# VI. Using Vulnerability Assessment Results

## Vulnerability Assessment Outputs

Conducting a vulnerability assessment is not an endpoint. Vulnerability assessments are an intermediate step, and results provide information used to develop adaptation strategies and inform management planning. The specific uses of results from vulnerability assessments are determined by factors such as the selection of conservation targets, management scale, tolerance for risk, and management approaches. Two common outputs from vulnerability assessments are a ranking of the relative vulnerability of target species or habitats, and an assessment of the specific factors that pose threats to species or habitats.

Relative vulnerability rankings may be displayed in tables or spatially through maps. These rankings can range from expected complete loss of the target, to a ranking of greatly increased abundance or distribution. In this way, conducting a vulnerability assessment helps to identify expected winners and losers under altered climate conditions. The vulnerability assessment case studies provided in Chapter VII offer examples of a wide range of outputs from vulnerability assessments. These assessments were conducted for locations throughout the United States, at various spatial scales, and for targets ranging from species to broadly defined habitat types.

***Vulnerability assessments provide information to develop adaptation strategies and inform management planning.***

Vulnerability assessments should also provide a confidence value associated with their relative vulnerability ranking as an output. This facilitates a transparent consideration of uncertainty in subsequent conservation and management decision-making. However, one must be careful not to allow uncertainty to preclude consideration of climate impacts on species and habitats. As discussed previously, uncertainty is inherent in all projections, whether or not climate is one of the factors considered in making the projections. In fact, simply because climate change is having and will continue to have major impacts on species and habitats, a greater degree of certainty is inherent in assessments accounting for climate change than those that do not recognize the influence of climate change on species and habitats. Although the magnitude of climate change's impacts on species and habitats may be uncertain, it is important to understand that climate change vulnerability assessments can, at

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a minimum, reveal information about the direction of species and habitat changes in response to climate change (e.g., whether populations or habitat area are likely to increase or decrease).

Another important output is the identification of the specific factors contributing to a species' or habitat's vulnerability. When assessing vulnerability, non-climate factors contributing to vulnerability (e.g., habitat fragmentation; the extent of watershed covered by impervious surfaces; impacts from invasive plants and animals; pest and pathogen outbreaks; and impacts from water withdrawals and aquifer depletion) should be included. Identification of specific vulnerability factors, from both climate and non-climate sources, as well as their interactions, is key to developing potential adaptation strategies. Knowing the factors or combination of factors that make a species or habitat vulnerable allows managers to develop specific management or conservation strategies that can help reduce those vulnerabilities.

## Informing Existing Planning Efforts

Most state, federal, and tribal natural resource agencies, as well as non-governmental organizations engaged in natural resource protection, are guided by well-established planning processes. A useful aspect of vulnerability assessments is that they can help inform the management process regardless of the administrative structure, function, and operating procedures of different management agencies. Carefully choosing the targets of the vulnerability assessment and methodology of assessment will make it easier to integrate the results of the climate change vulnerability assessment into the existing planning framework used by agencies.

Vulnerability assessments can be used to help inform many aspects of fish and wildlife conservation and management, including selecting which species or habitats should be the focus of conservation efforts, identifying priority areas for land acquisition, informing management decision-making, and directing monitoring efforts. Box 6.1 describes an example of how the Massachusetts Division of Fisheries and Wildlife is integrating habitat vulnerability assessment into its land protection prioritization process and management decision-making. Similarly, Case Study 6 describes a two-pronged assessment approach that builds on vulnerability assessment to identify potential management options.

Eric Engbretson/USFWS

## Box 6.1. Informing Land Protection Priorities in Massachusetts

The Massachusetts Division of Fisheries and Wildlife recently completed a Habitat Vulnerability Assessment (HVA) to inform their planning processes (see Case Study 4 in Chapter VII). The HVA was performed by an expert panel that determined the relative vulnerability to climate change for 20 key habitat types, as well as a confidence score for each habitat evaluated and an identification of the various factors contributing to a habitat's vulnerability ranking and confidence score. These results have been added as another factor for consideration in agency management, acquisition, and research and monitoring programs (Manomet Center for Conservation Sciences and MDFW 2010c). Potential management responses being considered include the following:

**1. Promote resistance and resilience.** The ability of a system or species to resist adverse climate change impacts will depend largely on its intrinsic resistance to the stressors and its resilience—its ability to recover from stress. The resilience of many species and systems has already been compromised by anthropogenic stressors and they are now in a weakened state. While there are no guarantees that increasing the resilience of these resources will safeguard them under climate change, it is certain that their current lack of resilience will render them vulnerable. Four main solutions to promoting resistance and resilience have been proposed:

- Mitigating the effects of non-climate stressors
- Conserving existing biodiversity, ecological functions, and high-quality habitats
- Restoring degraded habitats
- Managing habitats for ecological function

**2. Implement landscape-level planning.** One of the main impacts of climate change will be to increase the likelihood and magnitude of shifts in the distributions of species, habitats, and ecosystems. A landscape-level planning focus will be necessary to accommodate this. Specifically, it will be important to take such a view to: 1) Identify and preserve movement corridors; 2) Improve habitat connectivity to facilitate movement of displaced organisms; and 3) Improve buffering to safeguard core, high-quality habitats.

**3. Promote effective on-the-ground management of sites and habitats.** Adaptation goals need to be translated into effective on-the-ground management actions that will strengthen the resistance and resilience of sites, habitats, and species under a changing climate. Specifically, site managers and biologists need to focus on two primary management goals—managing resistance and resilience, and managing change.

**4. Promote and implement "climate-smart" regulation.** Some of the conservation regulations that have served well in the past may not be as effective under climate change. For example, regulations that prohibit the management and manipulation of resources and habitats might not be optimal at a time when a changing climate is forcing responses in resources. In such cases it may be necessary to introduce a degree of management flexibility into these existing regulations.

## Selecting Conservation Targets

Climate change vulnerability information can be integrated into processes aimed at identifying species or habitats most in need of conservation attention, such as efforts to identify and prioritize SGCN for State Wildlife Action Plans. In some cases, a consideration of climate change vulnerability will cause agencies to add species to their SGCN lists or alter the level of priority of an existing SGCN. The same may apply to habitats that agencies consider to be of high conservation need or priority.

While the relative vulnerability rankings an assessment generates may help managers understand which species are more and less vulnerable, it will not dictate whether to focus attention on the most vulnerable, the least vulnerable, or something inbetween. This emphasizes the fact that a vulnerability assessment is not an endpoint, but a source of information that can be incorporated into planning and decision-making. Furthermore, because vulnerability assessments should elucidate the specific factors that contribute to a species' or habitat's vulnerability, it can help managers identify options for reducing that vulnerability through management and conservation actions. In some cases there may be practical management options, but in other cases the factors leading to vulnerability may be very difficult or simply not feasible to address. This is an important consideration in selecting conservation targets and objectives.

## Setting Land Protection Priorities

Among the most powerful strategies for the long-term conservation of biodiversity is establishment of networks of protected areas that represent the full range of a region's species and ecosystems, and include multiple, robust examples of each type. These principles of *representation, resiliency,* and *redundancy* are at the core of many comprehensive conservation planning and land protection efforts (Shaffer and Stein 2000; Margules and Pressey 2000; Scott et al. 2001). Climate change vulnerability assessments can help aid such planning efforts by augmenting knowledge of the current distribution and status of species and ecosystems with projections of the possible future conditions and locations. Combining the results of species assessments may reveal landscape areas likely to have relatively high or low species diversity or important habitat for species of management concern. In either case, the results can be used to identify priority areas for areas for protection based on the principles of representation, resiliency, and redundancy. Land protection strategies can therefore take into account not only existing values and conditions, but also the likely value of specific areas under a changing climate.

***A vulnerability assessment is not an endpoint, but a source of information to incorporate into planning and decision-making.***

## Informing Management Decisions

Vulnerability assessments ideally incorporate uncertainty about climate change and about a system's response to it. Adaptation planning ideally evaluates management options across that range of uncertainty. As previously discussed, vulnerability assessments can help you to evaluate whether your existing goals, objectives, and targets are still appropriate in a changing climate, or to develop new goals, objectives, and targets (Millsap et al. 1990). Having identified management or conservation goals, objectives, and targets, the next step is to decide which actions will best achieve those aims.

## Directing Monitoring Efforts

Multiple management objectives and multiple factors affecting species of management concern, combined with limited resources, necessitate that monitoring programs to assess the success/failure of management objectives be designed to yield useful information in a cost-effective manner. In some cases, monitoring may be of the status or health of the target species or habitats, which should help determine the effectiveness of various management strategies. In other cases, it may be important to monitor major factors affecting the status of species or habitats. Because the process of assessing vulnerability requires determination of the major factors affecting the status of habitats and species, one can return to the vulnerability assessment to inform decisions about the most appropriate factors to monitor. Monitoring of these factors should provide useful information about species or habitat status.

Furthermore, if some of these factors are directly being managed in order to provide appropriate conditions for priority species or habitats, the degree of success in creating these conditions will come to light through their monitoring.

The potential factors to monitor that have major effects on species or habitats will no doubt vary widely depending upon the species and habitat type, and even vary within the range of given species and habitats. It will be important to ensure that the factors being measured provide useful information. Where key thresholds are identified for species or habitats, monitoring of these thresholds is important, especially if these factors are themselves being addressed in management.

There will very likely be many instances wherein the major factors affecting a species are not known at the time of the vulnerability assessment, or there is a high degree of uncertainty associated with the results. In these situations, the vulnerability assessments should help reveal those species for which further research is necessary to identify key factors and increase confidence in the vulnerability assessment results (Williams et al. 2008; IPCC 2005). Assuming success of this research, vulnerability assessments could be conducted again for these species and habitats and appropriate factors used in monitoring management results. Until then, it will be difficult to know how to manage for a species and which factors to manipulate and monitor for management purposes.

# Dealing with Uncertainty in Adaptation Planning

As highlighted in Chapter V, resource managers often must make conservation decisions under uncertainty, particularly where information about future conditions must be considered. Some management responses will be effective in meeting conservation goals under a range of potential climate futures, while others may need to be tailored to more specific conditions (Lawler et al. 2010). When future conditions are fairly certain, it makes sense to ask "Which actions will produce the single best outcome?" When there is significant uncertainty about future conditions, answering that question becomes increasingly difficult because the answer depends on which future comes to pass. In such situations it may make more sense to ask "Which actions will give me the best chance of some acceptable outcome?" This approach is called robust decision-making, and it is essentially a bet-hedging strategy. Rather than maximizing the chance of the single best outcome, it seeks to maximize the likelihood of an acceptable outcome. While this approach may initially seem at odds with the mandate to make decisions based on "the best available science," it is not. If the best available science is telling you that there are important uncertainties that will affect your management success, then taking a robust approach is in fact a decision based on the best available science. Two tools that can help resource managers make adaptation planning decisions under uncertainty are adaptive management and scenario planning.

*Instead of striving for the single best outcome, it may make more sense to ask "which actions will give the best chance of some acceptable outcome."*

### Adaptive Management

The U.S. Department of the Interior defines adaptive management as "a systematic approach for improving resource management by learning from management outcomes," based on principles laid out by the National Research Council (Williams et al. 2007; NRC 2004). The overarching purpose of adaptive management is to enable natural resource managers and other relevant decision-makers to deal with uncertainty about future conditions by supporting the development of conservation projects based on existing information and then providing the flexibility to modify their management activities to improve their effectiveness as new information becomes available. It is a concept that has been around for many years, and it has often been identified as a priority in resource management plans. Salafsky et al. (2001) identify a series of steps for adaptive management in conservation:

- Start: Establish a clear and common purpose
- Step A: Design an explicit model of your system
- Step B: Develop a management plan that maximizes results and learning
- Step C: Develop a monitoring plan to test your assumptions

- Step D: Implement your management and monitoring plans

- Step E: Analyze data and communicate results

- Iterate: Use results to adapt and learn

Adaptive management may be particularly useful in cases where immediate action is required to address short-term and/or potentially catastrophic long-term consequences, such as the collapse of important ecosystem services, or where management actions are likely to have "no regrets" near-term benefits (Ojima and Corell 2009).

It is important to recognize, however, that effective adaptive management can be difficult for several reasons, including insufficient long-term monitoring resources, unclear or conflicting conservation and management goals, political and institutional resistance to changing management practices, and/or inability to control a particular outcome through management (Johnson 1999).

### Scenario-Based Management Planning

Another framework for robust decision-making, or for decision-making under uncertainty in general, is scenario planning. Just as the use of multiple climate change scenarios can help address inherent uncertainty in assessing vulnerability, they also can provide a useful framework for informing possible adaptation options, particularly in cases where the levels of uncertainty about potential future conditions are especially high and uncontrollable (Peterson et al. 2003) (see Figure 6.1). The goal here is to identify and consider a broad range of options, appropriate responses to the array of future scenarios, and what management mechanisms you can put in place that will allow you maximum likelihood of success and flexibility given the array of possible future scenarios.

Scenarios, at their simplest, are descriptions of some plausible future. They are not predictions or forecasts, and

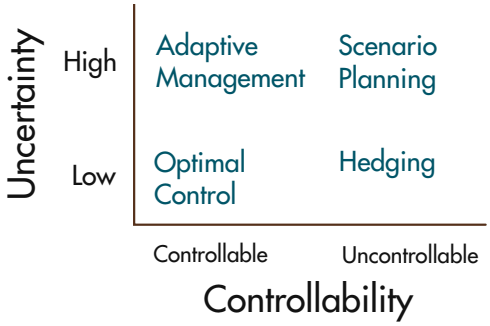


Figure 6.1. A framework for management under different levels of uncertainty (Peterson et al. 2003).

scenario planners make no assumptions about which scenario is most likely (if you knew which was most likely, you would not need scenario planning). Scenarios can be quantitative or qualitative, and they may include a complex web of interconnected problems or focus on a simple subset of the issues. Which is more appropriate depends on the goal of the scenario planning exercise and available information. Qualitative, exploratory scenarios may help to set the stage for the development of quantitative, targeted scenarios by stimulating creative thinking and deepening managers' and planners' understanding of their system. In a similar fashion, exploratory scenarios that include a range of complexity may help to identify those elements on which it is most important to focus.

Scenario planning exercises typically use around three to five different scenarios. Scenarios are created for the particular scenario planning exercise, and will ideally: (1) bracket the range of plausible futures, and (2) highlight those elements of uncertainty most important to management and planning. Having developed the scenarios, managers and planners then brainstorm possible management options and look at the performance of those options across all scenarios. Are there management approaches that are effective in all scenarios? Are there management options that are highly effective in one but disastrous in others? As you go through this exercise, you can highlight areas where uncertainty about climate change or the system's response to it is more or less important. For instance, if a particular management action is best regardless of future rainfall, decreasing uncertainty in rainfall projections would not be particularly useful. If, on the other hand, rainfall timing or intensity is the single biggest determinant of which management action is best, then you would want to focus on reducing uncertainty around those projections.

Scenario planning provides multiple benefits. It not only helps with making particular decisions in uncertain conditions, but increases the more general ability of planners and managers to cope with uncertainty. It also facilitates the design of monitoring programs that target key elements of uncertainty, be they uncertainty about climatic change, system responses to that change, or the effect of particular management actions.

Lindsay Baronoski

***Not considering climate change in management is akin to traveling in unknown territory without a map—one is not likely to arrive at the desired destination.***

Matt Greene

## Looking Ahead

The development of vulnerability assessments has resulted from concern about the pervasive impacts of climate change across the landscape. With so many species and habitats likely to be affected, it is critical that managers know the likely status of species and habitats in a changing climate. Not considering climate change in management is akin to traveling in unknown territory without a map—one is not likely to arrive at the desired destination or result (Lawler et al. 2010).

An added benefit of conducting vulnerability assessments is that they are not specific to assessing vulnerability to just climate change. Properly executed, vulnerability assessments should account for the factors affecting species and habitats, regardless of what those factors are. This comprehensive nature of vulnerability assessments makes them all the more important as a tool for informing the development and implementation of management objectives.

Regional vulnerability assessments, such as that underway in the Pacific Northwest (Case Study 7), will provide information useful to different agencies across the areas. Regional collaboration across several states to conduct vulnerability assessments may be economically efficient in a time of distressed state wildlife agency budgets and may also foster multi-state relationships (AFWA 2009). Furthermore, in light of the landscape-scale impact of climate change, increased collaboration among states is likely to be beneficial as species and habitat ranges move across the landscape.