Climate Adaptation Toolkit

for Marine and Coastal Protected Areas

Training Module

Commission for Environmental Cooperation

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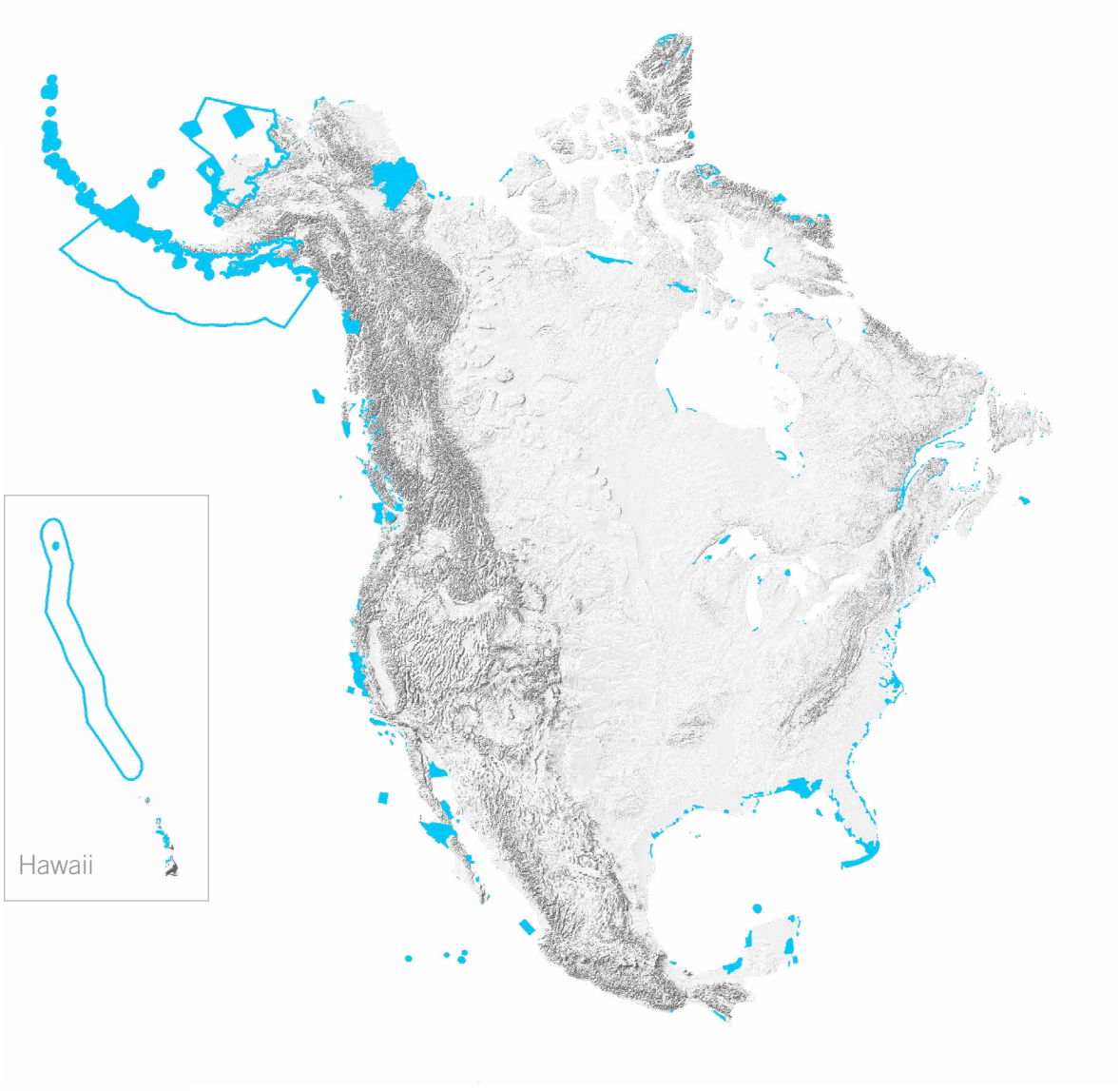
Table of Contents

About the Climate Adaptation Toolkit Training Module

This training module takes users through a basic process of climate adaptation planning, using the materials available in the Climate Adaptation Toolkit for Marine and Coastal Protected Areas ('Climate Adaptation Toolkit') as well as additional resources. Users will understand how to move from one adaptation planning step to the next, and the resources and information needed to accomplish each step. Each part of the training module consists of learning objectives, synthesis of relevant content, and supporting materials, including fillable worksheets.



North American Marine Protected Areas, CEC North American Environmental Atlas, 2011.

Training Module Objectives

1. Clarify and build familiarity with the steps in a basic climate adaptation planning process (e.g., the Adaptation Ladder of Engagement).
2. Understand how and why the Climate Adaptation Toolkit and training module were developed, and how they support climate adaptation planning for MPA practitioners.
3. Demonstrate how resources in the Climate Adaptation Toolkit can be used in climate adaptation planning.
4. Guide users through an adaptation planning process using exercises and the Climate Adaptation Toolkit.

Training Module Overview

Purpose

This training module is intended to provide the framework and resources necessary to successfully use the Climate Adaptation Toolkit in adaptation planning efforts. Though the Climate Adaptation Toolkit has been designed to be simple and easy to navigate without prior experience, this training module complements the toolkit by walking users through a basic climate adaptation planning process, using featured tools to accomplish each part's goals.

This training module is designed to address the major components of a basic climate adaptation planning process, and is separated into five parts: **(1) Project Scoping**, **(2) Awareness and Assessment**, **(3) Planning**, **(4) Implementation and Integration**, and **(5) Evaluation and Sharing** (Figure 1). The training module comprises several elements, such as definitions of key terms, background information, and exercises to practice the concepts covered.

Targeted Users

The intended users of this training module are managers of marine and coastal protected areas that want to ensure their management practices are informed by the far-reaching impacts of climate change. In most cases, multiple staff members from a site will need to be familiar with the Climate Adaptation Toolkit and the exercises contained within this training module to ensure successful implementation of adaptation planning. More broadly, restoration and conservation practitioners beyond protected areas management will find the resources highlighted here useful in their work. succinct with reference to supporting material, rather than inclusion.

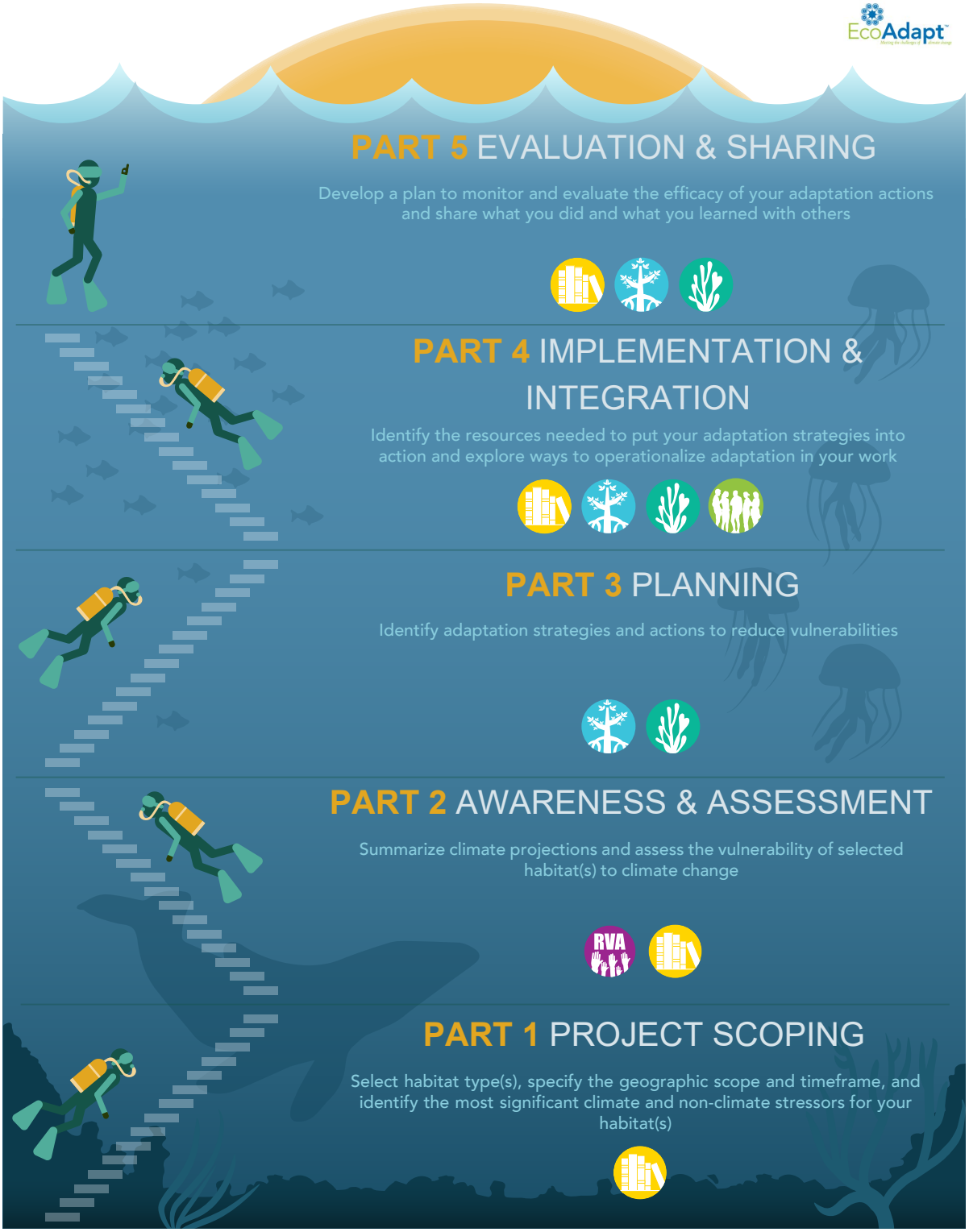


Figure 1. Training module framework, which takes users through the basic steps in a climate adaptation planning process.

About the Climate Adaptation Toolkit

The Climate Adaptation Toolkit for Marine and Coastal Protected Areas was created to make climate adaptation planning a simple, direct, and feasible process for MPA managers. It contains tools that help MPA managers evaluate the vulnerability of their sites to climate change, identify appropriate adaptation strategies, and learn more about those strategies through case studies, reports, and other resources. The Climate Adaptation Toolkit was developed by EcoAdapt and the Commission for Environmental Cooperation in response to needs expressed by marine and coastal managers for guidance and resources that specifically target climate adaptation planning in marine and coastal settings. It is focused on the natural resources and habitats within marine and coastal protected areas in North America and the local communities who value those resources. Creation of the Climate Adaptation Toolkit was guided by marine and coastal protected area managers from Canada, Mexico and the United States, and it has been built within the Climate Adaptation Knowledge Exchange (CAKE). The Climate Adaptation Toolkit was built using the Adaptation Ladder of Engagement ('Ladder') as a framework for climate adaptation planning. The Ladder consists of seven steps:

1. **Awareness** that climate change affects your resources and the ability to meet your goals.
2. **Assessment** to understand how and why climate change will impact your resources and goals.
3. **Planning** to prepare for and respond to changes (i.e., adaptation) that you are already experiencing or are likely to experience.
4. **Implementation** of adaptation actions, whether its new regulations, processes, or activities, or adjusting existing management activities.
5. **Integration** of adaptation actions and processes into how you manage your MPA by mainstreaming climate adaptation.
6. **Evaluation** of your adaptation actions to determine what is and is not working.
7. **Sharing** your project with others – what you did, how you did it, and what you learned.

Anticipated Outcomes

At the end of this training module, users will understand and be able to apply the basic steps of adaptation planning; know how to use the resources in the Climate Adaptation Toolkit in their adaptation planning efforts; and be able to show other marine protected area (MPA) practitioners how to use the Climate Adaptation Toolkit in their adaptation efforts.

Part 1
Introduction & Project Scoping

This part provides an overview of key terms and tools in the Climate Adaptation Toolkit and introduces project scoping as essential preparation for a climate adaptation planning process.

Learning Objectives

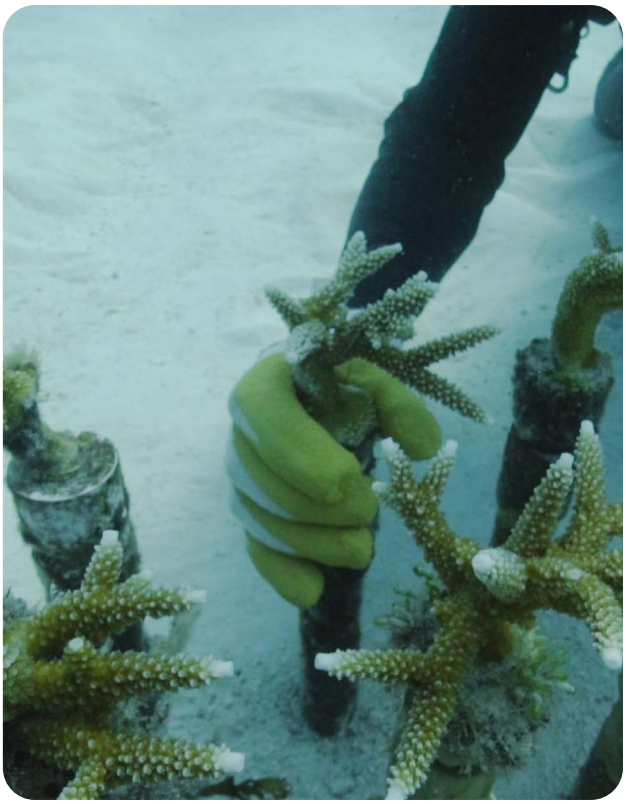
1. Understand and build familiarity with key terms and tools (e.g., Rapid Vulnerability Assessment [RVA] Tool) used in the training module.
2. Become familiar with project scoping components and how the Climate Adaptation Toolkit can help define project parameters.
3. Practice defining project parameters, including describing a habitat type, defining a timeframe, and identifying key climate and non-climate stressors.

Definitions of Key Terms[1]

Adaptation refers to adjustments in natural or human systems in response to changing climate conditions. Adaptation is how we prepare for and respond to changes that we are already experiencing or are likely to experience.

Mitigation (of climate change) refers to the reduction of greenhouse gas emissions in order to limit the magnitude and rate of climate change.

Vulnerability refers to the degree to which a resource is susceptible to, and unable to cope with, the adverse impacts of climate change. It is a function of the *sensitivity* of the resource to climate changes, its *exposure* to those changes, and its *capacity to adapt* to those changes.



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1. IPCC Data Distribution Centre Glossary: https://www.ipcc-data.org/guidelines/pages/glossary/glossary_a.html (IPCC 2007, 2014).

Descriptions and Features of Key Tools in the Climate Adaptation Toolkit

Rapid Vulnerability Assessment (RVA) Tool. The North American Marine Protected Area Rapid Vulnerability Assessment (RVA) Tool helps marine protected area managers evaluate the implications of climate change for the habitats they manage. The RVA Tool has three parts (a User Guide, a set of blank worksheets, and a booklet containing sample completed worksheets) that are available as downloadable PDFs. The blank worksheets are in a dynamic PDF format so that users can easily fill, save, and share their completed worksheets. The User Guide and sample completed worksheets provide the narrative explanation of how to use the tool, while the blank worksheets are the hands-on component. Together, they comprise a tool that can help marine protected area managers conduct a rapid vulnerability assessment to better understand how climate change may impact their site and the habitats they manage.

Adaptation Actions Table. Once a vulnerability assessment is completed, users can consult the Adaptation Actions Table, which includes adaptation actions and options specific to identified vulnerabilities, case studies demonstrating how such actions have been implemented, selected scientific reports, technical guidance, and helpful tools. All of these components can serve as resources for marine and coastal protected area managers seeking adaptation ideas for known climate vulnerabilities. Users can view habitats and natural resources of interest and their possible vulnerabilities in the Adaptation Actions Table or can search for specific keywords in the Adaptation Actions Search tool.

Foundational Resources. The Foundational Resources are a curated list of tools, documents, and guides that can inform adaptation work. The resources are organized according to the steps of an adaptation planning process, and are a great starting place to provide a comprehensive, high-level view of climate change adaptation from start to finish. Each step features at least one resource each for Canada, Mexico and the United States.

Experts. The experts list is a compilation of climate adaptation practitioners who can be contacted for questions or guidance. These are experts who have kindly offered a limited amount of free advice on supporting climate vulnerability assessments, adaptation planning, and implementation work for marine and coastal protected areas.

Exercise 1. **Project Scoping**

About this Exercise

In this exercise, you will select one habitat type to focus on for the remainder of the training. You will describe the habitat type, define the project boundary, describe the human uses and/or ecosystem services provided by the habitat type, identify the timescale for your assessment, and select the most significant climate and non-climate stressors for your habitat type.

Exercise Goal

Define project parameters for your habitat type.

Instructions

Complete the project scoping worksheet for your habitat type, including:

- Select one habitat type (e.g., coral reefs, coastal dune systems, pelagic) on which to focus.
- Describe your habitat type. What are the defining features, environmental conditions, and species?
- Define the project boundary.
- Describe the human uses and/or ecosystem services provided by the habitat type. Ecosystem services include provisioning (e.g., food, fresh water), regulating (e.g., flood and erosion control, water purification), supporting (e.g., primary production), and cultural (e.g., cultural heritage, recreation, education).
- Select a timescale (e.g., within the next 10 years to 100+ years) for your vulnerability assessment. A few things to note when selecting a timescale: (1) climate data for near term (<10 years) and very long term (100+ years) can often be difficult to find, and (2) planning horizons often extend beyond 10 years and it can be risky to focus on identifying management options for the short term when climate change will continue to impact resources for many years, even if emissions are curbed.
- Rank the impact of climate and non-climate stressors on your habitat type and select the most significant stressors (i.e., High impact). You may want to consider the economic and/or human use impacts of each stressor and any exacerbating or synergistic effects when selecting the most significant stressors for your assessment. If you identified more than three High impact stressors, document your rationale as to why you selected the final stressors over the others also ranked as High impact. In some cases, it can be useful to combine stressors (e.g., if the stressors have a similar impact on the habitat).

Use the Climate Adaptation Toolkit to help define project parameters. There are a number of entry points to use, including:

Adaptation Actions Table. Open the Climate Adaptation Toolkit and click on Adaptation Actions Table (under 'Tools'). The default organization of this table is alphabetical by habitat type. Using the Habitats/Locations column as a guide, scroll down to your habitat type. For each of your habitat rows, look at the Case Studies and Resources listed, as they may provide good examples of how others have defined project parameters.

Adaptation Actions Search. Open the Climate Adaptation Toolkit and click on Adaptation Actions Search (under 'Tools'). In the search bar, enter in your habitat type. Case studies and management and planning documents that pertain to your habitat type will appear, and can provide examples of how others have selected project timescale and key stressors, or defined project boundaries, among other things.

Foundational Resources. Open the Climate Adaptation Toolkit and click on Foundational Resources (under 'Tools'); navigate to the Assessment and Planning sections. Any resources listed here may contain information about how to define project parameters.

Roberto Vazquez

Part 2
Awareness & Assessment

Following project scoping, the first step in adaptation planning is improving awareness about current and projected climate changes in your region and/or within your project boundary. The next step is undergoing an assessment, such as a vulnerability or risk assessment, or a more general review, to better understand how climate change might affect the resources you manage and the ability to achieve your goals.

Learning Objectives

1. Understand how to access basic climate data for your region and create a simple climate change impacts summary table.
2. Practice assessing climate vulnerability for a habitat of interest, using the RVA Tool.
3. Understand the concept of scenario planning and how and when to use it.

Definitions of Key Terms[2]

Sensitivity (i.e., consequence) is a measure of whether and how a resource is likely to be affected by a given change in climate.

Exposure (i.e., likelihood) is a measure of how much change in climate or other environmental factors a resource is likely to experience.

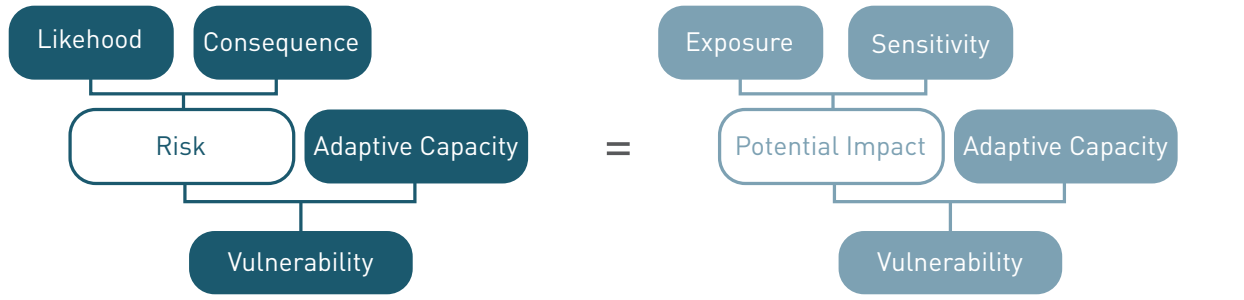
Adaptive Capacity is a measure of the ability of the resource to accommodate or cope with climate change impacts with minimal disruption.

Climate Change Vulnerability Assessments

Vulnerability assessments are a critical tool used by managers to understand how climate change is likely to impact a resource and its ability to respond to those changes. While there is no standardized methodology for vulnerability assessments across the field, most are based on a combination of expert opinion with peer-reviewed science and grey literature, and comprise both quantitative and qualitative information. Vulnerability assessments can help resource managers prioritize actions, develop strategies to address climate change, and efficiently allocate resources.

2. Glick, P., B.A. Stein, and N.A. Edelson, editors. 2011. *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment*. National Wildlife Federation, Washington, DC.

Figure 2. Comparison of risk and vulnerability assessment models. Likelihood can be considered analogous to exposure, consequence analogous to sensitivity, and risk analogous to potential impact in the standard vulnerability assessment model.



Risk assessment model used in RVA tool (CEC 2017)

Vulnerability assessment model (Glick et al. 2011)

It is important to evaluate all three components of vulnerability—sensitivity, exposure, and adaptive capacity—as it provides a holistic perspective on what is driving the resource's vulnerability to climate change.

- **Sensitivity (i.e., consequence)** focuses on likely physical and biological effects of projected changes in climate stressors (e.g., whether and how vegetation composition, structure, and distribution are likely to be affected by warmer temperatures). Sensitivity is also influenced by non-climate stressors that may exacerbate impacts of climate change on a given resource. For example, increases in winter precipitation could contribute to the spread of invasive dune grasses, displacing native species.
- **Exposure (i.e., likelihood)** focuses on the projected direction and magnitude of change in climate stressors that a resource is likely to experience (e.g., how many degrees temperature is projected to rise within a given timeframe). When evaluating exposure, it is also useful to consider historical trends and observed changes as well as the degree of uncertainty associated with climate projections (see below).
- **Adaptive capacity** focuses on intrinsic (inherent characteristics) and extrinsic (outside forces) factors that influence the ability of a resource to respond to climate change. This includes *ecological factors* such as distribution (e.g., rare versus widespread), connectivity, ability to recover from disturbances, physical diversity, biodiversity, and ecological or societal value. *Societal factors* that influence adaptive capacity are generally related to organizational and management capacity, and include things such as staff capacity, ability to adjust management, existing stakeholder/partner relationships, and available science and technological support.

G. Davis

A Note about Uncertainty

In adaptation planning, there are three general areas of uncertainty:

1. Uncertainty in terms of **climate projections**. For example, will precipitation increase or decrease? How much? How quickly?
2. Uncertainty in terms of **ecological responses**. For example, if salinity increases/decreases, how will my habitat type respond?
3. Uncertainty in terms of **management efficacy**. For example, does using kelp or other marine algae to remove carbon dioxide from the water (i.e., creating a marine "forest"), limit localized acidification and its associated impacts?

Documenting where and why there is uncertainty is critical for developing strategies to overcome it. For example, establishing a research and monitoring program to investigate salt tolerances of different seagrasses helps address uncertainty in terms of ecological responses, while monitoring salinity changes (how much, how quickly) helps address uncertainty in terms of climate changes and projections.

Scenario planning is a useful tool in dealing with uncertainty in climate projections by defining multiple, plausible futures as a framework for identifying impacts and developing management strategies. This tool can be applied at multiple points in the adaptation planning process.[3] When considering how to respond to uncertainty in management efficacy, it may also be helpful to learn from others that may have tried something similar, or to test the idea with pilot studies.

3. For more about this planning tool, see Rowland et al. 2014. *Considering Multiple Futures: Scenario Planning to Address Uncertainty in Natural Resource Conservation*.

Exercise 2. Climate Change Impacts Summary and Vulnerability Assessment

About this Exercise

In this exercise, you will draw upon existing information about projected changes in climate as well as your expertise and experience to assess the vulnerability of your habitat to climate change. This exercise is divided into two components.

1. **Climate Change Impacts Summary**. This is a preparatory step for the vulnerability assessment where you will use Foundational Resources in the Climate Adaptation Toolkit to create a Climate Change Impacts Summary table.
2. **Vulnerability Assessment.** Here you will use the RVA Tool to evaluate exposure (i.e., likelihood), sensitivity (i.e., consequence), and adaptive capacity of your habitat to climate change.

Exercise Goal

Create a simple climate change impacts summary table for three climate stressors and assess vulnerability of your habitat type to climate change.

1. Climate Change Impacts Summary

Before beginning your vulnerability assessment, it is important to understand climate changes and impacts within your project boundary. In this exercise, you will be creating a simple climate change impacts summary table (example below—Table A) using the Foundational Resources from the Climate Adaptation Toolkit. The summary table will inform your evaluation of exposure (i.e., likelihood) in Part II.

Garry Fletcher

Table A. Climate change impacts summary table for Papāhanaumokuākea Marine National Monument. See Appendix A of the RVA Tool for a more detailed example.

Ⓐ Climate stressor	Ⓑ Change to date	Ⓒ Projected change	Ⓓ Trend	Ⓔ Confidence
Sea surface temperature	**+0.58°C** (1.0°F) **in Hawaii from 1900-2016**[4]	**+1.6–2.8°C** (2.9–5.0°F) **in Hawaii by 2080**[4]	↑	**Very high**[4]
Ocean acidification	**30% increase in surface water acidity globally since 1850** (pH decline from 8.2 to 8.1 units)[4]	**100–150% increase in global surface water acidity by 2100 under high-emissions scenario** (decline from 8.1 to 7.8 units)[4]	↑	**High**[4]
Sea-level rise	**+0.14–0.19 m** (0.45–0.63 ft) **over past 100 years in two National Monument tide stations**[5]	**+0.5–1.4 m** (1.6–4.6 ft) **in Honolulu by 2100 under a high-emissions scenario** (90% probability within this range)[6] **Extreme global scenario of 2.5 m** (8.2 ft) **possible if Antarctic ice sheet collapses**[7]	↑	**Very high** (*lower bounds*)[4] **Low** (*upper bounds and extreme scenario*)[4]

Instructions

Transfer the top three climate stressors you selected in **Exercise 1. Project Scoping** to **Column A (climate stressor)** of the Climate Change Impacts Summary table. Open the Climate Adaptation Toolkit and navigate to the Foundational Resources page. Using the Foundational Resources listed under Awareness and Assessment, fill out Columns B through E of the summary table. The main objective when filling out **Columns B (change to date)** and **C (projected change)** is to present the general range of change that has occurred or is projected to occur, rather than to document all the different ranges that are available.

For Column D (trend), document whether the stressor is generally projected to increase (↑) or decrease (↓), or whether the trend is variable or undetermined (—) based on the information you entered in Column C. For example, in the western United States, precipitation projections are highly uncertain, with some models showing increases in annual precipitation while others show decreases. In this case, the trend would be variable (—).

In Column E (confidence), document your confidence in projected changes using the following ranking scale: Low, Moderate, High, or Very High. For example, if we use the previous precipitation example where models show conflicting results, our confidence would be ranked Low.

At the bottom of the worksheet, document the references used to fill out the Climate Change Impacts Summary table. Documenting references used throughout this process will be important if you plan to publish or present any of the findings from your assessment.

4. USGCRP. 2017. Climate Science Special Report: Fourth National Climate Assessment, Volume I. Page [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J.Dokken, B.C. Stewart, T.K. Maycock, editors.]. US Global Change Research Program, Washington, DC. Available from https://science2017.globalchange.gov/.
5. NOAA/National Ocean Service. 2019. NOAA Tides and Currents: Sea-level Trends. Available from https://tidesandcurrents.noaa.gov/sltrends/.
6. Kopp, R.E., R.M. Horton, C.M. Little, J.X. Mitrovica, M. Oppenheimer, D.J. Rasmussen, B.H. Strauss, C. Tebaldi. 2014. Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites. Earth's Future 2:2014EF000239.
7. Sweet, W.V., R.E. Kopp, C.P. Weaver, J. Obeysekera, R.M. Horton, E.R. Thieler, C. Zervas. 2017. Global and regional sea-level rise scenarios for the United States. NOAA Technical Report NOS CO-OPS 083. National Oceanic and Atmospheric Administration, Silver Spring, MD.

Additional Resources

The following resources may also be helpful as you fill out your summary table:

- Sistema de Información y Análisis de Ecosistemas Marinos de México
- Canada's Changing Climate Report
- Climate Signals
- US Global Change Research Program Indicator Platform
- NOAA Tides & Currents

2. Vulnerability Assessment

The rapid vulnerability assessment is a method to qualitatively describe and evaluate how climate and non-climate stressors will impact your habitat's vulnerability to climate change. This section of the training module will take you through an abbreviated version of the RVA Tool featured in the Climate Adaptation Toolkit; the tables in the exercise are the same as in the tool itself, so you will be well prepared to complete the full RVA on your own at a later time. Completed worksheets are also available in the RVA Tool as examples.

Instructions

Table 1: Climate Change Vulnerability Assessment is the master table for this exercise, and will incorporate information from Tables 2 and 3.

1. Fill in Column A with your top three climate stressors.
2. Fill in Column B by summarizing the information from Columns B and C in Exercise 2 (Part I). Include the direction and magnitude of the change for the timescale you have selected for this assessment.
3. In **Column C**, consider the changes described in Column B and describe how this will affect the habitat type you are assessing. List anticipated physical and biological effects based on projected climate change.
4. In Column D, given all the information you know, assign the likelihood of the anticipated effects described in Column C occurring in the chosen timescale. This evaluation is based on available information, including personal knowledge and/or formal assessments. In doing this you are considering certainty based on your knowledge of the evidence and consensus of the interpretation of this evidence. Use the following scale:[8]
   - **Almost certain** (greater than 50% probability)
   - **Likely** (50/50 probability)
   - **Possible** (less than 50% but not unlikely)
   - **Unlikely** (probability low but not zero)
   - **Rare** (probability very low, close to zero)
5. Complete all rows, through Column D, before moving over to Table 2: Consequences (you will come back to Table 1 soon!)

8. Likelihood scale based on Climate Change Impacts & Risk Management: A Guide for Business and Government (Australian Greenhouse Office 2006).

Table 2: Consequences provides an assessment of the consequence of the selected climate stressors on your habitat type.

1. Fill in Column A with the top three non-climate stressors you selected in Exercise 1.
2. Complete Column B by considering how each stressor is currently or has historically affected this habitat type.
3. In Column C, based on your local knowledge of these non-climate stressors and the current and anticipated effects of climate change, designate whether climate change will make the effect of the non-climate stressor better/less problematic (+) or worse/more problematic (-). If you believe there will be no interactive effect, indicate this (nil).
4. In Column D, fill in your top three climate stressors. In each subsequent row, describe the combined impact of the non-climate stressor with each climate stressor.

5. In the final row of Column D (at the very bottom), assign the degree of consequence the direct effect of the climate change stress combined with the effects of these non-climate stressors will have on this habitat type. This evaluation is based on available information, including personal knowledge and/or formal assessments, using the following scale:
   - **Catastrophic:** Habitat will cease to exist or have its function permanently altered.
   - **Major:** Key species or functions may be dramatically altered, such that value is undermined.
   - **Moderate:** Species numbers may decline, function may be diminished, such that habitat is seen as degraded but still present.
   - **Minor:** Habitat will continue to function but activities such as recovery will be impaired.
   - **Negligible:** Habitat and its key components will not be visibly or functionally affected.
6. Transfer these consequence rankings from Table 2 to the respective rows in Column E of Table 1.

Table 1: Climate Change Vulnerability Assessment (continued).

1. For each row in Table 1, use Figure A to determine the level of risk by combining the likelihood and consequence levels assigned to each climate stressor. Enter the risk ranking in Column F.
2. Skip over to Table 3: Adaptive Capacity (you will come back to Table 1 soon!)

Table 3: Adaptive Capacity provides an assessment of the capacity of the habitat (ecological potential) and of the institutions that manage the habitat (social potential) to adapt to climate stressors. This method provides a single adaptive capacity score for each of your three climate stressors; use the "rationale and notes" column to indicate if a factor may differ among your selected stressors (e.g., if your site has a robust monitoring program for ocean acidification, but not for ocean temperature, then your staff capacity score may differ for those stressors).

1. Assess the condition of each ecological factor and the status of each social factor using the following scale. If any of these factors do not apply for your habitat, just indicate with "N/A" (you do not have to score each factor). Definitions of ecological and social potential factors and customization options for Table 3 are provided below the table. Use the following scale to rate status and condition:
   - **5 Superior:** This factor exemplifies the ideal condition
   - **4 Good:** This factor does a better than adequate job but could use improvement
   - **3 Fair:** This factor is adequate but could easily be improved
   - **2 Poor:** This factor is not adequate, but it provides modest function
   - **1 Critical:** This factor is not functional or does not exist
2. At the end of each section (ecological and social) calculate the average for the column. Then, in the second row from the bottom, calculate the combined average of these two sections. Use that average value to determine adaptive capacity based on the scale provided in the table.
3. Transfer the Adaptive Capacity rating from Table 3 to the respective rows in Column G of Table 1.

Table 1: Climate Change Vulnerability Assessment (continued)

For each row in Table 1, use Figure B to determine the level of vulnerability by combining risk and adaptive capacity. Transfer vulnerability levels to their respective rows in Column H of Table 1.

Important Points

- A simple climate change impacts summary table facilitates a common understanding about current and projected future climate trends in a given geographic area.
- Vulnerability or risk assessments highlight why a resource is vulnerable to climate change, which provides the basis for developing and prioritizing adaptation strategies.
- As you evaluate the vulnerability of your resource to climate change, identify information gaps or areas of particular uncertainty. For example, there may be uncertainty in how a resource responds to a given climate stressor or uncertainty with the climate projections themselves. Knowing where there is uncertainty allows you to identify areas for future research and monitoring.
- Stakeholder participation early on in your assessment is key, as stakeholders frequently have local knowledge and experience to share—information that can be vital to your assessment. Additionally, it builds informed buy-in to the process and findings.
- Consider the opportunities presented by climate change as well as the threats.

Part 3
Planning

After assessing vulnerabilities, it's time to move on to identifying solutions to reduce vulnerability and/or increase resilience of your habitat to climate change. Solutions could be something you are already doing, a revision or modification to something you are already doing, or something brand new.

Learning Objectives

1. Understand how to move from awareness to planning: what do you do with the findings from the vulnerability assessment?
2. Become familiar with adaptation planning concepts and terms.
3. Understand how to develop adaptation strategies and actions using the Climate Adaptation Toolkit that will reduce identified vulnerabilities.
4. Practice using the Climate Adaptation Toolkit to develop adaptation strategies and actions.

Definitions of Key Terms

Adaptation strategies are broad or general adaptation responses that aim to reduce the negative effects or take advantage of the opportunities presented by climate change. *Example: anticipate and facilitate habitat migration*

Adaptation actions are more specific adaptation responses to implement that consider ecological and site conditions and context. *Example: implement living shorelines and green infrastructure*

Collaboration strategies or actions are focused on coordinating management efforts and/or capacity across organizations, jurisdictional, and/or political boundaries.

Knowledge strategies or actions gather information about climate changes, impacts, and/or management efficacy.

Resilience strategies or actions are designed to strengthen the ability of a resource to absorb and recover from change, enabling a return to prior desired conditions.

Resistance strategies or actions are designed to maintain current conditions by holding back change.

Response or Direct strategies or actions are designed to intentionally facilitate change and adaptively respond to new conditions.

G. Davis

Climate Change Adaptation Planning

Climate change adaptation is how we prepare for, respond to, and recover from climate impacts on natural and human systems. Conversely, climate change mitigation addresses the underlying causes of climate change by reducing greenhouse gas emissions. Effectively responding to climate change requires that we reduce greenhouse gas emissions while concurrently preparing for and adapting to impacts. Thus, any holistic adaptation planning effort should include both mitigation and adaptation strategies.

Understanding what drives the vulnerability of a resource to climate change (e.g., exposure/likelihood, sensitivity/consequence, or adaptive capacity, or some combination of these components) provides a good starting point for identifying possible adaptation strategies. For example, in the Hawaiian Islands Climate Synthesis Project,[9] Kaua'i beaches and dunes received a high vulnerability ranking due to a combination of high sensitivity (i.e., consequence) and exposure (i.e., likelihood) to climate change and low adaptive capacity. In particular, climate stressors such as sea-level rise, coastal flooding, and altered storm severity and frequency are likely to accelerate shoreline erosion, inundate habitats, and damage or kill native dune vegetation. Adaptation options such as using beach nourishment (reduces exposure/likelihood), restoring dune and coastal strand habitats (reduces sensitivity/consequence), or revising setback requirements to account for projected sea-level rise (reduces exposure/likelihood), can help to limit these impacts on Kaua'i beaches and dunes. Another adaptation option, planting salt- and flood-tolerant vegetation, can help to increase the adaptive capacity of dune habitats. It is helpful to begin by generating a broad array of possible adaptation options that reduce identified vulnerabilities (i.e., reduce sensitivity/consequence and exposure/likelihood, increase adaptive capacity).

9. Gregg, R.M., editor. 2018. Hawaiian Islands Climate Vulnerability and Adaptation Synthesis. EcoAdapt, Bainbridge Island, WA.

In addition to identifying adaptation options based on vulnerabilities, it is also important to balance the development of adaptation options across different approaches and timeframes. For example, generating adaptation options that focus on the shorter-term as well as options that focus on the longer-term. Climate change adaptation strategies can be organized into six general approaches and timeframes:

- **Resistance:** A near-term approach aimed at limiting climate impacts on a resource. *Example: nourish beaches in areas where habitat retreat is not an option*
- **Resilience:** A near- to mid-term approach aimed at accommodating some change but enabling a return to a prior desired condition. *Example: restore dune and coastal strand habitats*
- **Response/Direct:** A long-term approach aimed at facilitating change and adaptively responding to new conditions. *Example: maintain and/or increase habitat connectivity to facilitate species migrations* (e.g., limit development in inland/upland areas where coastal habitats may migrate)
- **Knowledge:** A near- to long-term approach aimed at gathering more information (e.g., about climate changes, impacts, and/or management efficacy) to make better management decisions. *Example: identify and map areas vulnerable to sea-level rise and areas of possible habitat migration*
- **Collaboration:** A near- to long-term approach aimed at coordinating management efforts and resources across organizational, jurisdictional, or political boundaries. *Example: build support for coastal habitat protection by conducting public education and outreach about climate risks and management responses*
- **Accept Change/No Action:** A deliberate management decision to accept change. Long-term approach. *Example: allow transition from one habitat type to another*

As you generate adaptation options, ensure that you have a portfolio of different approaches, even if you may be able to implement only a few of them at the outset. Engaging in scenario planning at this step can also be a useful exercise, as it helps to identify "no regrets" strategies that can be implemented under differing future conditions.

An Important Note on Adaptation Options

The adaptation options that you generate may not look all that different from the kinds of things that you are already doing, as much of what we do continues to make sense as a response to climate change. However, this *does not* mean that you can continue doing what you have always done and justify it as an adaptation strategy in response to climate change *unless* you have intentionally thought about and considered the ways in which climate may impact your resource. In general, the portfolio of climate adaptation options that you generate may be represented as:

- The same actions you are currently implementing but are now intentionally framed to address climate change (~45%). *Example: remove invasive plants from intact remnant habitats*
- Modifications to actions you are currently implementing so that they better address climate vulnerabilities (~40%). *Example: plant and seed with native species adapted to future conditions (e.g., drought-tolerant)*
- New or novel actions to address climate vulnerabilities (~15%). *Example: downscale infrastructure as a precursor to retreat*

Exercise 3. **Identifying Adaptation Strategies and Actions**

About this Exercise

In this exercise, you will use the Adaptation Actions Table, Adaptation Actions Search, and Foundational Resources in the Climate Adaptation Toolkit to develop adaptation strategies and actions that reduce the vulnerabilities you identified in the previous exercise. The objective is to identify a broad range of adaptation options for your habitat type. You will also begin exploring implementation considerations for your adaptation strategies, specifically their implementation cost, expected efficacy, and co-benefits and conflicts with other resources.

Exercise Goal

Identify and evaluate at least five adaptation strategies for your habitat type.

Instructions

Refer to the vulnerability table you developed in the previous exercise. For those rows that indicate High or Moderate vulnerability, transfer the climate stress and anticipated effects of that vulnerability to Column A in the Adaptation Strategy Development table. Open the Climate Adaptation Toolkit and navigate to the Adaptation Actions Table. The default organization of this table is alphabetical by habitat type. There are a number of entry points in this table that you can use to identify adaptation strategies, including:

- **Habitats/Locations.** Using the Habitats/Locations column as a guide, scroll down to your habitat type. For each of your habitat rows, look at the Climate Stressors & Impacts column and identify any that match with the stressors and anticipated effects transferred over to Column A of the Adaptation Strategy Development table. Where there is a match, transfer the corresponding Action/Option to Column B of the Adaptation Strategy Development table.
    - An important note: The Case Studies and Tools & Resources listed for each Action/Option in the Adaptation Actions Table may contain additional adaptation strategies relevant to your habitat type. For example, if your habitat type is Beach/Dune, the first Action/Option is "anticipate and facilitate inland/upland migration (e.g., buffers, setbacks, open space, etc.)". Navigate to the Tools & Resources listed with this action and click on the Hawaiian Islands Climate Vulnerability and Adaptation Synthesis, which has dozens of adaptation options for coastal habitats.

- **Search: habitat type.** Enter your habitat type into the Search bar. This will bring up any entries that mention your habitat type (e.g., in a case study or tool), even if it does not correspond to the Habitat/Location listed. Using this entry point can help you identify additional adaptation options that may be relevant to your habitat type. For example, searching "coral reef" brings up a Beach/Dune row with the adaptation option to "use soft-engineering techniques, restoration and natural infrastructure to increase resilience or replace or mimic natural buffers" in response to sea-level rise and increased storm frequency, severity, and wave action. If these climate stressors match with those entered in Column A of the Adaptation Strategy Development table, consider adding this adaptation option the table. A case study from the relevant column (e.g., *Valuing coral reefs as shoreline storm protection in Quintana Roo*) provides additional information that may be useful in determining whether this adaptation option is something to consider implementing.
- **Search: climate stressor or impact.** Using the Search bar, enter in one of the climate stressors or impacts listed in Column A of the Adaptation Strategy Development table. This will bring up any entries that mention the stressor or impact, and can help you to identify adaptation options that may be relevant (but not currently linked) to your habitat type. For example, searching "sea-level rise" brings up the adaptation option to "improve coastal zone development and management policy to better accommodate sea-level rise" under the Cliff/Rocky Shore habitat type. However, this option is also applicable to other habitat types, such as Beach/Dune. Associated case studies and tools and resources provide additional information that may be useful in determining whether an adaptation option is relevant for your habitat type.

Two other entry points to identify adaptation strategies and actions are also available in the Climate Adaptation Toolkit: Adaptation Actions Search and Foundational Resources.

Adaptation Actions Search. Open the Climate Adaptation Toolkit and click on Adaptation Actions Search (under 'Tools'). Narrow the list of resources using the filters along the right-hand side of the webpage. For example, if your habitat type is Beach/Dune, select Sea-level Rise (under 'Target Climate Changes and Impacts') and Coastal (under 'Habitat'). This limits the resources (e.g., planning documents, tools) to a smaller group that may have adaptation strategies relevant to Beach/Dune.

Foundational Resources. Open the Climate Adaptation Toolkit and click on Foundational Resources (under 'Tools'); navigate to the Planning section. Any resources listed here may contain adaptation strategies and actions relevant to your habitat type.

We recommend starting from the first entry point, **Habitats/Locations**, to begin identifying adaptation strategies and actions for your habitat type. Use additional entry points, as needed, to develop a more complete portfolio of options. Write down any adaptation strategies that address the vulnerabilities listed in Column A. For each adaptation strategy listed in Column B, evaluate its implementation cost (Column C), efficacy (Column D), and co-benefits and conflicts with other resources (Column E):

- **Implementation Cost** (High/Medium/Low) – What is the financial cost to implement the strategy? Is it a one-time implementation cost or is sustained funding required for maintenance and/or monitoring?
- **Efficacy** (High/Medium/Low) – Is the strategy likely to reduce vulnerability and help you achieve your desired goal?
- **Co-benefits and Conflicts** – List any potential co-benefits or conflicts with other resources.

Important Points

- Use vulnerability assessment results to identify adaptation options that reduce exposure (i.e., likelihood) and sensitivity (i.e., consequence) and increase adaptive capacity.
- Climate adaptation reflects the intentional integration of climate change into your work. This likely means you will continue to implement some of your same management actions, modify some of your current actions so they better address climate vulnerabilities, and identify some novel actions that will need to be implemented in response to climate change.
- Build a portfolio of adaptation options that represent a range of approaches (i.e., resistance, resilience, response/direct, knowledge, collaboration, accept change/no action).
- Stakeholder participation early in your assessment is key, as stakeholders frequently have local knowledge and experience to share—information that can be vital to your assessment. Additionally, it builds informed buy-in into the process and findings.
- Consider ways in which to take advantage of the opportunities presented by climate change.

Part 4
Implementation & Integration

Once you have identified adaptation options, it's time to put them into action, whether it's implementing new regulations, processes, or actions or adjusting existing management activities. The next step is all about integrating climate-informed thinking into what you do on a regular basis.

Learning Objectives

1. Understand how to move from planning to action – you know what needs to be done, so how do you do it?
2. Explore how to leverage case studies, planning documents, and experts to implement your desired actions.
3. Develop an understanding of how to "institutionalize" adaptation into your work and your agency so that it becomes the standard way you do business.

Implementation

Putting adaptation strategies into action is the most important step of climate-informed planning, but it can also be incredibly challenging. Strategies for successful implementation include: identifying thresholds to trigger certain actions, creating a timeline of actions for implementation, finding partners to share the work and costs, and identifying barriers ahead of time and strategies to overcome them. Barriers to implementation, and potential strategies to overcome them, may include:

- Limited resources (e.g., time, staff, funding) – leverage or engage non-traditional or new partnerships
- Lack of political will and public perception issues – involve the community in your work to educate and build support; focus on the risks of inaction to the things they care about
- Lack of leadership – spend time educating staff and leadership within your agency about the risks and impacts of climate change
- Lack of agreement in selecting options for implementation – conduct pilot studies of multiple options
- Institutional roadblocks – demonstrate success from other case studies; emphasize the risks of inaction
- Lack of certainty – evaluate the tradeoffs and quantify the risks of action vs. inaction; if implementing an action, set incremental targets to determine if progress is being made in the intended direction as a way to build certainty/demonstrate attribution

Explicitly documenting what you need to implement a given adaptation strategy, identifying where potential barriers may arise, and identifying strategies for overcoming those barriers can help you to overcome the inertia that often occurs with this step.

Exercise 4. **Adaptation Strategy Implementation and Integration**

Part I. Adaptation Strategy Implementation

About this Exercise

In the previous exercise, you identified adaptation strategies that can help address the challenges to your habitat type brought by climate change. In this exercise, you will use the Adaptation Actions Table, Adaptation Actions Search, Foundational Resources, and Experts in the Climate Adaptation Toolkit to develop and describe the resources needed to put these strategies into action.

Exercise Goal

Build an implementation plan for at least three of your adaptation strategies.

Instructions

Refer to the adaptation strategy table you developed in the previous exercise. Transfer those strategies evaluated as having High or Moderate efficacy and Low or Moderate cost to Column A in the Adaptation Strategy Implementation table. For each strategy, identify the following:

- **Leader and potential partners** (Column B) – What agency, organization, or individual would be responsible for leading the implementation of this strategy? Who are key partners to involve?
- **Funding** (Column C) – Is funding needed to implement this strategy? Can existing funding be repurposed or is there a likely source for new funding?
- **Existing or needed management mechanisms** (Column D) – Does the mandate to enact the strategy exist or would policy need to change? Are there legal barriers to implementing the strategy?
- **Timeline** (Column E) – When should the strategy be implemented? Near-term (i.e., within the next 5 years), mid-term (5-10 years), or long-term (>10 years).

Pacific Rim National Park Reserve, Jennifer Yakimishyn

Use the Climate Adaptation Toolkit to help you fill out Columns B-E. There are a number of entry points that you can use, including:

Adaptation Actions Table. Open the Climate Adaptation Toolkit and click on Adaptation Actions Table (under 'Tools'). Use the Search bar to find your adaptation strategy and its associated Case Studies and Tools & Resources; you will be relying on the associated case studies, tools, and resources to find implementation details that you can use in your worksheet. For example, enter in the term "migration," locate the row for Beach/Dune that has the action "anticipate and facilitate inland/upland migration," and find the case study for managed retreat at Surfer's Point. Click on the case study and select the Surfrider Foundation–Ventura project file. This will take you to the project page, where you can find the latest information on their phased implementation plan, including how and what they implemented.

Adaptation Actions Search. Open the Climate Adaptation Toolkit and click on Adaptation Actions Search (under 'Tools'). Narrow the list of resources using the filters along the right-hand side of the webpage, select one of the resources listed, and review the document for implementation details. For example, if your habitat type is Beach/Dune, select Sea-level Rise (under 'Target Climate Changes and Impacts') and Coastal (under 'Habitat'). Select the first resource "Adaptation Toolkit: Sea-level Rise and Coastal Land Use" and open the attached file, which details many different land-use practices that governments can use to adapt to sea-level rise. Scroll to page 19 in the document, which provides a number of ways in which local governments can use zoning in response to sea-level rise and gives an example of a program implementing zoning.

Foundational Resources. Open the Climate Adaptation Toolkit and click on Foundational Resources (under 'Tools'). Review the resources listed under Implementation/Integration to find relevant implementation details for your adaptation strategies. For example, select the resource "Panorama: Solutions for a Healthy Planet: Marine and Coastal Solutions". Narrow the list of solutions using the filters below the search bar. Review relevant solutions to find implementation details such as leaders and partners, funding, and lessons learned.

Experts. Open the Climate Adaptation Toolkit and click on the Experts tab to find people and resources to assist you in developing your implementation plans.

Integration

Adapting to climate change is not a one-time action. Rather, it requires mainstreaming adaptation into your work on a daily basis. Mainstreaming adaptation exploits the planning and implementation mechanisms that are already in place within agencies, organizations, countries, or other decision-making bodies. Mainstreaming can occur by integrating climate considerations into ongoing planning and implementation as they are carried out or by developing adaptation strategies separately and then inserting them into plans and projects already scheduled for implementation.

Integrating, or operationalizing, climate adaptation into the way you manage your protected area will ensure that as climate science improves and as the field of climate adaptation continues to progress, you will be ready to incorporate that new information in your management practices. This will look different across protected areas, based on how each is managed. As an example, the Office of National Marine Sanctuaries in the United States is working toward operationalizing climate planning by incorporating climate considerations into each step of the Sanctuary management cycle. This typically begins with an update to the site's Condition Report, a snapshot of the current condition of the site's resources, followed by a climate vulnerability assessment to understand the projected future condition of the site's resources, and finally an update to the site's management plan to ensure the management approaches and strategies are climate-informed and based on the results of the climate vulnerability assessment.

Eduardo Prieto

Alejandro Boneta

Part II. Climate Adaptation Integration

About this Exercise

In this exercise, you will discuss the ways in which adaptation can be mainstreamed into your projects, programs, and day-to-day work. This is often referred to as "institutionalizing" or "operationalizing" climate adaptation.

Exercise Goal

Identify opportunities for integrating adaptation in your work and make climate adaptation part of all management processes related to your agency's work.

Instructions

Complete the Adaptation Integration worksheet.

Important Points

- Putting your adaptation strategies into action is the most important step, but also very challenging. Explicitly documenting what you need to implement a given strategy, identifying where potential barriers may arise, and identifying strategies for overcoming those barriers can help you to overcome the inertia that often occurs with this step.
- Operationalizing climate adaptation into the way you manage your protected area will ensure that as climate science improves and as the field of climate adaptation continues to progress, you will be ready to incorporate that new information in your management practices.

Part 5
Evaluation & Sharing

The next step of climate adaptation planning is to determine what is working and what is not by developing a monitoring and evaluation plan for your adaptation strategies. Monitoring and evaluation are critical to integrate into your efforts to minimize the risk of wasting time, money, and effort. Lastly, it's important to share what we have learned with others—what did you do and how did you do it? Were there specific challenges and, if so, how did you overcome them? The likelihood of long-term success is improved if we share with and learn from others.

Learning Objectives

1. Understand how to develop a plan to monitor and evaluate the efficacy of your actions.
2. Understand how best to share your project, including successes and failures, with the marine protected areas community.

Monitoring and Evaluation

Monitoring progress and evaluating the efficacy of strategies is an essential part of climate adaptation. Monitoring helps you to understand whether or not adaptation strategies are having their intended effect and may indicate when and where changes in management actions might be needed. While it is critical to monitor the results of your adaptation strategies (i.e., is vulnerability being reduced?), it is also important to monitor changes in climate variables (e.g., temperature, salinity) and associated impacts on species and habitats (e.g., reduced abundance, range shifts).

Strategies for successful monitoring and evaluation include: identifying indicators to track progress along the way to meeting a desired outcome, finding ways to use existing MPA monitoring efforts to tell you something about climate change, and sharing information and learning with stakeholders and partners. Barriers to monitoring and evaluation, and potential strategies to overcome them, may include:

- Being unable to discern progress toward a desired outcome — identify indicators and track periodic targets along the way to meeting a desired outcome.
- Limited resources (e.g., time available, staffing, funding) — look at what you are currently monitoring and explore what it can tell you about climate change. *Example: increased sediment delivery could indicate an increase in the frequency of extreme precipitation events.*

Exercise 5. **Monitoring and Evaluation**

About this Exercise

In an earlier exercise, you identified adaptation strategies to address the impacts of climate change on your habitat type. In this exercise, you will use the Adaptation Actions Table, Foundational Resources, and Experts in the Climate Adaptation Toolkit to develop a monitoring and evaluation plan to help determine whether or not your adaptation strategies are having their intended effect.

Exercise Goal

Build an implementation plan for at least three of your adaptation strategies.

Instructions

Transfer the adaptation strategies from Exercise 4 (Part I) into Column A of the Monitoring & Evaluation table. For each strategy, identify the following:

- **Desired outcome(s)** (Column B) – Once implemented, what should the adaptation strategy successfully achieve (i.e., what is the change you want to see in the system)? *Example: no significant decrease in intertidal and subtidal habitats, including restored mudflat*
- **Monitoring parameter & method** (Column C)[10] – What should be measured to assess effectively and efficiently whether you are achieving your desired condition? How will you measure it? *Example: monitoring parameter – area of restored mudflat; method – bathymetry and LiDAR survey every 5 years*
- **"Red flag" indicator** (Column D) – What if the adaptation strategy is not meeting the desired outcome(s)? It is important to identify a "red flag" indicator or threshold that signals a diversion from the desired outcome. Managers can then reassess the status of the project and consider new management actions. *Example: outboard mudflat decreases greater than the range of natural variability*

Luis Bouillon Cob

10. The same monitoring parameter and method can apply to one or more adaptation strategies.

Use the Climate Adaptation Toolkit to help you fill out Columns B-D. There are a number of entry points that you can use, including:

Adaptation Actions Table. Open the Climate Adaptation Toolkit and click on Adaptation Actions Table (under 'Tools'). Use the Search bar to find your adaptation strategy and its associated Case Studies and Tools & Resources; you will be relying on the associated case studies, tools, and resources to find monitoring and evaluation details that you can use in your worksheet. In particular, look for the (EV) tag, which indicates a monitoring and evaluation component. For example, search for the term "natural infrastructure," locate the row for Estuary/Wetlands/Mudflats, and find the South Bay Salt Pond Restoration Project case study. In the case study, click on the link to the project website. Once there, search "adaptive management plan" and download or open the plan to see the monitoring table they created to evaluate restoration progress. As you review the case studies, tools, and resources to find relevant monitoring and evaluation information, also consider contacting project leads with any questions.

Foundational Resources. Open the Climate Adaptation Toolkit and click on Foundational Resources (under 'Tools'). Review the resources listed under Evaluation to find relevant documents that will help you design your monitoring and evaluation plan. For example, select the CoastAdapt resource to see sample monitoring parameters and methods.

Experts. Open the Climate Adaptation Toolkit and click on the Experts tab to find people and resources that can assist you in developing the monitoring and evaluation plan.

G. Davis

Sharing

Sharing your adaptation work more broadly helps others in the adaptation community. The larger and more open we make the adaptation community, the more we can learn, improve our adaptation practices, and increase the likelihood of successful conservation efforts in the face of climate change. As you move forward with adaptation planning, consider sharing your progress by submitting a case study to the Climate Adaptation Knowledge Exchange (CAKE, www.cakex.org). Even if you are in the early stages (e.g., have recently completed a vulnerability assessment), it may help others to learn about what you did, including any challenges or lessons learned.

Use the following template as a guide to sharing your adaptation project on CAKE:

1. **Project background** – Provide basic information about the project, such as where and why the project was started, the resources on which you are focused, and the climate impacts of concern.
2. **Project implementation** – Provide details on how the project is being implemented, including your methods and partners involved.
3. **Project outcomes** – Provide details on any outcomes or lessons learned from the project, including products, challenges that arose and how they were overcome, factors critical to the project's success (e.g., extensive stakeholder engagement, dedicated leadership, funding, etc.), and next steps.

Use the case studies in the Climate Adaptation Toolkit (found under the Adaptation Actions Table or Adaptation Actions Search of the 'Tools' menu) as a guide for the level of detail to include when sharing your project.

Important Points

- Monitoring and evaluation plans can measure the efficacy of adaptation strategies toward achieving outcomes (e.g., reducing vulnerabilities, meeting goals or objectives) and help determine why strategies were or were not successful.
- In addition to monitoring the efficacy of strategies, it is important to track changes in climate stressors and associated ecological responses.
- Sharing the results of your project helps build capacity and learning in the field of climate adaptation and the MPA community.

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Worksheets

Exercise 1. **Project Scoping**

1. Habitat Selection

Select one habitat type to focus on for your assessment. Some examples include: rocky intertidal, beaches and dunes, mangroves, coral reefs, seagrasses, and pelagic, among others.

2. Habitat Definition

Describe/define this habitat type. For example: Coastal cliffs are located along rocky portions of the coastline; these are vertical or near-vertical rocky faces above the water line that provide habitat for seabirds and are subject to erosion due to exposure to wave action, sun, wind, and rain.

3. Project Boundary

Describe/define the project boundary. For example: We are considering coastal cliffs that extend from the Oregon border south to the Sonoma County border in California.

4. Human Uses and Ecosystem Services

Describe the human uses and/or ecosystem services provided by this habitat type. Ecosystem services include things such as provisioning (e.g., food, fiber, natural medicines, fresh water), regulating (e.g., flood and erosion control, water purification, natural hazard regulation), supporting (e.g., primary production, nutrient cycling), and cultural (e.g., spiritual and religious, cultural heritage, recreation, educational values).

5. Assessment Timescale

From the following list, select the timescale you will use for the vulnerability assessment. Write it in the box below.

- Near term (present to 10 years)
- Medium term (next 50 years)
- Long term (next 100 years)
- Very long term (next 100+ years)

Timescale: _____

6a. Climate Stressors

Rank each climate stressor below on a scale from little to no impact on your habitat type (i.e., Low) to very significant impact on your habitat type (i.e., High).

	Low impact	Moderate impact	High impact
Increased water temperature	☐	☐	☐
Diminished dissolved oxygen	☐	☐	☐
Altered precipitation patterns	☐	☐	☐
Altered storm frequency/severity	☐	☐	☐
Increased wave action/coastal erosion	☐	☐	☐
Sea-level rise	☐	☐	☐
Altered upwelling/mixing	☐	☐	☐
Increased ocean acidification	☐	☐	☐
Increased harmful algal blooms	☐	☐	☐
Altered currents	☐	☐	☐
Increased turbidity	☐	☐	☐
Altered salinity	☐	☐	☐
Altered ENSO/PDO	☐	☐	☐

Other (describe) _____

6b. Select Significant Climate Stressors

From your rankings above, select the three (3) most significant (i.e., High impact) climate stressors for your habitat type. Write these in the text boxes below (i.e., Climate Stressor #1). If you identified more than three (3) High impact stressors in the table above, use the box below to document your rationale for why you selected the final stressors over the others also ranked as High impact.

Climate Stressor #1

Climate Stressor #2

Climate Stressor #3

7a. Non-Climate Stressors

Rank each non-climate stressor below on a scale from little to no impact on your habitat type (i.e., Low) to very significant impact on your habitat type (i.e., High).

	Low impact	Moderate impact	High impact
Land-source nutrient pollution	☐	☐	☐
Land-source non-nutrient pollution (e.g., plastics, PCBs, PAHs)	☐	☐	☐
Marine-source pollution and spills	☐	☐	☐
Development/population growth	☐	☐	☐
Harvest	☐	☐	☐
Aquaculture	☐	☐	☐
Overwater/underwater structures	☐	☐	☐
Invasive species	☐	☐	☐
Disease	☐	☐	☐
Tourism/recreation	☐	☐	☐
Extraction (mining, oil & gas)	☐	☐	☐
Energy production	☐	☐	☐
Roads/armoring	☐	☐	☐
Noise	☐	☐	☐
Dredging	☐	☐	☐
Transport (shipping, oil & gas)			
Other (describe)			

7b. Select Significant Non-Climate Stressors

From your rankings above, select the three (3) most significant (i.e., High impact) non-climate stressors for your habitat type. Write these in the text boxes below (i.e., Non-Climate Stressor #1). If you identified more than three (3) High impact stressors in the table above, use the box below to document your rationale for why you selected the final stressors over the others also ranked as High impact.

Non-Climate Stressor #1

Non-Climate Stressor #2

Non-Climate Stressor #3

Exercise 2 (Part I).
Climate Change Impacts Summary

Habitat: _____ **Timescale:** _____

Ⓐ Climate stressor	Ⓑ Change to date	Ⓒ Projected change	Ⓓ Trend	Ⓔ Confidence

References

Exercise 2 (Part II).
Vulnerability Assessment

Habitat: _____ **Timescale:** _____

Table 1. Climate Change Vulnerability Assessment

Ⓐ Climate stressor	**Ⓑ Observed or projected change** (direction and magnitude; relevant details)	**Ⓒ Anticipated effects on your habitat type**	**Ⓓ Likelihood**	**Ⓔ Consequence** (Table 2)	**Ⓕ Risk** (Figure A)	**Ⓖ Adaptive Capacity** (Table 3)	**Ⓗ Vulnerability Level** (Figure B)

Table 2: Consequences

Ⓐ Non-climate stressor	Ⓑ How does this stressor affect your habitat type?	Ⓒ Will climate change make this better or worse? (+/-)	Ⓓ What is the combined impact of this non-climate stressor and... [Insert your three climate stressors here]		
Consequence Assess the consequence of the direct effect of the climate stressor in tandem with existing non-climate stressors on this habitat type. (**Negligible**, **Minor**, **Moderate**, **Major**, **Catastrophic**)					

Figure A. Risk = Likelihood x Consequences

Likelihood	Consequences				
	Negligible	Minor	Moderate	Major	Catastrophic
Rare	Low	Low	Low	Low	Low
Unlikely	Low	Low	Moderate	Moderate	Moderate
Possible	Low	Moderate	Moderate	High	High
Likely	Low	Moderate	High	High	Extreme
Almost certain	Low	Moderate	High	Extreme	Extreme

Figure B. Vulnerability = Risk x Adaptive Capacity

Risk	Adaptive Capacity		
	Low	Moderate	High
Low	Low	Low	Low
Moderate	Moderate	Moderate	Low
High	High	Moderate	Moderate
Extreme	High	High	Moderate

Table 3: Adaptive Capacity

Assess the status and condition of each factor of Adaptive Capacity for your habitat type.
Rate on a scale from 1-5 (5=Superior, 4=Good, 3=Fair, 2=Poor, 1=Critical)

Ecological potential	Rating	Rationale & notes
Extent, Distribution & Connectivity		
Past Evidence of Recovery		
Value/Importance		
Physical Diversity		
Biodiversity		
Keystone & Indicators Species		
Other:		
Average		

Social potential	Rating	Rationale & notes
Organization Capacity		
Staff Capacity (training, time)		
Responsiveness		
Stakeholder Relationships		
Stability/Longevity		
Other:		
Management potential		
Existing Mandate		
Monitoring & Evaluation Capacity		
Ability to Learn and Change		
Proactive Management		
Partner Relationships		
Science/Technical Support		
Other:		
Average		

Combined Average		
Adaptive Capacity		
Convert average to adaptive capacity rating: Low = 1–2.3; Moderate = 2.4–3.6; High = 3.7–5		

Adaptive Capacity Factor Descriptions

Ecological Potential

To help in the evaluation of the ecological potential factors of adaptive capacity, consider the following explanation of each factor. Keep in mind that you do not need to evaluate a factor that does not apply to your habitat, and that you can add a more relevant factor to evaluate in the "Other" line.

Extent, distribution & connectivity: Habitats with high integrity and continuity, and that are currently widespread in their geographic extent, are likely to have greater adaptive capacity and may be more likely to withstand climatic and non-climatic stresses and persist into the future. Habitats that are degraded, isolated, limited in extent, or that are currently declining due to non-climatic or climatic stresses, are likely to have less capacity and may be less likely to persist into the future.

Past evidence of recovery: Some habitats may have more rapid regeneration times and/or are dominated by species with short generation times. Habitats with a shorter period of recovery from the impacts of stressors (<20 years) may have greater inherent ecological adaptive capacities than slower developing/recovering habitats (>20 years), which may be more inherently vulnerable to the potential intervening effects of climate change.

Value/importance: Is the habitat highly valued ecologically or societally? Habitats with a high societal value likely have higher adaptive capacity, as people may have a greater interest in protecting and/or maintaining them and the ecosystem services they provide. Habitats may be ranked as having high ecological value due to greater compositional heterogeneity/variability, or as a result of their high value they may benefit from greater conservation prioritization, either of which could confer greater adaptive capacity.

Physical diversity: Habitats that include diverse physical and topographical characteristics (e.g., variety of aspects, sediment types) may have higher adaptive capacity. Also known as heterogeneity, such sites could have a more varied depth profile, complex currents, north and south facing habitat, or other variable physical features that could confer adaptive advantage.

Biodiversity: The level of diversity of component species and functional groups in a habitat may affect the adaptive capacity of that habitat to climate change impacts. For example, habitats with multiple species per functional group likely have greater adaptive capacity because response to changes in climate varies among the species. Greater biodiversity in terms of variety and number of component species and functional groups may increase potential adaptive capacity for a given habitat at a given location.

Keystone and indicator species: A habitat may include populations of important species, whether protected, endangered, or ecologically critical. The adaptive capacity of these species should be evaluated on your assessment of their condition. Habitats where keystone and indicator species are in better condition may have greater adaptive capacity.

Social Potential

To help in the evaluation of the social potential factors of adaptive capacity, consider the following explanation of each factor. Keep in mind that you do not need to evaluate a factor that does not apply to your habitat, and that you can add a more relevant factor to evaluate in the "Other" line.

Staff capacity (training, time): It is useful to consider the diversity of expertise, the understanding and confidence in addressing climate change challenges, and the institution's ability to be flexible and accommodate additional management responsibility and effort. Few resource management professionals have been trained in climate science and adaptation. Adaptive capacity can be greater if you have staff with the right professional training and the time to apply it.

Responsiveness: The ability of an organization to adjust its management and structure may be necessary in responding to climate change. In some cases, this could be a dramatic shift, such as changing a site's management strategies from restoration to retreat for a habitat type. Does your management structure allow you to stop taking action and accept the loss of a once-protected resource? In other cases, responsiveness may be more subtle, such as changing the timing of actions, including seasonal or temporary closures during periods of high stress.

Stakeholder relationships: Many adaptation actions will require changes in management. In some cases, this will require stakeholder buy-in or action. Having good stakeholder relationships can enhance adaptive capacity.

Stability/longevity: Organizations that have short planning horizons, short governance structures or lack long-term commitment will have less adaptive capacity as there may not be any ability to follow through on needed actions.

Existing mandate: If management mandate does not exist for the habitat or it cannot be interpreted to include climate change planning, adaptive capacity is diminished.

Monitoring and evaluation capacity: Even if you have the ability to implement actions, if you cannot measure its efficacy through monitoring and evaluation procedures you will not be able to know if it is effective or if it needs modification to improve outcomes. Adaptive capacity is enhanced when monitoring and evaluation are part of management practice.

Ability to learn and change: Having a culture or structure that allows for modification of management actions as new information is acquired is vital to effective adaptation. Often referred to as adaptive management, organizations where this is common practice will have a higher adaptive capacity.

Proactive management: Often adaptation actions will need to be put into practice before a problem becomes evident. For example, planning for range shifts of species of concern may require changes in species management or habitat restoration before a species arrives at a new location. If proactive management can be practiced, adaptive capacity will be enhanced.

Partner relationships: When adaptation actions require transboundary or interagency cooperation, it is essential to have strong partner relationships. Partners will need to have a common understanding of climate projections, vulnerabilities, and adaptation options. In cases where partner relationships are strong, adaptive capacity may be greater owing to the ability to work collaboratively and flexibly to make management changes as needed.

Science/technology support: Climate science advances daily. Having access to science partners or inhouse science expertise is essential for maintaining a sufficient awareness of current understanding of processes to make informed management decisions. Adaptive capacity will be improved when science and technology support are available.

Exercise 3.
Adaptation Strategy Development

Habitat: _____

Ⓐ Vulnerability (climate stressors & anticipated effects)	**Ⓑ Adaptation strategy**	**Ⓒ Cost** (H/M/L)	**Ⓓ Efficacy** (H/M/L)	**Ⓔ Co-benefits & conflicts**

Exercise 4 (Part I).
Adaptation Strategy Implementation

Habitat: _____

Ⓐ Strategy	Ⓑ Leader and potential partners	Ⓒ Funding	Ⓓ Existing or needed management mechanisms	Ⓔ Timeline

Exercise 4 (Part II).
Adaptation Strategy Implementation

There is no one "right way" to operationalize or integrate climate adaptation into the management of your protected area. For the exercise, consider the following questions as opportunities to explore how you might ensure your protected area is managed in a climate-informed way. The ultimate goal is to ensure that the impacts of climate change are always considered in the management of a protected area.

1. What is the process by which your site's management plan, or guiding document, is updated? Consider how climate change (e.g., vulnerabilities, adaptation) can be integrated into this process.

2. What current projects or programs are already incorporating climate change (e.g., vulnerabilities, adaptation)? Consider how you can expand upon these, or extend a similar process to other programs.

3. Is your agency leadership and/or site staff knowledgeable regarding climate impacts? Consider how to help all staff and relevant decision-makers realize that climate change will affect everything in their work.

4. Do your current policies, permits, regulations, etc., explicitly consider the impacts of climate change? If not, how could you make these management processes more climate-informed?

5. Who must be consulted when making management decisions (e.g., an advisory body, tribal communities, etc.)? Consider how to ensure these consultations incorporate climate change.

Exercise 5.
Monitoring & Evaluation

Habitat: _____

Ⓐ Strategy	**Ⓑ Desired outcome(s)** (once implemented, what should your strategy achieve?)	**Ⓒ Monitoring parameter & method**	**Ⓓ Red flag indicator** (identify a threshold that will indicate if the strategy is diverging from the desired outcome)

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