Massachusetts Wildlife

Climate Action Tool

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Climate Change Vulnerability Assessments

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Climate Change Vulnerability is defined by the IPCC as the susceptibility of a species, system or resource to the negative effects of climate change and other stressors, and includes three components: exposure, sensitivity, and adaptive capacity:

- *Exposure* is the amount and rate of change that a species or system experiences from the direct (e.g., temperature, precipitation changes) or indirect (e.g., habitat shifts due to changing vegetation composition) impacts of climate change;
- *Sensitivity* refers to characteristics of a species or system that are dependent on specific environmental conditions, and the degree to which it will likely be affected by climate change (e.g., temperature or hydrological requirements); and
- *Adaptive capacity* is the ability of a species to cope and persist under changing conditions through local or regional acclimation, dispersal or migration, adaptation (e.g., behavioral shifts), and/or evolution.

What are Climate Change Vulnerability Assessments?

Climate Change Vulnerability Assessments (CCVAs) are emerging tools that can be used as an initial step in the adaptation planning process. A CCVA focuses on species, habitats, or systems of interest, and helps identify the greatest risks to them from climate change impacts. A CCVA identifies factors that contribute to vulnerability, which can include both the direct and indirect effects of climate change, as well as non-climate stressors (e.g., land use change, habitat fragmentation, pollution, and invasive species[?]).

The process of completing a CCVA includes the synthesis of existing information about the target species or system, confidence levels in those data, and identification of knowledge gaps. A CCVA combines this background information with climate projections to identify the specific elements of exposure, sensitivity, and adaptive capacity that contribute to the overall vulnerability of the species or system.

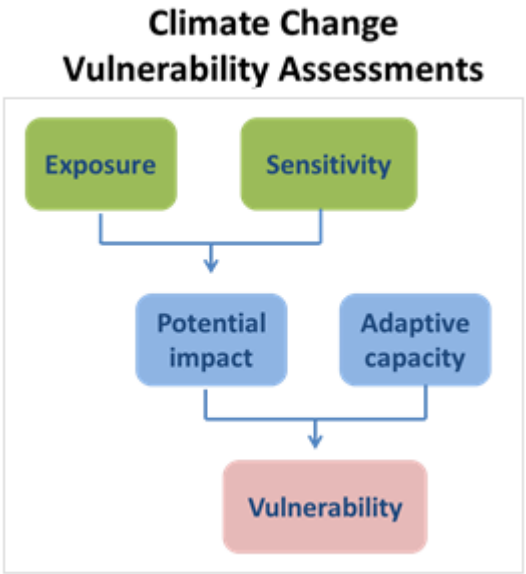

Figure adapted from Glick et al. 2011

There is no standard method or framework to conduct a CCVA, and a variety of methods are being implemented at government, institutional, and organizational levels. Because of this, interpretation of CCVA results should carefully consider whether and how each of the three components of vulnerability (exposure, sensitivity, and adaptive capacity) were evaluated, if non-climate stressors were included in the assessment, how uncertainty is presented, the geographic location covered by the assessment, and whether the entire life cycle of a target species was evaluated, particularly for those that are migratory. Generally, the approach chosen should be based on the goals of practitioners, confidence in existing data and information, and the resources available (e.g., financial, personnel).

Some of the most common frameworks applied regionally are:

- ***NatureServe Climate Change Vulnerability Index*** (CCVI) – A quantitative assessment based on the traits of fish, wildlife, and habitats that might make them more vulnerable to

climate change. The CCVI is suitable for assessing large numbers of species and comparing results across taxa. It is based in Microsoft Excel, relatively easy to use, and includes factors related to direct and indirect exposure, species-specific sensitivity, and documented or modeled responses to climate change.

- ***Climate Change Response Framework*** (CCRF) – A collaborative, cross-boundary approach among scientists, managers, and landowners designed to assess the vulnerability of forested habitats. The assessment incorporates downscaled climate projections into tree species distribution models to determine future habitat suitability. Experts conduct a literature review to summarize the effects of climate change, as well as non-climate stressors, and consider all three components of vulnerability to come to a consensus on a vulnerability ranking and level of confidence.

- ***Northeast Association of Fish and Wildlife Agencies (NEAFWA) Habitat Vulnerability Model*** – An approach created to consistently evaluate the vulnerability of all non-tidal habitats across thirteen Northeastern US states. This method is based on an expert-panel approach, and is made up of 4 sections, or modules, based in Microsoft Excel. The modules score vulnerability based on climate sensitivity factors (adaptive capacity is also partially addressed) and non-climate stressors to produce vulnerability rankings and confidence scores. Experts use these scores to construct descriptive paragraphs explaining the results for each species or habitat evaluated. These narratives help to ensure transparency, evaluate consistency, and clarify underlying assumptions. The National Park Service, the U.S. Forest Service, and several states have used this model successfully to assess habitat vulnerability.

- **Expert opinion workshops and surveys** – These are often qualitative (or mixed qualitative/quantitative), and have been used by a number of states including a report on habitat vulnerability in Massachusetts. These assessments are usually developed independently, and are typically not based on a standardized framework. This allows greater flexibility for the institution conducting the CCVA; however, it is more difficult to make direct comparisons across assessment results since the specific factors evaluated may vary.

Outputs from the CCVAs outlined above compare the relative vulnerability among species or systems and identify major factors contributing to the vulnerability, confidence in the factors assessed, and remaining knowledge gaps. This information can inform adaptation strategies and actions by identifying the areas where additional monitoring and research is needed, and helping to prioritize management and policy decisions.

How are CCVAs presented in the Massachusetts Wildlife Climate Action Tool?

The CCVAs presented in this tool are drawn from assessments completed throughout the Northeast United States, as well as the Midwest and Mid-Atlantic regions. The NatureServe Climate Change Vulnerability Index was the most common method of assessing species vulnerability, though other methods were also included (see descriptions above). The Massachusetts Climate Action Tool presents a summary of CCVA results for individual species and forest habitats; in cases where more than one CCVA result is offered, studies come from various locations and may have used different assessment methodologies. Users should consult the original source for a complete understanding of how vulnerability was assessed and detailed results.

We present multiple Climate Change Vulnerability Assessment (CCVA) results because not all species were assessed specifically in Massachusetts. For example, an assessment may have included Massachusetts, but been regional in scope. Because species' ranges and life histories extend beyond state boundaries, assessments conducted in other areas may provide a more comprehensive understanding of their vulnerability. We suggest starting with CCVAs that include Massachusetts (e.g., North Atlantic LCC, North Atlantic coast), and then comparing results from nearby states. We also suggest considering the life history and migration patterns of species to determine what factors might be most influential as the species moves in or out of Massachusetts. In some cases, CCVA rankings may vary for the same species because of unique factors within a given area, or because different methodologies were used in different studies. It is important to read the expert opinions supporting ranking to understand why a ranking differs from one state to another.

In the Massachusetts Climate Action Tool, the following information is presented for each species assessed:

Ranking: The vulnerability ranking categories refer to the predicted extent that the assessed species will be impacted by climate change. Because the ranking category names and definitions vary across reports, similar rankings have been grouped and are presented in a standardized format. See Table 1 (next page) to compare these with the original ranking categories and definitions used by the CCVAs cited in this tool.

Confidence: This category describes how confident the authors are in the vulnerability ranking assigned to each species in the assessment. Confidence scores refer to the amount and quality of the available background information on that species, and do not necessarily include the uncertainty associated with the projected climate data used for rankings.

Emission Scenarios: Emissions scenarios describe future releases of greenhouse gases, aerosols, and other pollutants into the atmosphere, and are based on expected changes in human populations and technology. *See climate change page for more information on emission scenarios and climate models*.

Time Period: Vulnerability for each species is considered for a specific time period. Many vulnerability assessments consider the current and future impacts that a species may experience through the years 2050, 2080, or 2100.

Location: This field refers to the geographic region considered in the vulnerability assessment. CCVAs can be conducted on local, regional, state, and national levels.

	Massachusetts Wildlife Climate Action Tool Vulnerability Ranking Categories						
	Extremely Vulnerable	**Highly Vulnerable**		**Moderately Vulnerable**	**Slightly Vulnerable**	**Presumed Stable**	**Increase Likely**
	Original Climate Change Vulnerability Assessment Ranking Categories						
Original Source Report 1	**Extremely Vulnerable:** Abundance and/or range extent extremely likely to substantially decrease or disappear by 2050	**Highly Vulnerable:** Aundance and/or range extent likely to decrease significantly by 2050		**Moderately Vulnerable:** Abundance and/or range extent likely to decrease by 2050		**Presumed Stable:** Available evidence does not suggest that abundance and/or range will increase or decrease substantially	**Increase Likely :** Available evidence suggests that abundance and/or range extent is likely to increase
2	**Extremely Vulnerable:** Abundance and/or range extent in VT extremely likely to substantially decrease (>90% loss) or disappear	**Highly Vulnerable:** Abundance and/or range extent in VT likely to decrease significantly (60-90% loss)		**Moderately Vulnerable:** Abundance and/or range extent in VT likely to decrease (30-60% loss)	**Slightly Vulnerable:** Available evidence does not suggest that abundance and/or range extent in VT will change (15 - 30% loss)	**Not Vulnerable:** Abundance and/or range extent in VT likely to increase or decrease by less than 15%	**Increase Possible or Likely:** Available evidence suggests that abundance and/or range extent in VT is likely to increase (>15% increase)
3		**High Vulnerability:** A large negative impact (>66% loss) on this species' range area and/or population size in ME including potential state-level extirpation in 50 to 100 years from now		**Medium Vulnerability:** An intermediate impact (33-66% loss) on this species' range and/or population size in ME 50 to 100 years from now		**Low Vulnerability:** Little negative impact (<33% loss) or a positive impact on this species' range area and/ or population size in ME 50 to 100 years from now	
4		**Large Decrease**		**Moderate Decrease**	**Minimal Decrease**	**Minimal Increase**	**Moderate Increase**
5	**Critical**	**Highly Imperiled**	**High Concern**	**Moderate Concern**	**Low Concern**		

*Overall description of vulnerability used in the Massachusetts Wildlife Climate Action Tool to summarize CCVA rankings across all referenced studies. [1]NatureServe Climate Change Vulnerability Index (Byers & Norris 2011; Cullen et al. 2013; Furedi et al. 2011; Hoving et al. 2013; Schlesinger et al. 2011; Sneddon & Hammerson 2015); [2]Tetratech, Inc. 2013; [3]Whitman et al. 2014; [4]Adaptation Subcommittee 2010; [5]Galbraith et al. 2014

Simplified vulnerability ranking categories as presented in the Massachusetts Wildlife Climate Action Tool, cross-referenced with the original vulnerability ranking categories and definitions used in the assessment reports cited in this tool.

Additional Resources on CCVAs

Climate Registry for the Assessment of Vulnerability (CRAVe): The Climate Registry for the Assessment of Vulnerability (CRAVe) is a searchable, public registry on CCVAs. The purpose of CRAVe is to make information about ongoing and completed vulnerability assessments readily accessible. CRAVe is hosted in two locations: 1) USGS National Climate Change and Wildlife Science Center and 2) the EcoAdapt Climate Adaptation Knowledge Exchange. The assessments in CRAVe include studies on species and ecosystems, built environments and infrastructure, cultural resources, and socioeconomic systems. Users can access CRAVe to conduct searches across all vulnerability assessments to find the information necessary for decision making.

Vulnerability Assessment Trainings: The U.S. Fish and Wildlife Service's National Conservation Training Center (NCTC) offers training courses to guide conservation and resource management practitioners in the theory, design, interpretation, and implementation of CCVAs. Participants also gain a perspective of how CCVAs fit into the broader context of adaptation planning. Courses follow the guidelines established in *Scanning the Conservation Horizon - A Guide to Climate Change Vulnerability Assessment*.

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