extra-striped snaketail	1	PS[b]	16
Ophiogomphus howei	Pygmy snaketail	1	PS[a]	16
Rallus elegans	King Rail	1	PS[a]	16
Stylurus amnicola	Riverine snaketail	1	PS	16
Stylurus laurae	Laura's snaketail	1	PS[a]	16
Stylurus notatus	Elusive snaketail	1	PS[a]	16
Stylurus plagiatus	Russet-tipped clubtail	1	PS[a]	16
Tachopteryx thoreyi	Grey petaltail	1	PS[a]	16
Tyto alba	Barn Owl	1	PS[a]	16
Ammodramus henslowii	Henslow's sparrow	2	PS[a]	17
Asio otus	Long-eared Owl	2	PS	17
Callophrys henrici	Henry's elfin	2	PS	17
Catocala robinsonii	Robinson's underwing	2	PS[a]	17
Erynnis baptisiae	Wild indigo duskywing	2	PS[a]	17
Fundulus dispar	Starhead topminnow	2	PS	17
Gomphus lineatifrons	Splendid clubtail	2	PS[a]	17

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix D. Climate stable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Gomphus quadricolor	Rapids clubtail	2	PS[a]	17
Loxia leucoptera	White-winged Crossbill	2	PS	17
Oporornis agilis	Connecticut Warbler	2	PS[b]	17
Setophaga americana	Northern Parula	2	PS	17
Perimyotis subflavus	Eastern pipistrelle or Tri-colored bat	2	PS[a]	17
Phalaropus tricolor	Wilson's Phalarope	2	PS	17
Parkesia motacilla	Louisiana Waterthrush	2	PS[a]	17
Accipiter cooperii	Cooper's Hawk	3	PS[a]	18
Accipiter gentilis	Northern Goshawk	3	PS[b]	18
Ammodramus savannarum	Grasshopper Sparrow	3	PS[a]	18
Anas crecca	Green-winged Teal	3	PS	18
Anas rubripes	American Black Duck	3	PS	18
Bucephala clangula	Common Goldeneye	3	PS	18
Buteo lineatus	Red-shouldered Hawk	3	PS[a]	18
Canis lupus	Gray Wolf	3	PS[b]	18
Cervus elaphus	Elk	3	PS	18
Cistothorus palustris	Marsh Wren	3	PS	18

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix D. Climate stable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Fulica americana	American Coot	3	PS	18
Gallinula galeata [G. chloropus]	Common Gallinule [Common Moorhen]	3	PS[a]	18
Ictiobus niger	Black buffalo	3	PS[a]	18
Lasiurus cinereus	Hoary bat	3	PS	18
Lophodytes cucullatus	Hooded Merganser	3	PS	18
Loxia curvirostra	Red Crossbill	3	PS	18
Mergus merganser	Common Merganser	3	PS	18
Microtus pinetorum	Woodland vole	3	PS[a]	18
Minytrema melanops	Spotted sucker	3	PS[a]	18
Pantherophis spiloides	Gray Ratsnake/ Central Ratsnake	3	PS[a]	18
Poecile hudsonica	Boreal Chickadee	3	PS[b]	18
Rallus limicola	Virginia Rail	3	PS	18
Tympanuchus phasianellus	Sharp-tailed grouse	3	PS[b]	18
Setophaga citrina	Hooded Warbler	3	PS[a]	18
Ammodramus leconteii	Le Conte's Sparrow	1	IL[b]	19
Setophaga discolor	Prairie Warbler	1	IL[a]	19
Setophaga dominica	Yellow-throated Warbler	1	IL[a]	19

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix D. Climate stable, rare species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Nycticorax nycticorax	Black-crowned Night-heron	2	IL[a]	20
Picoides arcticus	Black-backed Woodpecker	2	IL[b]	20
Setophaga caerulescens	Black-throated Blue Warbler	3	IL[b]	21
Empidonax virescens	Acadian Flycatcher	3	IL[a]	21
Icteria virens	Yellow-breasted Chat	3	IL[a]	21
Protonotaria citrea	Prothonotary Warbler	3	IL[a]	21
Spiza americana	Dickcissel	3	IL[a]	21

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix E. Climate-stable (PS and IL) common (S4 and S5) species. NatureServe Climate Change Vulnerability Index (CCVI) scores for Michigan game species and Species of Greatest Conservation Need (SGCN). S rank is conservation status derived from rarity, population trends, and threats other than climate change at the state scale. Ranks range from five (secure) to one (critically imperiled.) Species ranked from most vulnerable to least vulnerable. Relative vulnerability is a combination of rarity, other conservation threats and climate vulnerability. Species with the same rank order are tied (same S-rank and same CCVI).

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Anodontoides ferussacianus	Cylindrical papershell	4	PS	22
Aphredoderus sayanus	Pirate perch	4	PS[a]	22
Cistothorus platensis	Sedge Wren	4	PS	22
Grus canadensis	Sandhill crane	4	PS	22
Lasionycteris noctivagans	Silver-haired bat	4	PS	22
Lontra canadensis	Northern River Otter	4	PS	22
Martes pennanti	Fisher	4	PS[b]	22
Pandion haliaetus	Osprey	4	PS[b]	22
Perisoreus canadensis	Gray Jay	4	PS[b]	22
Phyciodes batesii	Tawny crescent	4	PS	22
Podilymbus podiceps	Pied-billed Grebe	4	PS[a]	22
Regulus calendula	Ruby-crowned Kinglet	4	PS[b]	22
Sturnella neglecta	Western Meadowlark	4	PS	22
Taxidea taxus	American Badger	4	PS[a]	22

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix E. Climate stable, common species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Thamnophis sirtalis sirtalis	Eastern garter snake	4	PS	22
Urocyon cinereoargenteus	Gray Fox	4	PS[a]	22
Aix sponsa	Wood Duck	5	PS	23
Anas discors	Blue-winged Teal	5	PS	23
Anas platyrhynchos	Mallard	5	PS	23
Ardea herodias	Great Blue Heron	5	PS	23
Bonasa umbellus	Ruffed Grouse	5	PS[b]	23
Butorides virescens	Green Heron	5	PS[a]	23
Castor canadensis	American Beaver	5	PS	23
Chelydra serpentina serpentina	Snapping Turtle	5	PS	23
Chrysemys picta	Painted Turtle	5	PS	23
Cicindela limbalis	a tiger beetle	5	PS[a]	23
Cicindela macra	a tiger beetle	5	PS[a]	23
Coluber constrictor foxi	Blue racer	5	PS	23
Dryocopus pileatus	Pileated woodpecker	5	PS	23
Elaphe vulpina vulpina	Western fox snake	5	PS	23
Glaucomys volans	Southern flying squirrel	5	PS[a]	23

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix E. Climate stable, common species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Graptemys geographica	Common map turtle	5	PS[a]	23
Lampropeltis triangulum	Eastern milk snake	5	PS	23
Lasiurus borealis	Red bat	5	PS	23
Liochlorophis vernalis	Smooth green snake	5	PS	23
Mustela erminea	Ermine / Short-tailed Weasel	5	PS[b]	23
Mustela frenata	Long-tailed Weasel	5	PS[a]	23
Mustela nivalis	Least Weasel	5	PS	23
Neovison vison	American Mink	5	PS	23
Nerodia sipedon sipedon	Northern water snake	5	PS[a]	23
Noturus gyrinus	Tadpole madtom	5	PS[a]	23
Odocoileus virginianus	White-tailed deer	5	PS	23
Ondatra zibethicus	Muskrat	5	PS	23
Peromyscus maniculatus	Deer mouse	5	PS	23
Progne subis	Purple Martin	5	PS[a]	23
Sciurus carolinensis	Eastern Gray Squirrel	5	PS[a]	23
Sciurus niger	Eastern Fox Squirrel	5	PS[a]	23
Sialia sialis	Eastern bluebird	5	PS[a]	23

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix E. Climate stable, common species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Sorex arcticus	Arctic shrew	5	PS	23
Spermophilus tridecemlineatus	Thirteen-lined Ground Squirrel	5	PS[a]	23
Storeria dekayi	Brown snake	5	PS	23
Storeria occipitomaculata occipitomaculata	Northern red-bellied snake	5	PS	23
Sturnella magna	Eastern Meadowlark	5	PS[a]	23
Sylvilagus floridanus	Eastern Cottontail	5	PS	23
Synaptomys cooperi	Southern bog lemming	5	PS	23
Tamias striatus	Eastern chipmunk	5	PS[a]	23
Tamiasciurus hudsonicus	Red Squirrel	5	PS	23
Ursus americanus	Black bear	5	PS	23
Ameiurus nebulosus	Brown bullhead	4	IL	24
Bartramia longicauda	Upland Sandpiper	4	IL[a]	24
Colinus virginianus	Northern Bobwhite	4	IL[a]	24
Contopus cooperi	Olive-sided Flycatcher	4	IL[b]	24
Haliaeetus leucocephalis	Bald Eagle	4	IL	24
Hylocichla mustelina	Wood Thrush	4	IL	24
Lynx rufus	Bobcat	4	IL	24

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix E. Climate stable, common species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Mimus polyglottos	Northern Mockingbird	4	IL[a]	24
Toxostoma rufum	Brown Thrasher	4	IL	24
Tyrannus tyrannus	Eastern Kingbird	4	IL	24
Vireo griseus	White-eyed Vireo	4	IL[a]	24
Canis latrans	Coyote	5	IL	25
Caprimulgus vociferus	Whip-poor-will	5	IL[a]	25
Charadrius vociferus	Killdeer	5	IL	25
Chordeiles minor	Common Nighthawk	5	IL	25
Coccothraustes vespertinus	Evening Grosbeak	5	IL	25
Coccyzus americanus	Yellow-billed Cuckoo	5	IL[a]	25
Coccyzus erythropthalmus	Black-billed Cuckoo	5	IL	25
Colaptes auratus	Northern Flicker	5	IL[b]	25
Corvus brachyrhynchos	American Crow	5	IL	25
Didelphis virginiana	Virginia Opossum	5	IL[a]	25
Dolichonyx oryzivorus	Bobolink	5	IL	25
Marmota monax	Woodchuck	5	IL	25
Melanerpes erythrocephalus	Red-headed Woodpecker	5	IL[a]	25

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix E. Climate stable, common species… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Meleagris gallopavo	Wild Turkey	5	IL[a]	25
Mephitis mephitis	Striped Skunk	5	IL	25
Passerculus sandwichensis	Savannah Sparrow	5	IL	25
Pipilo erythrophthalmus	Eastern Towhee	5	IL[a]	25
Pooecetes gramineus	Vesper Sparrow	5	IL	25
Procyon lotor	Raccoon	5	IL	25
Scolopax minor	American Woodcock	5	IL	25
Spizella pusilla	Field Sparrow	5	IL[a]	25
Vermivora chrysoptera	Golden-winged Warbler	5	IL[a]	25
Vermivora pinus	Blue-winged Warbler	5	IL[a]	25
Vulpes vulpes	Red Fox	5	IL	25

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix F. Species without a numeric S-rank (Historic, Unknown, or Not Ranked), ranked by climate vulnerablity.

Species	English Name	S Rank	CCVI	Relative Vulnerability
Coregonus bartlettii	Siskiwit lake cisco	H	EV	N/A
Siren intermedia nettingi	Western lesser siren	H	EV	N/A
Speyeria idalia	Regal fritillary	H	EV[a]	N/A
Obliquaria reflexa	Threehorn wartyback	NSR	EV	N/A
Fontigens nickliniana	Watercress snail	SU	EV	N/A
Anguispira kochi	Banded globe	U	EV	N/A
Discus patulus	Domed disc	U	EV	N/A
Lasmigona compressa	Creek heelsplitter	SNR	HV	N/A
Mesodon elevatus	Proud globe	SU	HV	N/A
Pomatiopsis cincinnatiensis	Brown walker	SU	HV	N/A
Apidoscelis sexlineatus	Six-lined racerunner	U	HV	N/A
Appalachina sayana	Spike-lip crater	U	HV	N/A
Mesomphix cupreus	Copper button	U	HV	N/A
Pyrgulopsis letsoni	Gravel pyrg	U	HV	N/A
Papaipema aweme	Aweme borer	H	MV[b]	N/A
Nycticeius humeralis	Evening bat	NA	MV[a]	N/A

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix F. Species without state-level numeric conservation rank… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Bufo americanus americanus	Eastern American toad	NR	MV	N/A
Aythya affinis	Lesser Scaup	NRN	MV	N/A
Aythya marila	Greater Scaup	NRN	MV	N/A
Aythya valisineria	Canvasback	NRN	MV	N/A
Ligumia nasuta	Eastern pondmussel	NSR	MV	N/A
Helisoma anceps	Two-ridge rams-horn	SU	MV	N/A
Potamopyrgus antipodarum	New Zealand mudsnail	SU	MV	N/A
Pupilla muscorum	Widespread column	U	MV	N/A
Vertigo pygmaea	Crested vertigo	U	MV	N/A
Hypopthalmichthys nobilis	Big head carp		PS[a]	N/A
Helmitheros vermivorus	Worm-eating Warbler	NA	PS[a]	N/A
Bombus affinis	Rusty-patched bumble bee	NR	PS[a]	N/A
Bombus terricola	Yellow banded bumble bee	NR	PS[b]	N/A
Myotis septentrionalis	Northern bat or Northern myotis	NR	PS	N/A
Anas acuta	Northern Pintail	NRN	PS	N/A
Anas clypeata	Northern Shoveler	NRN	PS	N/A
Anas strepera	Gadwall	NRN	PS	N/A

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."

Appendix F. Species without state-level numeric conservation rank… continued

Species	English Name	S Rank	Climate Vulnerability	Relative Vulnerability
Oxyura jamaicensis	Ruddy Duck	NRN	PS	N/A
Dreissena polymorpha	Zebra mussel	SNA	PS	N/A
Phasianus colchicus	Ring-necked Pheasant	SNA	PS[a]	N/A
Branta hutchinsii	Cackling Goose	U	PS	N/A
Philomycus carolinianus	Carolina mantleslug	U	PS	N/A
Puma concolor	Cougar	H	IL	N/A
Aeshna canadensis	Canada darner	NR	IL[b]	N/A

Vulnerability: EV Extremely Vulnerable, HV Highly Vulnerable, MV Moderately Vulnerable, PS Presumed Stable, IL Increase Likely

[a] The CCVI output included the caveat that "Species may expand range in assessment area."
[b] The CCVI output included the caveat that "Species range may shift and perhaps leave the assessment area."