Guide for Considering Climate Change in Coastal Conservation

National Oceanic and Atmospheric Administration (NOAA)
Office for Coastal Management

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NOAA Writing Team

Lauren Long, The Baldwin Group
Rachael Franks Taylor, The Baldwin Group
Elaine Vaudreuil, NOAA Office for Coastal Management
Bethney Ward, NOAA Office for Coastal Management

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Nancy Cofer-Shabica, NOAA Office for Coastal Management
Matt Lettrich, NOAA Fisheries
Laura McKay, Virginia Coastal Zone Management Program
Mike Molnar, Indiana Lake Michigan Coastal Program
Shep Moon, Virginia Coastal Zone Management Program
Kim Penn, NOAA Office for Coastal Management
Nadine Peterson, California Coastal Conservancy
Beth Polak, Virginia Coastal Zone Management Program
Sacha Spector, Scenic Hudson
Rachel Stevens, Great Bay National Estuarine Research Reserve
Kim Wren, Apalachicola National Estuarine Research Reserve

Table of Contents

Executive Summary

Climate change is altering the way coastal conservation is approached and must be considered to protect the ecological integrity of natural habitat over the long term. Conservation plans that target lands or habitats offering natural protective benefits for communities represent an important climate adaptation strategy.

There is a gap, however, between land conservation theory and practice when considering climate. This guide lessens this gap and provides a step-by-step approach, with links to relevant tools, information, and other resources. The approach should be familiar to those already practicing strategic conservation planning, but unlike other guides, this document focuses on climate considerations and tools specifically relevant to the coastal environment, including coastal watersheds.

The six iterative steps, described here, draw on existing guidelines for conservation, as well as newer climate adaptation resources. The information is suitable for anyone working to manage or conserve lands in coastal areas, such as coastal planners, land or watershed conservation organizations, wetland and floodplain managers, emergency managers, and more. The approach provided in this guide can be used to create a new plan if one is needed, to update an existing plan, or to further other types of planning, such as hazard mitigation or comprehensive plans. Overall, the approach encourages groups from different sectors to work toward similar or complementary goals.

The steps are outlined on the next page. If you have already identified conservation goals or developed a conservation plan and are mainly interested in assessing how climate might affect those conservation priorities, you may wish to skip to the third step.

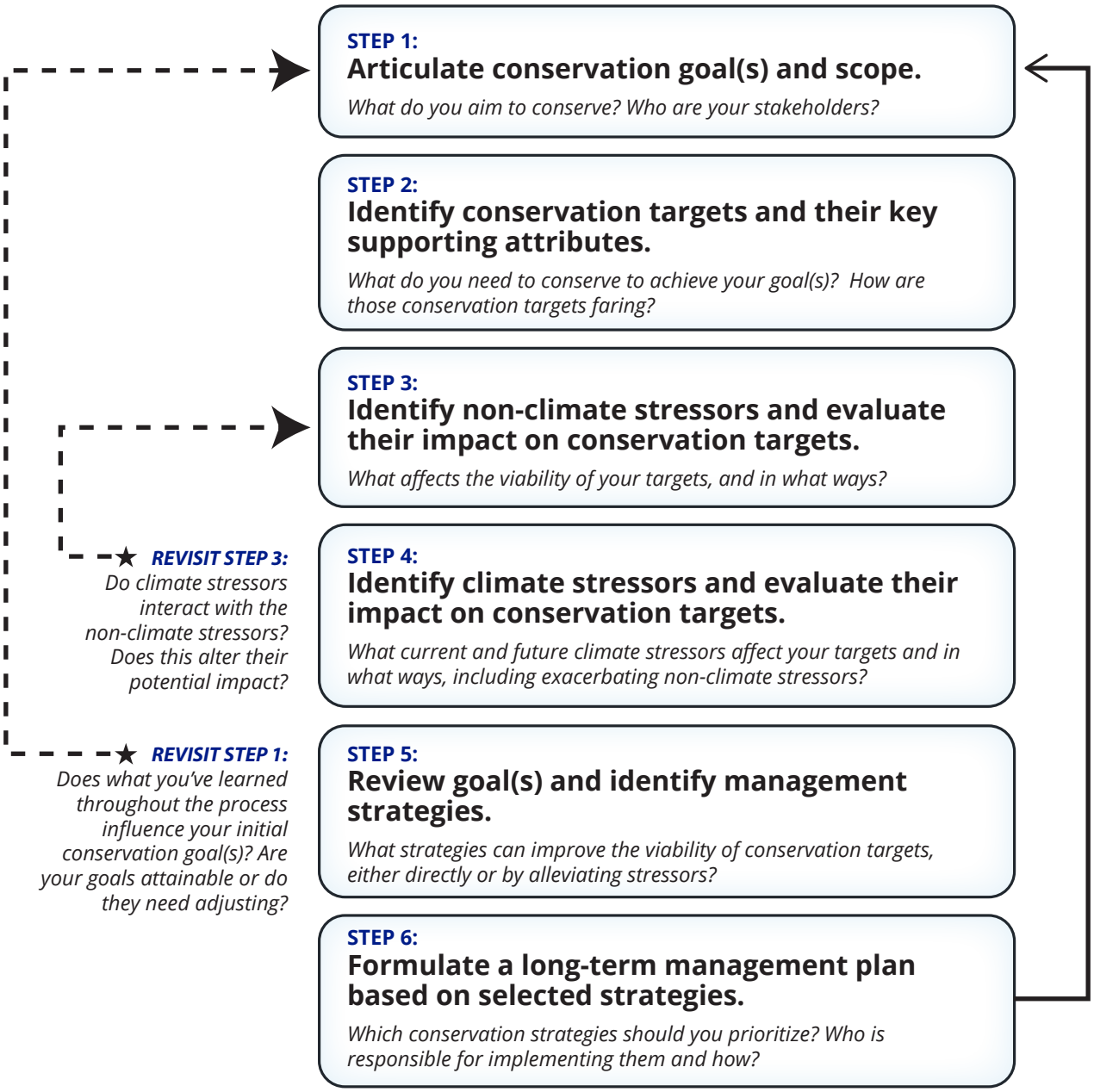


Figure 1. Step-wise process for considering climate change in coastal conservation planning.

Introduction

Global climate observations document shifting climatic conditions. These shifts are changing the distribution of habitats and species, as well as the dynamics among ecosystems (IPCC 2014, USGCRP 2009, Glick and others 2011). And these changes have important implications for land conservation, especially in the coastal zone. While climate stressors can be a challenge for long-term land conservation, actions can be taken to reduce the impact and to facilitate long-term adaptation. This guide can help.

Coastal areas historically are the preferred geography for human settlements and development, making coastal ecosystems one of the most degraded natural systems. Coastal areas also are particularly vulnerable to climate change, with impacts that include increased flooding, erosion, sedimentation, and physical impacts to the built and natural environments. For example, between 2010 and 2015, NOAA documented 49 billion-dollar natural disasters in the United States caused by floods, severe storms, and tropical cyclones. Researchers calculate an upward trend of approximately five percent more billion-dollar disasters each year when looking at data from 1980 to 2011 (Smith and Katz 2013).

Coastal managers must evaluate how conservation efforts might be affected by changing climatic conditions, which will result in communities and natural environments being better prepared for, and able to adapt to, predicted changes, and able to perform valuable ecosystem functions.

This *Guide for Considering Climate Change in Coastal Conservation* gives coastal planners, resource managers, and conservation practitioners a framework needed to accomplish this task. These professionals are often responsible for developing or updating conservation strategies but may not be knowledgeable about how to best incorporate climate change impacts.

Part of the challenge is the continuing gap between theory and practice. Conservation tools and resources vary widely in scope and scale. Some provide high-level strategic assessment, and others provide enough detail for site-level efforts, but require greater expertise or resources. Also challenging are the climate impact reports, which usually provide projections at a large regional or national scale, or for a specific sector (e.g., agriculture or wildlife), but do not provide a comprehensive look across sectors, or details at a local or site-specific scale.

Another challenge is the gap in scientific understanding about species and ecosystem impacts and response. A great deal of research and analysis is taking place, but closing this information gap will take time. This guide takes into account the reality of the evolving knowledge and is flexible enough for users with all levels of expertise in climate-impact assessment to proceed through each step in the process. Understanding the long-term impacts and available solutions can help to overcome institutional challenges that may affect many conservation efforts, such as short planning horizons, reliance on historical trends to drive management decisions, and lack of political will.

This guide is part of NOAA's continuing effort to provide specific, coastal-relevant guidance on preparing for and addressing the impacts of climate change. The guide is an updated version of a 2012 NOAA document, *Voluntary Step-by-Step Guide for Considering Potential Climate Change Effects on Coastal and Estuarine Land Conservation Projects* (NOAA 2012). The original audience was applicants to NOAA's Coastal and Estuarine Land Conservation Program (CELCP). To produce this guide, NOAA reviewed and assessed needs identified by stakeholders interested in incorporating climate adaptation into conservation planning efforts. Based on this research, NOAA revised the 2012 guide to incorporate new and updated tools and resources, and to reach a broader audience of coastal management practitioners working at multiple scales. Although many resources specific to states and regions are now available, this guide primarily focuses on nationally available resources. State coastal zone management programs and Sea Grant programs may be able to help suggest locally relevant resources. Resources that can aid with the overall framework provided in this guide are listed on the next page.

Overarching Resources

- Conservation Action Planning Handbook: Developing Strategies, Taking Action and Measuring Success at Any Scale – this Nature Conservancy handbook provides overall guidance and case studies for each step of the way – *www.conservationgateway.org/Files/Pages/action-planning-cap-handb.aspx*

    - » Conservation Action Planning Workbook – a companion to the handbook, this Excel-based tool is helpful for documenting your work through the process, developing strategies, taking action, and measuring success. It can be downloaded and used by enabling macros – *www.conservationgateway.org/Files/Pages/conservation-action-plannaspx122.aspx*

- Open Standards for the Practice of Conservation – this is an overarching framework developed by the Conservation Measures Partnership that we used to design this guidance – *http://cmp-openstandards.org/wp-content/uploads/2014/03/CMP-OS-V3-0-Final.pdf*

- Climate-Smart Conservation: Putting Adaptation Principles into Practice – the National Wildlife Federation's guidance goes through the entire process, start to finish – *www.nwf.org/pdf/Climate-Smart-Conservation/NWF-Climate-Smart-Conservation_5-08-14.pdf*

- Introduction to Stakeholder Participation – has tips on engaging stakeholders throughout the planning process – *coast.noaa.gov/digitalcoast/training/stakeholder*

- NOAA's Digital Coast – provides a breadth of data, tools, trainings, and other information for uses in coastal management – *coast.noaa.gov/digitalcoast*

Step-by-Step Method

Step 1: Articulate Conservation Goals and Scope

What do you aim to conserve? Who are your stakeholders? What do they care about?

Examples

- Improve water quality of coastal tributaries and nearshore waters
- Reduce coastal flooding using natural areas
- Conserve biodiversity
- Maintain and enhance natural shorelines
- Protect a coastal community from hazards

Why

Before you reach your destination, you need to know where you're going. Clear goals set the foundation for the conservation planning process and are necessary for determining your conservation targets and appropriate management strategies to achieve these goals. They are the key to evaluating where and how to invest time and resources. Whether developing a new conservation plan or revising an existing one, it is important to first identify the conservation goals and geographic scope of the conservation planning effort.

In coastal areas, conservation goals might reflect one or more of the following purposes, among others, to protect or enhance

- Habitat for important species, whether fish, plants, or wildlife, such as vegetated shorelines or corridors that allow species to migrate;
- Lands that provide natural protection against storm damage and shoreline erosion, such as beaches, dunes, or floodplains;
- Lands that absorb floodwaters, filter pollutants, or recharge groundwater aquifers, such as tidal and freshwater wetlands; or
- Open space or other valuable lands for recreation, public access, and scenic enjoyment of the coast.

How

Determine the geographic scope. The geographic scope of the project may be based on the geographic range of a particular species, the watershed of a particular coastal river, or one or more land types of particular interest, among other factors. Depending on the management or policy driver, the scope may reflect jurisdictional boundaries (e.g., city, county, state or territory), but that

approach can lead to challenges when considering ecological or physical features and processes that likely do not match political boundaries. In these cases, you may wish to use coastal watershed boundaries, river stretches, or other ecosystem boundaries to define a planning area and identify other jurisdictions that could contribute to this effort. If your conservation goal or target crosses multiple jurisdictions or areas outside your direct influence, it will be important to engage potential partners in other jurisdictions to help achieve your goal (see stakeholder discussion below).

Understand relevant policy or management drivers. A conservation goal could be informed by policy or management needs such as organizational or strategic goals; applicable laws or regulations; local, state, or regional context (e.g., existing regional plans or initiatives in the area); or other drivers. For example, conservation goals may be driven by a need to protect habitat for threatened or endangered species or habitats facing rapid losses or declines; a community's interest in reducing the cost of flood damages or its flood insurance premiums (see Community Rating System fact sheet under "Resources"); or a desire to preserve open space as part of a strategy to maintain natural areas or promote coastal "smart growth" (see NOAA's *Achieving Hazard-Resilient Coastal and Waterfront Smart Growth Report* under "Resources"). When updating an existing plan, it is also important to confirm any existing or "legacy" conservation goals, as well as identify any goals that should be updated or adjusted. This will be especially important when incorporating climate considerations into existing conservation plans (Stein and others 2014).

Identify and engage relevant stakeholder interests. When defining conservation goals, it is helpful to engage key partners and stakeholders early in the process to look for intersections among your interests and those of community or stakeholder organizations. Engaging stakeholders early may help gain support, and potentially resources, for the implementation of management strategies later. A number of factors should be considered when engaging stakeholders, such as the number and type of stakeholders to involve and when and how to involve them. Stakeholders could include local, state, or federal agencies, nongovernmental organizations (e.g., land trusts, watershed organizations, community groups), or any other trusted or influential groups. Many methods can be used to engage stakeholders, such as focus groups, interviews, and public meetings. NOAA has developed an *Introduction to Stakeholder Participation* guide that will help conservation planners choose which methods are most likely to be effective for them (see "Resources"). Most likely a smaller planning team will need to be established; however, stakeholders should continue to be involved throughout the entire planning process and given opportunities to provide input along the way.

Establish your conservation goals based on the scope, drivers, and stakeholder considerations identified. Climate change can be considered in goal-setting in several ways:

- It can help define the initial conservation goals (e.g., identifying natural areas that will help species or communities adapt); or

- It can help refine existing conservation goals (e.g., identify what shift in conservation targets or management strategies are needed to achieve goals in light of anticipated climate impacts).

Because there are unique considerations for climate adaptation in coastal areas, Step 4 provides additional information on how to identify projected climate stressors within coastal environments.

Resources for Determining the Geographic Scope

- Climate-Smart Conservation: Putting Adaptation Principles into Practice – see pages 71-82 for information on identifying your conservation goal and geographic scope – *www.nwf.org/pdf/Climate-Smart-Conservation/NWF-Climate-Smart-Conservation_5-08-14.pdf*

- NOAA Digital Coast GeoZone Blog: Watershed or County Boundaries? – a short blog that provides some considerations for identifying whether your geographic scope should follow natural or political boundaries – *https://geozoneblog.wordpress.com/2014/08/15/watershed-or-county-boundaries*

- C-CAP Coastal Comparison Tool – explore land cover in different counties and watersheds to decide your geographic scope – *coast.noaa.gov/digitalcoast/tools/ccap-comparison*

Resources for Understanding Policy or Management Drivers

- Achieving Hazard-Resilient Coastal and Waterfront Smart Growth Report – learn how your conservation efforts can be incorporated into community design to achieve hazard resilience, along with other multiple benefits – *http://coastalsmartgrowth.noaa.gov*

- Community Rating System (CRS) Fact Sheet – learn how you can receive points through the Federal Emergency Management Agency (FEMA) CRS program by preserving natural areas within your community's floodplain to maintain or restore natural floodplain functions – *coast.noaa.gov/data/docs/digitalcoast/crs.pdf*

Resources for Identifying and Engaging Stakeholders

- Climate-Smart Conservation: Putting Adaptation Principles into Practice – see pages 77-78 for information on engaging partners – *www.nwf.org/pdf/Climate-Smart-Conservation/NWF-Climate-Smart-Conservation_5-08-14.pdf*

- Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans – see pages 13-17 for engaging stakeholders – *www2.epa.gov/sites/production/files/2014-09/documents/being_prepared_workbook_508.pdf*

- Introduction to Stakeholder Participation – has tips on approaches for doing this – *coast.noaa.gov/digitalcoast/training/stakeholder*

- Stakeholder Analysis Worksheet – worksheet that walks through some basic questions to identify stakeholders and analyze them in order to design the best participatory process - *coast.noaa.gov/digitalcoast/training/stakeholder-analysis-worksheet*

- Adapting to Climate Change: Planning Guide for State Coastal Managers – see pages 9-22 for a list of potential stakeholders to engage – *coast.noaa.gov/czm/media/adaptationguide.pdf*

- To foster community buy-in for your conservation effort, the Green Infrastructure Protective Services Animation (*coast.noaa.gov/greeninfrastructurevis*), Wetlands Benefit Coastal County Snapshot (*coast.noaa.gov/digitalcoast/tools/snapshots*), or CanVis (*coast.noaa.gov/digitalcoast/tools/canvis*) can help communicate community issues, benefits of conservation, and visually show options.

- ENOW Explorer – get graphs and statistics showing how living resources contribute to your area's ocean and coastal economy to help justify their conservation to stakeholders – *coast.noaa.gov/digitalcoast/tools/enow*

Resources for Establishing Conservation Goals

- Adapting to Climate Change: A Planning Guide for State Coastal Managers – see pages 45-51 on setting goals for coastal adaptation – *coast.noaa.gov/czm/media/adaptationguide.pdf*

- Climate-Smart Conservation: Putting Adaptation Principles into Practice – see pages 72-75 for information on identifying your conservation goal – *www.nwf.org/pdf/Climate-Smart-Conservation/NWF-Climate-Smart-Conservation_5-08-14.pdf*

- Coastal Planning Advisor – use to select questions that could help facilitate discussions establishing a conservation goal; sections on Wetland Conservation, Wetland Restoration, Erosion and Shoreline Protection, Nonpoint Source Pollution, Climate Change, and Land Use Planning may be particularly relevant – *coast.noaa.gov/digitalcoast/training/coastalplanningadvisor*

- Open Standards for the Practice of Conservation – see pages 18-24 for more guidance on developing conservation goals – *http://cmp-openstandards.org/wp-content/uploads/2014/03/CMP-OS-V3-0-Final.pdf*

Step 2: Identify Conservation Targets and Their Key Supporting Attributes

What do you need to conserve in order to achieve your goals? How are these targets and attributes faring?

Examples

Conservation Targets:

- Ecologically significant areas such as unfragmented areas, biodiversity hotspots, habitats that support particular species or processes (e.g., maritime forest, tidal wetlands)
- Populations of a particular species or group of species, such as indicator, listed, or other important species (e.g., migratory fish, shorebirds, turtle nesting grounds)
- Lands or habitats that provide a certain ecosystem service or benefit, such as pollutant filtration, storm protection, or groundwater recharge (e.g., coastal wetlands, natural shorelines, floodplain forests)

Key Supporting Attributes or Features:

- Habitat size or extent and connectivity
- Hydrologic connectivity or sediment transport
- Water temperature or salinity tolerances, nutrient levels, etc.

Why

It is critical to understand and identify the land types and other ecological or physical features that are needed to achieve your conservation goals. A "conservation target" generally refers to the physical, biological, or ecological features (e.g., species, habitats, ecological processes, or other entities) that are the focus of one's conservation attention (Stein and others 2014). Conservation targets are the basis for implementing management actions and measuring project effectiveness (CMP 2013). Identifying targets also represents the first opportunity in this process to conduct a spatial analysis, which can determine the location and extent of the lands, habitats, and populations you aim to conserve. In addition, the health or long-term viability of a conservation target may depend on the underlying ecological forces that sustain it. Therefore, once conservation targets are identified, it is critical to keep in mind the ecological or other attributes underpinning those targets that are important for sustaining their health and functionality over time ("key supporting attributes").

How

Identify the conservation targets that, taken together, represent the most critical elements that contribute to the conservation goals identified in Step 1. The conservation target is the subject of the conservation goal described in Step 1, but provides more detail on the characteristics of natural areas that will support the conservation goal. For example, if the conservation goal is to "reduce coastal flooding using natural areas," it is important to identify the specific land or habitat types that provide flood protection benefits, such as wetlands or other vegetated lands (e.g., forests). These

become the conservation targets. A summary of several coastal habitat types and their benefits for coastal risk reduction is provided in the Appendix 2. NOAA's Green Infrastructure Mapping Guide (*coast.noaa.gov/digitalcoast/training/gi-mapping*) provides examples and case studies for translating conservation goals into mapping objectives to identify and map the location of conservation targets.

Identify the key supporting attributes, ecological or physical elements or features that support the conservation targets. These attributes are aspects of a conservation target's biological or ecological requirements that, if present, define a healthy target or, if missing or altered, would lead to the outright loss or extreme degradation of that target over time (CMP 2013). For example, particular wetland types depend not only on water supply (freshwater vs. tidal), but are sensitive to changes in water level, salinity, and structure of the adjacent shoreline. Understanding how these attributes support your conservation targets is valuable in highlighting stressors that will have the most significant effect on the conservation targets, as well as illuminating how changing climatic conditions might fundamentally affect your conservation targets. The Nature Conservancy's Conservation Action Planning framework (Nature Conservancy 2007) provides a list of key ecological attributes that can be considered (see "Resources").

Identify the spatial location or extent of your selected conservation targets. Identifying the location of your targets can be done in several ways:

- If you have access to geographic information system (GIS) software and expertise, GIS is an effective tool for generating maps that show multiple conservation targets. NOAA's Coastal Change Analysis Program (C-CAP) land cover data provides spatial information on coastal landscapes, and NOAA's Habitat Priority Planner (available for ArcGIS 9.0-10.2) enables spatial analysts to classify land cover data to reflect project goals.

- If you *do not* have access to GIS tools or expertise, you can consult individual data sources for each of your conservation targets. For example, many states and conservation organizations have maps or databases of species locations or range. Floodplain maps are available to download and print. There are also a number of tools to help visualize conservation targets without needing advanced GIS software or expertise. See "Resources" below, for a list of data sources or other tools that can assist with this step, such as NOAA's Land Cover Atlas.

- **Note:** Some key ecological or physical attributes might also be factored into a spatial analysis to help prioritize occurrences of conservation targets within the planning area. For example, if salinity is a key attribute, you could use available monitoring data within your spatial analysis to identify areas that are near their maximum or minimum salinity threshold. (This can be done in Step 2 before considering climate, or later, in Step 6 after considering climate.)

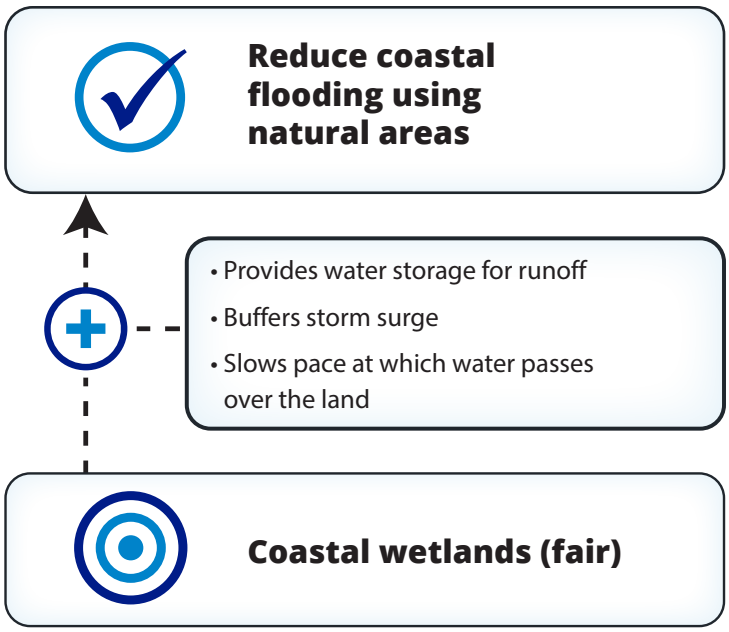
Assess the health of your conservation targets. The Nature Conservancy's Conservation Action Planning framework (Nature Conservancy 2007) provides a process for describing the health of a conservation target by assigning it a "viability rank" (see "Resources"). This viability assessment is important because it provides a framework for defining the current status and desired future condition of conservation targets, and helps underscore the relationship between conservation targets and key supporting attributes. Once defined, the current status can also serve as your baseline condition for monitoring change over time. This assessment also becomes important when considering stressors and their relative significance to your targets' health. The difference between the current status and desired future condition informs the strategies to employ in later strategy-development steps. It may point to opportunities for land protection as a strategy if seeking to maintain current condition and conservation context. On the other hand, it may require a strategy of intervention if the target or one of its attributes is not viable or is trending downward, requiring more aggressive action to remain or become viable.

As you consider the health of your conservation targets and how this health is likely to change with current and future stressors, it is also helpful to begin to start to wrestle with trade-offs. Will your planning effort focus on improving the viability of struggling targets or focus more on maintaining targets that are in good condition? Although this is not a binary decision, starting to consider return on investment early in the process can help when identifying and prioritizing strategies later. The concept of ecological tipping points may also be a useful one to familiarize your team with early on. A tipping point refers to a phenomenon when a small, incremental change can lead to a non-linear response, greater in magnitude than anticipated. How might your targets be susceptible to such changes? As you consider climate and non-climate stressors, which may be particularly prone to create these non-linear responses? A team in the Great Lakes created a decision-support tool (*www.tippingpointplanner.org*) to help planning teams walk through an analysis of thresholds that may exist within a chosen watershed; although it is focused on the Great Lakes region, the process may be useful for others.

A Note on Conceptual Models

Conceptual models are a tool you may want to use to help think about the relationships between targets, attributes, stressors, and strategies throughout a planning process using qualitative descriptions and diagrams. These models are useful to help show how non-climate and climate stressors affect their targets' key supporting attributes and determine what actions may best influence the conservation targets of interest. In this guide, a simple conceptual model is used to illustrate the concepts outlined in each step of the process. For more information, see pages 138-147 in Margoluis and others, 2009, "Using Conceptual Models as a Planning and Evaluation Tool in Conservation" (*www.fosonline.org/wordpress/wp-content/uploads/2010/06/FOS_2009_Conceptual_Model_EPP.pdf).*

Conceptual model with example goal, conservation targets, and attributes



= conservation goal

= conservation target (viability)

= positive relationship

Tip: Identifying co-benefits can help prioritize several viable conservation strategies. In this example, potential co-benefits that coastal wetlands provide include:

- Fish spawning and nursery habitat
- Waterfowl and migratory bird stopover habitat
- Water quality enhancements

Figure 2. Conceptual model with example outcomes from Steps 1 and 2. In this example, coastal wetlands are identified as a "conservation target," or important natural feature contributing to the example conservation goal. (Note that other targets may also be identified for this goal.) The current condition is assessed as "fair," meaning that protecting what's there alone is insufficient to guarantee persistence and attain the goal. The conservation target selected for the conservation goal may provide additional ancillary benefits, also referred to as "co-benefits."

Resources to Identify Conservation Targets

(Note: national tools and data sets are listed below; however, more locally relevant resources may be available.)

- Open Standards for the Practice of Conservation, Version 3 – see pages 10-12 for identifying conservation targets – *http://cmp-openstandards.org/wp-content/uploads/2014/03/CMP-OS-V3-0-Final.pdf*

- Coastal Land Cover:

  - » C-CAP Land Cover Atlas – view and print maps online showing coastal land cover and how it has changed over time to help determine which land cover types are declining and might warrant being included as conservation targets to reverse trends, such as loss and fragmentation. Select counties or watersheds of interest – *coast.noaa.gov/digitalcoast/tools/lca*

  - » C-CAP Land Cover Data – download coastal land cover data, including wetlands and forests, or land cover change data to use in a GIS to map conservation targets – *coast.noaa.gov/digitalcoast/data/home*

  - » National Wetlands Inventory – download wetland data to use in a GIS to map wetland conservation targets – *coast.noaa.gov/digitalcoast/data/home*

- Habitat Priority Planner – use this GIS tool to classify land cover and habitat data to create maps of your conservation targets. It can be used for prioritization too (see Step 6) – *coast.noaa.gov/digitalcoast/tools/hpp*

- Natural Heritage Data – for geospatial or tabular data about species and natural communities in your geography; check out the NatureServe Explorer (*http://explorer.natureserve.org*),or contact your state's program to learn more about what might be available for your area.

- Essential Fish Habitat Mapper – view locations and download GIS data on essential fish habitat and habitats of concern for use in planning; contact your NOAA Fisheries regional office for site-specific detail – *coast.noaa.gov/digitalcoast/tools/efhmapper*

- Coastal Flood Exposure Mapper– use this online tool to visualize potential conservation targets for flood protection (see Ecosystem Exposure Maps) and to communicate to others their importance in community resilience – *coast.noaa.gov/digitalcoast/tools/flood-exposure*

- Conserved Areas – the following resources can help identify protected lands in your area:

  - » Protected Areas Database of the U.S. (PAD.US), for lands conserved by federal, state, local, and nongovernmental organizations through direct ownership or conservation easement – *http://gapanalysis.usgs.gov/padus*

  - » National Conservation Easement Database, for lands protected through conservation easements – *http://conservationeasement.us*

- Environmental Sensitivity Index (ESI) – view maps or download GIS data showing locations of sensitive species and coastal resources along the shoreline that could be conservation targets – *http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html*

Resources for Identifying Key Supporting Attributes

- The Nature Conservancy Standard Key Ecological Attributes (the download is an excel file) – provides a list of key ecological attributes you'll want to consider – *www.conservationgateway.org/Files/Pages/standard-key-ecological-a.aspx*

- Conservation Action Planning Handbook: Developing Strategies, Taking Action and Measuring Success at Any Scale – see page 26-42 for more information on viability assessments for key supporting ecological attributes – *www.conservationgateway.org/Files/Pages/action-planning-cap-handb.aspx*

Step 3: Identify Non-Climate Stressors and Evaluate Their Impact on Conservation Targets

What affects the viability of your targets? How intense or pervasive are these threats within your geography?

Examples

- Residential or industrial development, roads, infrastructure, agriculture, or forestry activities resulting in habitat fragmentation, degradation, or loss
- Physical barriers such as dams, dikes, and culverts resulting in alterations to hydrologic regime or sediment transport
- Other stressors such as pollution, invasive species, unsustainable extraction, or overuse resulting in degradation of lands or waters

Why

Stressors, or threats, are primarily human activities that immediately degrade a conservation target (e.g., development, harvesting, or extraction activities), but they can also be a result of natural phenomena (e.g., impact from storm events) (CMP 2013). Stressors can include physical, biological, or chemical perturbations to a natural system (Mitchell and others 2006), and they can stem from past, ongoing, or likely future activities. Also, stressors can result from an individual impact (e.g., a primary source) or through a cumulative impact (the result of many smaller stresses adding up). Over time, stressors can threaten the viability or effectiveness of conservation targets and their supporting ecological or physical attributes. Identifying non-climate-related threats affecting these key attributes is valuable in understanding the root causes of any changes to your conservation targets and is an important first step in managing them. Non-climate stressors also make your conservation targets more susceptible to impacts from climate change.

How

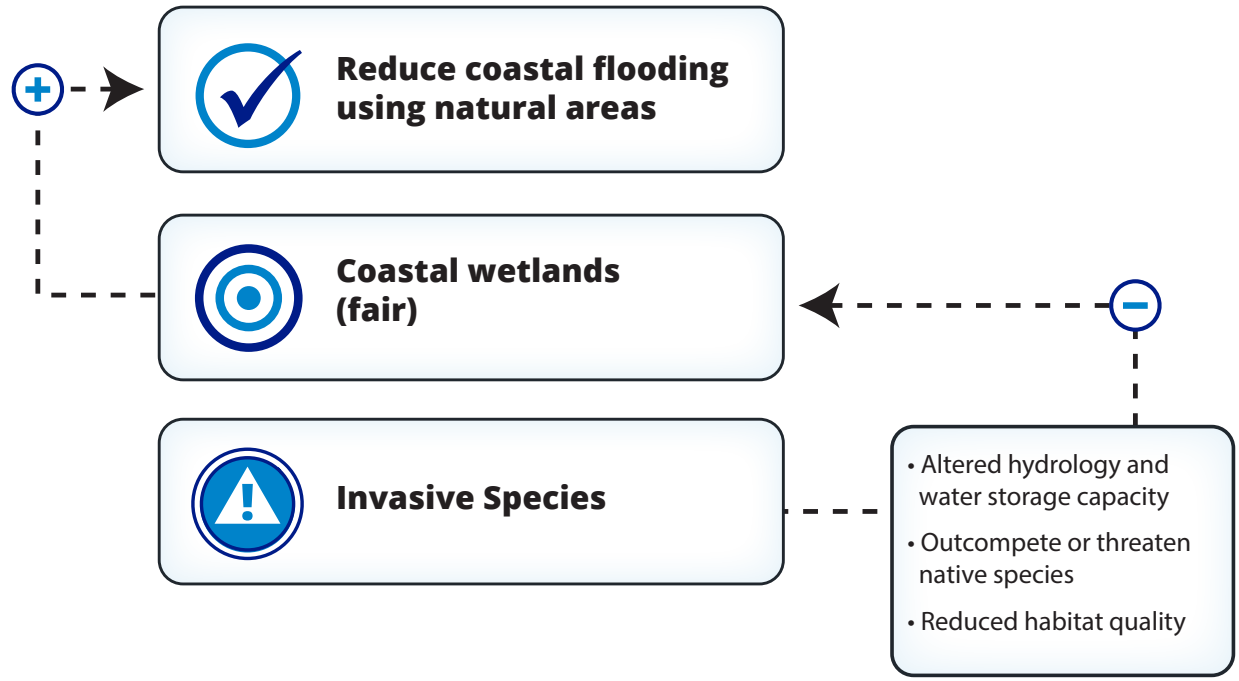
Identify direct and indirect threats to your conservation targets and their key supporting attributes. To do this, it is important to assess trends in land use or land cover driven by population or other socio-economic trends; laws and policies affecting the conservation targets within the planning area (e.g., state laws or local ordinances that may apply to specific areas or habitats); or other factors that may impact your conservation targets or the key attributes that support those targets. At this stage, it is important to distinguish between non-climate-related stressors (this step) and climate-related stressors (discussed in Step 4), since these two types of stressors may require different management approaches.

A conceptual model can be used to illustrate the types and anticipated impacts of non-climate stressors on conservation targets. For example, non-climate stressors to coastal wetland health might be activities that disrupt or restrict water inflow to the wetlands, such as dams, water diversions, or seasonal droughts that limit freshwater inflow, or dikes, undersized culverts, or tide gates that restrict tidal inflow.

Identify the spatial extent or geographic footprint of the identified non-climate threats or stressors, where possible. This can include a formal mapping process using GIS technology or a less formal participatory mapping exercise that identifies locations based on the knowledge of local experts. For example, if trying to protect water quality, you might be concerned with the amount of natural buffers you have around areas of impervious surface and will want to locate these stressors on the landscape. Part of your strategy to meet conservation goals might be to identify high-priority buffer areas for protection. This will require more in-depth spatial analysis, and Step 6 and NOAA's Green Infrastructure Mapping Guide provide further guidance.

Assess the severity and permanence of the impacts of non-climate stressors on your conservation targets using the information you already gathered. The Nature Conservancy's Conservation Action Planning framework is also helpful for assessing the degree of threat that non-climate stressors pose to conservation targets. If the conservation target or its attributes are likely to be severely or permanently impacted (such that their viability is unlikely), serious consideration should be given whether to invest limited funding dollar or other resources to conserve them. Other, less-threatened areas may become a higher priority, or other strategies may be needed to address the source of threats to conservation targets.

Conceptual model with non-climate stressors added



= conservation goal

= conservation target (viability)

= non-climate stressor

= positive relationship

= negative relationship

Figure 3. Conceptual model with example outcomes from Steps 1-3. The non-climate stressor identified in this example is invasive species. Evaluation of this non-climate stressor's effects on the conservation target, coastal wetlands in this case, reveals negative impacts on the ecological health and function of the coastal wetlands, shown in the text box, thus affecting the conservation target's contribution to the conservation goal and co-benefits. In addition to what is shown in this simplified model, identifying multiple non-climate stressors would be typical, as well as evaluating their impacts on a suite of conservation targets.

Resources

(Note: national tools and data sets are listed below; however, more locally relevant resources may be available.)

- National Fish, Wildlife, and Plants Climate Adaptation Strategy – see pages 21-24 for non-climate stressors to fish, wildlife, and plants – *www.wildlifeadaptationstrategy.gov/pdf/NFWPCAS-Final.pdf*

- Habitat fragmentation and land use changes:

  - C-CAP Land Cover Atlas (*coast.noaa.gov/digitalcoast/tools/lca*) and C-CAP Data (*coast.noaa.gov/digitalcoast/data/home*) – see where coastal wetlands and forests have changed to development or other land use types to help understand trends in non-climate stressors on the landscape.

  - National Inventory of Dams – query and view locations and information on major dams across the U.S. Must request access to database from the U.S. Army Corps of Engineers – *www.agc.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11913/Article/480923/national-inventory-of-dams.aspx*

  - Landscape Fragmentation Tool – this GIS tool analyzes and quantifies habitat fragmentation (e.g., forest, wetland) displayed in maps and by four metrics (core, patch, edge, perforated) – *coast.noaa.gov/digitalcoast/tools/lft*

- Water quality:

  - How to Use Land Cover Data as a Water Quality Indicator – this six-step process can help you determine whether water quality is a concern based on your current landscape – *coast.noaa.gov/digitalcoast/training/water-quality-indicator*

  - Impervious Surface Analysis Tool – calculate how much impervious surface is in a user-selected geography, see where areas have good, fair, or poor water quality based on this calculation, and explore how changes in land cover can impact water quality – *coast.noaa.gov/digitalcoast/tools/isat*

- Coastal Flood Exposure Mapper – see where natural areas could be exposed to coastal flooding and storm surge and potentially impacted by pollution sources (see Ecosystem Exposure Maps) – *coast.noaa.gov/digitalcoast/tools/flood-exposure*

- Environmental Sensitivity Index (ESI) – view maps or download GIS data showing locations of species and coastal resources at risk from the impacts from oil spills – *http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html*

- National Invasive Species Information Center – portal to invasive species information, including federal, state, local and international sources – *www.invasivespeciesinfo.gov/index.shtml*

- International Union for Conservation of Nature (IUCN) Threat and Action Classifications – use to classify threats with a common language used in the conservation community to better share experiences and lessons learned – *cmp-openstandards.org/tools/threats-and-actions-taxonomies*

- The Active River Area: A Conservation Framework for Protecting Rivers and Stream – see pages 44-45 and Appendix A for non-climate stressors to rivers and streams – *www.conservationgateway.org/Files/Pages/active-river-area-conserv.aspx*

Step 4: Identify Climate Stressors and Evaluate Their Impact on Conservation Targets

What climate stressors, current and projected, affect your targets? How do these additional stressors affect viability—either directly, or indirectly through exacerbating other non-climate stressors?

Examples

- Changes in precipitation or in the magnitude and frequency of extreme weather events resulting in increased stream flooding or more severe droughts affecting sediment movement, water levels, and salinity regimes in habitats downstream
- Changes in temperature (air, water) resulting in species shifts, such as allowing invasive species to better compete with native species
- Relative sea level change or Great Lakes water level fluctuation resulting in inundation of coastal habitats without migration pathways or sufficient sediment input; salt intrusion into freshwater habitats and drinking water supplies
- Changes in water chemistry (e.g., coastal or ocean acidification) resulting in damage to coral reefs

Why

Climate-related changes can affect conservation targets either directly or indirectly by amplifying the impacts of non-climate-related stressors. In this way, climate stressors can affect conservation targets that are not already facing threats, or they can add to existing non-climate-related stressors. Either way, they can threaten the long-term viability or functioning of certain habitats. Identifying the projected climate stressors is an important first step in determining how climate changes may affect (or are already affecting) your conservation targets and their key supporting attributes. Examining *how* projected climate stressors might affect your conservation targets is critical to project design, planning, and long-term management.

How

Familiarize yourself with the projected climate stressors for your target area and determine those most likely to affect your planning area or conservation targets. To do this, review available climate change information for your region and the specific geography covered by your planning effort or conservation targets. As noted above, these stressors may include such phenomena as rising sea levels, fluctuating Great Lakes levels, increasing storm intensity and frequency, changing precipitation patterns, increasing air or water temperature, or coastal or ocean acidification. Appendix 3 provides a summary of climate phenomena and stressors and their potential impacts on coastal areas and estuarine systems. Additional information sources are provided under "Resources." Some of these resources give projections of precipitation and temperature scenarios, while others go beyond climate scenarios and project the possible cascade of ecological impacts.

Because of the strong regional variations in most of these stressors, the planning team will need to decide which stressors to include in its assessment. The U.S. Global Change Research Program's *National Climate Assessment* contains information about potential impacts by region and is the authoritative source on climate change science and impacts in the United States. Other good resources for region-specific projections include research institutions (e.g., Sea Grant

institutions), regional climate centers, state climatologists, and NOAA Regional Integrated Sciences and Assessments programs (NOAA 2010). Some specific data sources and information on climate projections are also provided below under "Resources."

Identify the time horizon (e.g., 5-year, 50-year) **or climate projections** (e.g., anticipated amount of temperature or sea level change) you would like to consider. It's important to keep in mind the time horizons for the climate impact projections and the uncertainty, since they are useful for conservation planning and the development of a long-term management plan. The time horizon for which to consider potential climate impacts may depend on the conservation targets and the ecology of the area of interest.

It's important to note that climate stressors can also influence the impact of non-climate stressors. For example, a change in temperature (a climate stressor) may give an additional competitive advantage to an invasive species (a non-climate stressor), since they tend to be habitat generalists while native species tend to be more specifically adapted to their local conditions; a change in the conservation target's key supporting attribute of temperature range could result in the invasive species posing an even greater threat. For another example, an increase in erosion due to sea level rise (climate stressor) may cause more homeowners to harden their shorelines (non-climate stressor), which further exacerbates impacts to habitat.

Use available tools and information to assess the potential impacts of the projected climate stressors on the conservation targets and their key attributes identified in Step 2. This analysis is often referred to as a "vulnerability assessment."

The tools and approach for performing this assessment will vary depending on the nature of the stressors and the conservation targets. For example, this could include mapping the extent of flooding expected under various projections of sea level rise within your target geography or mapping wetland areas that may dry out under arid conditions. It could also include reviewing available research on the impact of temperature or salinity on specific habitats or species range. The approach used to assess climate impacts will depend, in large part, on the amount of data or information on particular stressors (causes) and their impacts on conservation targets (effects), as well as your organization's capacity for analyzing climate impacts. Again in this step, using conceptual models can be helpful to determine what stressors may affect your conservation targets of interest or affect the key supporting attributes on which those targets depend.

For organizations with a limited ability to model how a climate stressor may influence a conservation target, consulting literature that has already hypothesized ecological impacts will provide a general idea of potential changes without needing to conduct rigorous modeling and quantitative analyses. For example, NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers* (2010) and the Environmental Protection Agency's *Synthesis of Adaptation Options for Coastal Areas* (2009) provide information about potential impacts of climate stressors. Appendix 3 summarizes these stressors. These documents and other information to help with this step are provided below under "Resources." There are also a number of screening-level tools online that have already mapped potential impacts of sea level rise and storm surge, for example, that may cover your conservation targets. Examples include NOAA's Sea Level Rise Viewer, the Coastal Flood Exposure Mapper, and the Sea Level Affecting Marshes Model (SLAMM) viewer. See the "Resources" section below for more tools. Once you have an idea of general climate impact trends from these tools, you can follow up with literature review, ground-truthing, expert opinion, or other information to localize the impacts to your conservation targets.

For organizations that *do* have the ability to conduct modeling and other quantitative analyses of climate impacts, or that work with partners who have that expertise, doing so will help to more readily determine potential climate impacts that are specific to your project. Compile and map the relevant climate data for the stressors identified in this step. Use downscaled climate models

for your geographic area if they exist or can be created. If not, the U.S. government's open data portal at *www.data.gov/climate* or NOAA's climate portal at *www.climate.gov* are authoritative and comprehensive sources of climate data and information. Sort through the growing richness of information available on data portals can be daunting, so consider checking with your state climatologist for recommendations on the best sources of climate data for your area. Use the best available local habitat data, maps, or other data that best represent your conservation targets, as done in Steps 2 and 3.

Assess the vulnerability of your conservation targets to climate changes using the data and tools you identified above. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as a function of the *sensitivity* of a particular system to climate change, the system's *exposure* to those changes, and the *capacity to adapt* to those changes (page 26, NOAA 2010). Vulnerability assessments based on the IPCC framework evaluate these three primary components, where *exposure* (a measure of the character, magnitude, and rate of climatic changes a species or system may experience) and *sensitivity* (the degree to which a conservation target is likely to be affected by climatic change) interact to determine potential impact, and with *adaptive capacity* representing a species' or system's ability to accommodate or cope with that impact (pages 89-95, Stein and others 2014).

Some of the more commonly used methods to evaluate vulnerability include vulnerability indices, quantitative ecological models, spatial analyses of current and predicted distributions, multi-disciplinary models, and expert elicitation processes (Stein and others 2014).

Once you have your results, be mindful of the general rules of modeling that will influence your results, such as the scales and inherent uncertainty of the data sets you worked with, as well as the uncertainty of your modeling and assessment approach. As the science of climate modeling continues to improve and as more data are collected, it is imperative to periodically review updated climate impacts and scenarios, and new documentation of ecological responses. The updated information will allow you to determine whether there are any changes to the status of the climate impacts originally considered in your plan.

A Note on Vulnerability Assessments

As described in this guide, Steps 3 and 4 represent a relatively simple type of vulnerability assessment—identifying the climate and non-climate stressors on conservation targets and evaluating the impacts of those stressors. Other frameworks exist for conducting vulnerability assessments and could essentially guide the same process as described in these two steps (see Chapter 4, Steps 2.1 to 2.6 in NOAA 2010; Glick and others 2011; Chapter 6 in Stein and others 2014; Steps 1-5 in U.S. EPA 2014).

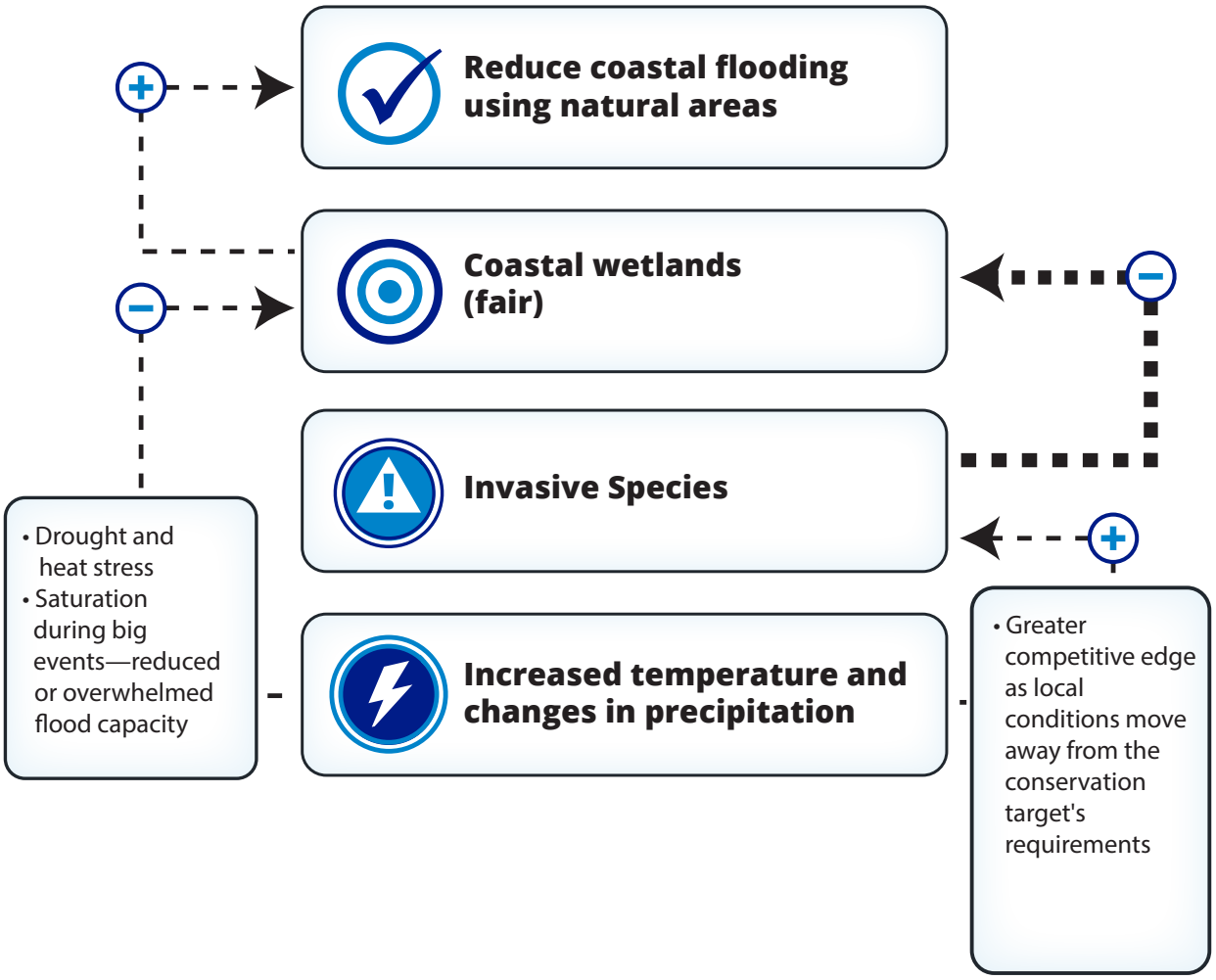
Consider what the results of this assessment mean in terms of the long-term viability of your conservation goals or targets or for choosing the strategies you will use to achieve those goals. Tough choices may need to be made. Consider the following:

- For areas that are the most vulnerable, is there an opportunity to build or restore their resilience so they can better withstand increasing stressors over time, or would efforts be better focused elsewhere (e.g., the least vulnerable areas)?

- If an area will be lost or degraded over time, do the near-term benefits it provides for adaptation outweigh the long-term risk?

These are important considerations to weigh when selecting strategies in Step 5.

Conceptual model with climate stressors and impacts added



= conservation goal

= conservation target (viability)

= non-climate stressor

= climate stressor

= positive relationship

= negative relationship

Figure 4. Conceptual model with example outcomes from Steps 1-4. In this example, local climate stressors of increased temperature and precipitation changes are identified. These climate stressors directly impact the conservation target, and also indirectly affect the target by exacerbating the non-climate stressor's impact.

Tip: Use available data, information, and models to identify anticipated climate phenomena in your planning geography and during your planning time horizon.

Resources for Understanding Climate Stressors

- National Climate Assessment – U.S. Global Climate Change Research Program provides potential climate impacts and trends by region and sector – *http://nca2014.globalchange.gov*

  - » Regional Climate Trends and Scenarios for the National Climate Assessment – climate change impacts by region – *http://scenarios.globalchange.gov/regions*

- Intergovernmental Panel on Climate Change (IPCC) Climate Change 2014: Synthesis Report – provides information on observed changes and causes, future climate change risks and impacts, and future pathways for adaptation and sustainable development – *www.ipcc.ch/report/ar5/syr*

  - » The interactive website makes it easier to navigate through the report – *http://ar5-syr.ipcc.ch*

- U.S. Environmental Protection Agency Climate Change Indicators in the United States – website describes climate change indicators by sector - *www.epa.gov/climate-indicators*

- National Fish, Wildlife, and Plants Climate Adaptation Strategy – provides information on potential climate stressors and their impacts on conservation targets – *www.wildlifeadaptationstrategy.gov/pdf/NFWPCAS-Final.pdf*

- Adapting to Climate Change: a Planning Guide for State Coastal Managers – pages 6-14 provides information on climate change impacts to potential conservation targets – *coast.noaa.gov/czm/media/adaptationguide.pdf*

- Synthesis of Adaptation Options for Coastal Areas – see pages 2-4 for potential climate change impacts on estuarine systems – *www.epa.gov/sites/production/files/2014-04/documents/cre_synthesis_1-09.pdf*

- NOAA Climate.gov – a source of timely and authoritative scientific data and information from NOAA about climate; includes maps, data, news, tools, reports, and educational materials – *www.climate.gov*

- Data.gov/climate – find data sets from multiple federal data providers on climate change related to coastal flooding, flood resilience, water, ecosystems, vulnerability, human health, energy infrastructure, and transportation, as well as data specific to the Arctic region – *www.data.gov/climate*

Resources for Identifying Climate Stressors on the Landscape

- Sea Level Rise Viewer – use this tool to view user-selected sea level rise scenarios on the landscape and how they might impact your conservation targets – *coast.noaa.gov/digitalcoast/tools/slr*

- Lake Level Viewer – this tool allows users to visualize lake level changes that range from six feet above to six feet below historical long-term average water levels in the Great Lakes, along with potential shoreline and coastal impacts – *coast.noaa.gov/digitalcoast/tools/llv*

- Coastal Flood Exposure Mapper – view sea level rise, storm surge (that could increase in frequency), and natural areas maps (see Ecosystem Exposure Maps) – *coast.noaa.gov/digitalcoast/tools/flood-exposure*

- ClimateData.US – map-based visualizations of NASA data on future climate conditions, including projected local temperature and precipitation change across the contiguous United States – *www.climatedata.us*

- ClimateWizard – this website provides predictions of temperature and rainfall around the world – *www.climatewizard.org*

- U.S. Climate Resilience Toolkit: Climate Resilience Explorer – interactive online tool for visualizing climate data and maps – *http://toolkit.climate.gov/tools/climate-explorer*

Resources for Evaluating Impacts Caused by Climate Stressors

- Climate Change Vulnerability Assessment Tool for Coastal Habitat (CCVATCH) – a spreadsheet-based decision-support tool that integrates local data and knowledge with climate change research, predictions, and assessment to provide an evaluation of habitat vulnerability – *www.northinlet.sc.edu/stewardship/CCVATCH/Overview.html*

- Adapting to Climate Change: A Planning Guide for State Coastal Managers – pages 23-41 provide information on conducting a vulnerability assessment to evaluate climate change impacts on conservation targets – *coast.noaa.gov/czm/media/adaptationguide.pdf*

- Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment – provides guidance on conducting a climate change vulnerability assessment on natural areas and case studies of what others have done – *www.nwf.org/~/media/pdfs/global-warming/climate-smart-conservation/nwfscanningtheconservationhorizonfinal92311.ashx*

- Sea Level Rise Viewer Marsh tab – use this tool to view user-selected sea level rise scenarios and how they will impact wetland migration in order to assess conservation or restoration options to enable migration – *coast.noaa.gov/digitalcoast/tools/slr*

- Sea Level Affecting Marshes Model (SLAMM) – model potential impacts from sea level rise on marsh migration – *coast.noaa.gov/digitalcoast/tools/slamm*

- Marshes on the Move – this guidance document provides considerations for practitioners undertaking marsh migration modeling – *coast.noaa.gov/digitalcoast/training/marshesonthemove*

- Coastal Resilience Mapping Portal – this mapping application is organized by state and allows communities to assess risk by examining their coastal exposure and social vulnerability while identifying solutions and sites where habitat may most reduce risk (not available for all regions) – *http://maps.coastalresilience.org/network*

- OceanAdapt – this website contains graphics that allow you to explore data on the distribution of marine animals in the U.S. for individual species; the graphics show how the average latitude and depth have changed through time for the center of the species distribution – *http://oceanadapt.rutgers.edu*

- Climate Registry for the Assessment of Vulnerability (CRAVe) – this community resource houses information on vulnerability assessments for specific geographic regions and includes information on assessment targets or endpoints, managing entity, and other factors. Information is based on users entering information – *https://nccwsc.usgs.gov/crave/*

Step 5: Review Goals and Identify Management Strategies

What strategies can improve the viability of conservation targets through direct action or through abatement of non-climate and climate stressors?

Examples

- Reduce existing non-climate stressors (e.g., through regulatory or policy action)
- Increase landscape connectivity (e.g., by expanding protected areas or conserving buffers or corridors into which habitats can shift in response to changes in sea or lake levels and other attributes)
- Protect or restore habitat to support ecological functions

Why

As described in Step 1, identifying clear conservation goals is necessary for determining the management strategies to achieve the desired goal. When circumstances change—whether due to climate or non-climate stressors—it is important to review both the conservation goals and the strategies used to manage progress toward that goal to ensure that they adapt to the new conditions. This is a key step in the climate-smart conservation cycle (Stein and others 2014). Identifying long-term management strategies that address potential climate impacts is useful for implementing plans that effectively reduce non-climate stressors on conservation targets and their key supporting attributes to increase their long-term resilience. Considering long-term climate change in your conservation strategies now can also help inform the longevity of those strategies. If the analysis from the previous steps suggests that your conservation targets may be affected by projected climate stressors or impacts, revising your goals or strategies or identifying new strategies with your partners and stakeholders may be necessary to adapt to the changing climate.

How

Evaluate whether the goal is still achievable or feasible in light of climate and non-climate stressors, both from an ecological perspective (are the conservation targets still viable?) and technical perspective (can management actions or strategies be implemented?). While this step may seem daunting, breaking it into manageable pieces can help. You may find that you only need to modify certain aspects of your goals. Asking the following questions, adapted from page 115 of *Climate-Smart Conservation* (Stein and others 2014), can help identify where you need to adjust:

- **What?** Are existing conservation targets still appropriate, or do you need to change which ecological features or processes should be the focus of attention?
- **Why?** Are the desired conditions (end-state) for the conservation targets still feasible, or is a change needed to reflect physical, ecological, or socio-economic realities?
- **Where?** Is the current geographic scope still appropriate, or does it need to be shifted?
- **When?** Will the original goals continue to make sense over time, or is there a need to identify short-term and long-term goals within a specified time period?

Based on the answers to these questions, revisit and update the goals identified in Step 1, as appropriate.

Identify potential management strategies to achieve the stated goals. You may ask: what are the options for managing non-climate stressors affecting the conservation targets and their key supporting attributes? What management options can be used to increase their sustainability in the context of both non-climate and climate stressors? The resources listed at the end of this step provide examples of a variety of potential management strategies to achieve conservation goals.

The table in Appendix 4 was excerpted and adapted from pages 121 and 127 of *Climate-Smart Conservation* (Stein and others 2014) and summarizes general strategies that can be adapted from traditional conservation approaches for "climate-smart" conservation, particularly of species.

NOAA's *Adapting to Climate Change: a Planning Guide for State Coastal Managers* (NOAA 2010) outlines a variety of management strategies that are particularly relevant for coastal areas. These include strategies for

- Managing growth and development (page 64),
- Reducing loss of infrastructure (page 69),
- Managing shorelines (page 78),
- Managing coastal and marine ecosystems (page 85), such as
    - » Creating ecological buffer zones,
    - » Preserving open space,
    - » Facilitating wetland migration,
    - » Restoring damaged or degraded habitats, and
    - » Restoring natural processes, such as water flow and sedimentation; as well as
- Managing and protecting water resources (page 93).

Many of these strategies, when used in combination, can address goals of multiple stakeholders working in the area. Work with stakeholders to identify these "win-win" strategies, which ultimately may generate partnerships and provide more resources and support for implementing the strategies. For example, as part of the National Flood Insurance Program, conserving open space can help communities participating in the Community Rating System earn credits to improve their overall rating, since these areas help mitigate flooding, which in turn reduces the community's flood insurance premiums. Because open space conservation helps earn these credits, the community may be more likely to support or fund it.

Coastal resource and conservation planners should consider a number of potential management strategies and actions and evaluate which ones are the most appropriate for them. There are multiple ways to evaluate potential management strategies and actions, so it will be important to select the criteria you want to use to evaluate and select among potential strategies. This is discussed further in Step 6.

Conceptual model with potential strategies added

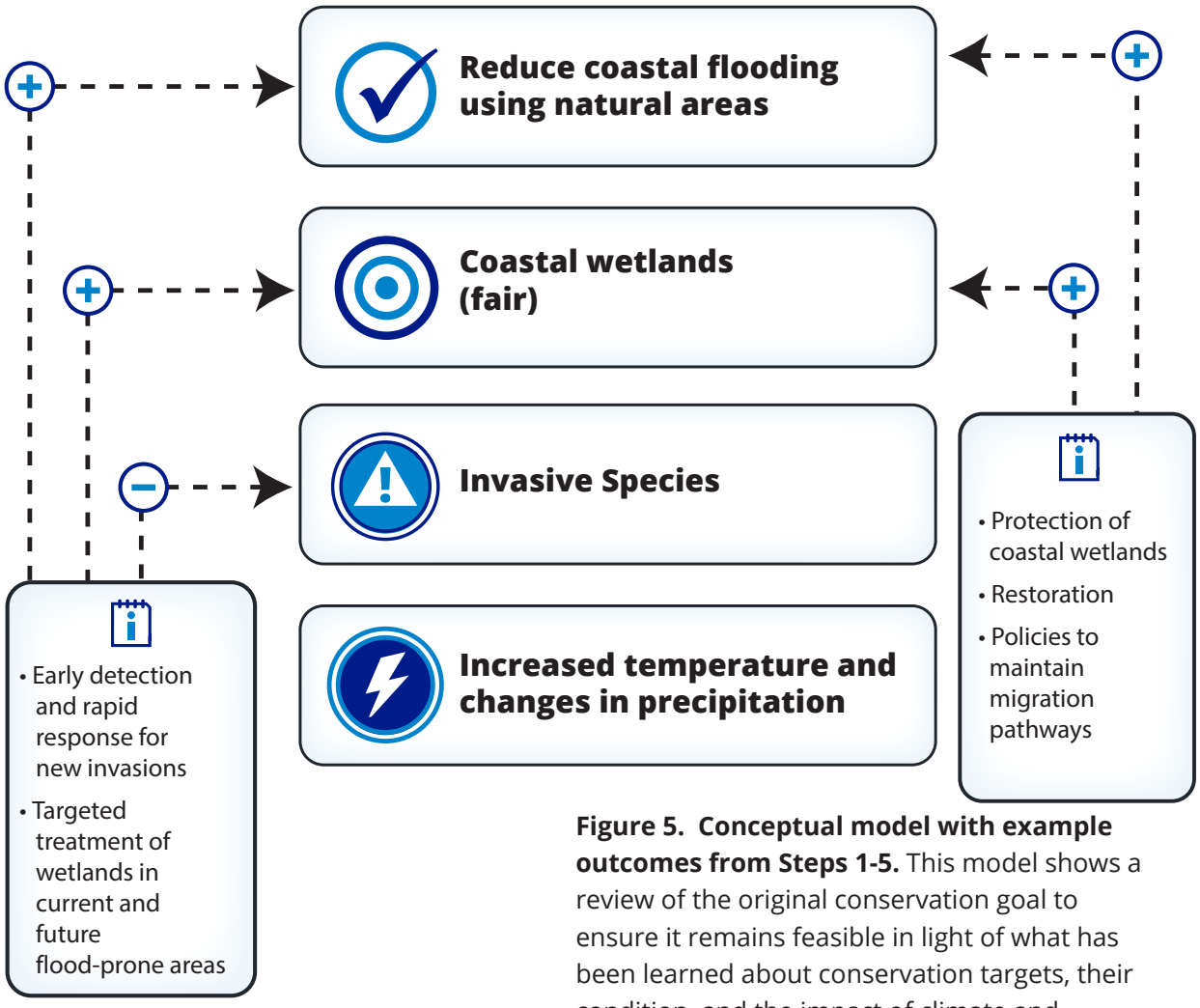


Figure 5. Conceptual model with example outcomes from Steps 1-5. This model shows a review of the original conservation goal to ensure it remains feasible in light of what has been learned about conservation targets, their condition, and the impact of climate and non-climate stressors. Specific strategies for this example are noted in boxes, with arrows indicating where positive or negative effects of those strategies would be anticipated on goals, targets, and stressors.

Tip: When brainstorming potential strategies, look for the positive and negative relationships noted in each version of the conceptual model; a positive relationship icon represents an opportunity to identify a conservation or restoration strategy ("we want more of this"), while each negative relationship icon represents an opportunity to identify an intervening strategy ("we want to break this cycle or lessen the negative impact")

Resources for Re-Evaluating Your Conservation Goals

- Climate-Smart Conservation: Putting Adaptation Principles into Practice – see pages 109-117 for information on reconsidering your conservation goals in light of climate change – *www.nwf.org/pdf/Climate-Smart-Conservation/NWF-Climate-Smart-Conservation_5-08-14.pdf*

Resources for Identifying Strategies

- Conservation Action Planning Guidelines for Developing Strategies in the Face of Climate Change – page 21, appendix 2, provides guidance on developing strategies to address climate change impacts on conservation targets – *www.conservationgateway.org/Documents/CC%20CAP%20Guidance%20Document%20version%20October%2022-%202009-v1.pdf*

- A Review of Climate Change Adaptation Strategies for Wildlife Management and Biodiversity Conservation – potential conservation strategies for climate adaptation – *onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.2009.01264.x/full*

- National Fish, Wildlife, and Plants Climate Adaptation Strategy – see pages 53-76 for examples of conservation strategies for climate adaptation – *www.wildlifeadaptationstrategy.gov/pdf/NFWPCAS-Final.pdf*

- Synthesis of Adaptation Options for Coastal Areas – see pages 4-21 for potential adaptation strategies to address climate change impacts on conservation targets – *www2.epa.gov/sites/production/files/2014-04/documents/cre_synthesis_1-09.pdf*

- Adapting to Climate Change: A Planning Guide for State Coastal Managers – pages 45-96 provides information on considering and selecting conservation strategies– *coast.noaa.gov/czm/media/adaptationguide.pdf*

- Design of Conservation Strategies for Climate Adaptation – guidance on developing conservation strategies is on pages 504–507 – *http://onlinelibrary.wiley.com/doi/10.1002/wcc.127/pdf*

- Climate-Smart Conservation: Putting Adaptation Principles into Practice – guidance on developing conservation strategies is on pages 119-139 – *www.nwf.org/pdf/Climate-Smart-Conservation/NWF-Climate-Smart-Conservation_5-08-14.pdf*

- International Union for Conservation of Nature (IUCN) Threats and Actions Classification – use a common language among the conservation community to better share experiences and lessons learned – *openstandards.org/tools/threats-and-actions-taxonomies*

    - » See also the following Conservation Biology article for a narrative of selecting strategies to address specific threats: A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions – *http://cmp-openstandards.org/wp-content/uploads/2014/03/Classification-of-threats-and-actions.pdf*

- Strategically Placing Green Infrastructure: Cost-Effective Land Conservation in the Floodplain – read this 2013 article about how a flood-prone community in Wisconsin analyzed and targeted cost-effective nonstructural flood damage mitigation policies – *http://pubs.acs.org/doi/abs/10.1021/es303938c*

- Climate Change Adaptation Strategies for Resource Management and Conservation Planning – article discusses landscape-scale conservation strategies from climate change adaptation – *http://courses.washington.edu/cfr590/climatechange/Lawler.2009.pdf*

Step 6: Formulate a Long-Term Management Plan Based on Selected Strategies

What strategies can be used to address legacy, current, and predicted impacts on conservation targets? Are there existing plans that can be updated? Who's responsible, and how will the group hold each other accountable? How will implementation be monitored?

Examples

- New or updated strategic land conservation plan, local land use comprehensive plan, watershed plan, floodplain protection or open space plan, hazard mitigation plan, climate adaptation plan, etc.
- Updated target areas in a species recovery or conservation plan
- Development of an integrated plan that addresses cross-cutting goals

Why

To move into implementation, it is important to chart the course forward. Creating long-term management plans that identify the appropriate near- or long-term strategies and key players allows you to better prepare for the environmental changes ahead and take timely actions to increase the viability and resilience of your conservation targets. Having identified where you want to go, you need to clearly identify how to get there.

How

Evaluate the strategies identified in Step 5 to select the best ones to implement. There are multiple ways to evaluate which management strategies and actions to implement, so it will be important to select the criteria you want to use to evaluate and select among potential strategies. Below are three examples of different criteria you can use.

One example, the *Open Standards for the Practice of Conservation* (page 20, CMP 2013), uses a conceptual model to illustrate how management actions can be applied at key intervention points to influence the conservation target. To select among potential strategies, it recommends

- Investigating strategies that have been used in the past and whether, and why, those strategies succeeded or failed,
- Considering the factors (opportunities or constraints) that make particular strategies more or less feasible, and finally,
- Narrowing and selecting the best strategies based on whether they are *linked* (directly affect critical factors), *focused* (have a clear course of action), *feasible* (can be accomplished within resources and constraints), and *appropriate* (fit within site-specific cultural, social and biological norms).

As another example, NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers* (NOAA 2010, p. 52-53) describes a similar method for selecting among the best strategies, specifically considering the social, technical, administrative, political, legal, economic, and

environmental (STAPLEE) opportunities and constraints of each management action. Adapted from FEMA's *Developing the Mitigation Plan: Identifying Actions and Implementing Strategies* (2003), these considerations recognize that difficult decisions and trade-offs may need to be made.

Similarly, Chapter 9 of *Climate-Smart Conservation* (Stein and others 2014, pages141-146) describes four categories of criteria that can be used to evaluate and select among various management alternatives:

- *Effectiveness at achieving conservation goals and objectives,* focusing on whether a strategy is likely to make a significant contribution toward the desired outcomes (vs. "low-hanging fruit")

- *Effectiveness at achieving broader societal goals*, considering whether the strategy or action offers "win-win" co-benefits toward other related goals as well as the trade-offs for other goals

- *Feasibility*, including direct costs, opportunity costs, technical feasibility, institutional capacity, partnership and cost-sharing opportunities; community acceptance, and consistency with existing laws and policy

- *Climate-smart considerations*, including whether the strategy

    - » Will be effective in reducing key vulnerabilities or accommodating projected climate impacts,

    - » Is forward-looking, with a timeframe for expected benefits that addresses both near-term and longer-term threats,

    - » Considers broader landscapes, taking into account landscape context and potential shifts in species or other ecological features and avoiding impacts to other resources,

    - » Is robust to uncertainty and could perform well under multiple future scenarios,

    - » Is agile, with flexibility to make adjustments or change course, or is irreversible,

    - » Minimizes its carbon footprint by minimizing emissions or sequestering carbon, and

    - » Safeguards people and nature, providing benefits to other sectors or societal goals.

This chapter (pages 146-150) also provides guidance on making trade-offs and describing decision tools that can be used, such as multi-criteria decision-making, cost-benefit analysis, decision tree, or spatial analysis.

Formulate or update the appropriate management plan so that it identifies the actions needed to increase the resilience of your conservation targets and how success will be gauged. The type of plan can take a variety of forms, as noted in the examples listed above. Within the plan, you will select among the available management options for reducing existing non-climate stressors or mitigating climate stressors, if possible. The planning horizon for your management plan should match the time horizon you used for assessing the potential climate change impacts. If you need a refresher on writing a meaningful and strategic management plan, see this easy-to-follow online guide, How to Write a Strategic Plan *(coast.noaa.gov/digitalcoast/training/write-strategic-plan).*

Identify the who, the when, and the how. It is important to clearly identify who will be responsible for implementing the strategies identified in the plan, the desired timeline for implementing proposed actions, and resources that may potentially be available to support implementation. In this step, it will be important to identify the roles and responsibilities of the active planning team and key stakeholders that have been engaged throughout for implementation of the plan. Additional partners may need to be engaged to help carry out the plan as well. In general, funding can be one of the biggest challenges for implementation. Working with partners and stakeholders can be a good way to identify potential funding from federal, state, local, private, or nonprofit sources that are a good fit for the strategies you plan to implement. Appendix A of NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers* (NOAA, 2010) identifies a range of potential federal funding sources that may support climate change adaptation activities, either directly or indirectly. Please note that this list is not comprehensive, and funding for programs may vary from year to year.

Determine whether, and where, you may need to prioritize areas within your broader conservation target to maximize the impact of limited funds. If the scope of your conservation goal or target area is greater than the resources available to achieve it, you may need to do some additional prioritization to focus your effort or identify where best to start. If you have been mapping conservation targets, stressors, and impacts along the way, that information can be used in prioritization. For example, if one of your strategies is to identify and protect high priority wetlands that can reduce flooding, you'll want to define criteria that constitute a "high priority" wetland and that will help you identify those high priority wetlands on the landscape that will likely reduce flooding impacts (e.g., located in the floodplain, located in storm surge zones). Identifying these priority areas can be done using GIS and spatial analysis. NOAA's Green Infrastructure Mapping Guide can help walk you through this process, and the Habitat Priority Planner can help you conduct this type of analysis (both listed under Resources).

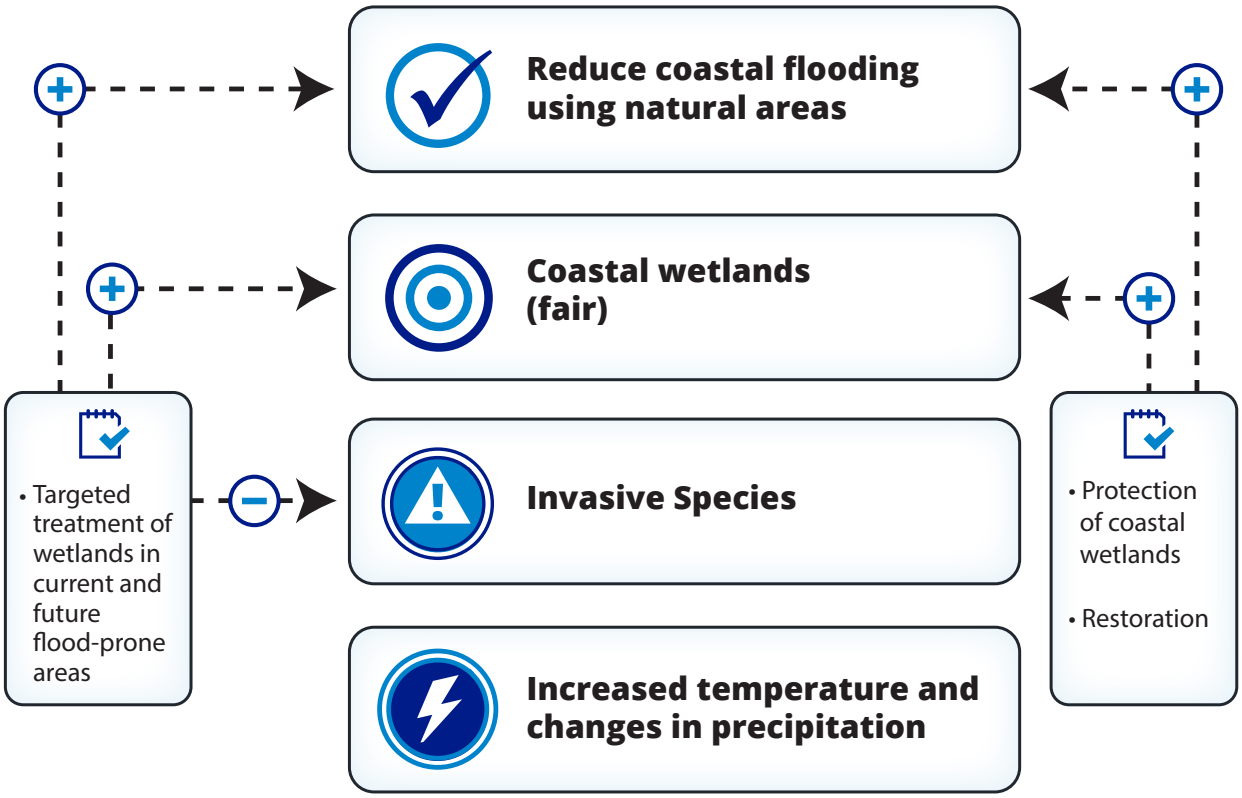
Monitor progress toward achieving your goals, as well as changes in the extent or condition of your conservation targets, particularly their response to climate and non-climate stressors. To track progress toward achieving the plan's goals, it is helpful to consider the following:

- How often should the planning team review progress, and with what reporting method?
- How will progress be communicated to agency leaders, elected officials, and stakeholders?
- How will challenges, such as unexpected delays or obstacles, be addressed and overcome?
- Were there any unintended consequences (positive or negative) from implementing an action, and if so, how will those lessons help inform or tweak future actions?

It is also helpful to have a target schedule for reviewing the plan and revising as actions are taken or circumstances change. This gives a chance to adjust your management actions in a timely manner.

To track changes in the extent or condition of your conservation targets, it is important to have a monitoring strategy that identifies monitoring parameters that would provide information on any changes to your project's key attributes and the magnitude of existing stressors. Some of the resources identified in Step 3 for assessing the severity and permanence of non-climate stressors on the conservation targets may also be helpful for monitoring these impacts over the long term. Also, it will be helpful to periodically review the most updated climate information and projections, as well as documentation of relevant ecological responses, so that the climate and ecological information on which you base your management decisions are up-to-date and management plans can be updated accordingly.

Conceptual model with selected strategies added



= conservation goal

= conservation target (viability)

= non-climate stressor

= climate stressor

= selected strategy

= positive relationship

= negative relationship

Figure 6. Conceptual model with example outcomes from Steps 1-6. Strategies identified in Step 5 are analyzed to determine which are most feasible, cost-effective, and beneficial for the example conservation target and goal. Engaging with stakeholders is particularly important when selecting strategies. In this example, strategies in boxes are those identified as the highest priority based on analysis and public input. Selected strategies get incorporated into long-term, adaptive management plans, which, to the extent possible, will also outline implementation steps, roles and responsibilities, and monitoring plans.

Tip: When prioritizing, develop criteria that work for your purposes; you may consider co-benefits, as identified in Step 2, or other aspects of return on investment in service of your conservation goal.

Resources

- Adapting to Climate Change: A Planning Guide for State Coastal Managers – provides information on implementing strategies and case studies of what others have done – *coast.noaa.gov/czm/media/adaptationguide.pdf*

- How to Write a Strategic Plan – online guidance walks you through 10 key steps for writing a strategic plan; includes worksheets for each step – *coast.noaa.gov/digitalcoast/training/write-strategic-plan*

- Coastal Planning Advisor – the decision-making framework offered in this tool—from studying the management issue, selecting alternatives, to implementing and evaluating actions—can result in the making of a strategic management plan for your conservation effort – *coast.noaa.gov/coastalplanningadvisor/*

- A Policy Analysis of the Use of Ecosystem Service Values in State and Local Decision-Making – identifies policy questions, data sources, and gaps in using ecosystem services valuation to support decision-making – *coast.noaa.gov/digitalcoast/training/ESV*

- Smart Growth for Coastal and Waterfront Communities – this guide adapts 10 smart growth principles to the unique development challenges and opportunities along the water and describes the issues, tools, techniques, and case studies – *coastalsmartgrowth.noaa.gov*

- Restoration Monitoring and Current Studies – although not specific to climate considerations, this site offers a number of resources for designing science-based monitoring of estuarine habitat restoration projects – *http://www.era.noaa.gov/information/monitor.html*

- Adaptation Monitoring and Assessment Tool (AMAT) – tool that helps measure progress toward achieving climate adaptation goals – *www.thegef.org/documents/gef-climate-change-adaptation-tracking-tool*

- Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans – report that provides an approach to creating a monitoring program and gleans information from experiences with landscape-scale conservation plans in California – *www.scwa2.com/home/showdocument?id=1010*

Resources for Prioritizing Conservation Targets

(Note: you'll want to use data from previous steps in these tools.)

- Green Infrastructure Mapping Guide – guidance that walks a spatial analyst through developing a GIS work plan to prioritize green infrastructure or conservation areas for hazard and climate resilience – *coast.noaa.gov/digitalcoast/training/gi-mapping*

- Habitat Priority Planner – GIS-based tool that can be used to prioritize areas for conservation that meet your conservation goals and objectives and help you implement your conservation strategies; visit the in Action and Support tabs to see how others have used this tool to identify conservation priorities – *coast.noaa.gov/digitalcoast/tools/hpp*

- Marxan – a conservation planning software that helps identify priority conservation areas based on ecological processes, threats, and conditions data – *marxan.net*

- NatureServe Vista – ArcGIS extension that helps users identify priority areas for conservation – *www.natureserve.org/conservation-tools/natureserve-vista*

Glossary

Adaptation – Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that moderates harm or exploits beneficial opportunities (US CCSP 2008).

Climate change impacts – The effects of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts. *Potential impacts* are all impacts that may occur given a projected change in climate, without considering adaptation. *Residual impacts* are the impacts of climate change that would occur after adaptation (US CCSP 2008).

Conceptual model – A diagram that represents relationships between key factors that are believed to impact or lead to one or more conservation targets. A good model should link the conservation targets to threats, opportunities, stakeholders, and intervention points where a team can develop strategies that will influence the key factors. It should also indicate which factors are the most important to monitor (CMP 2013).

Conservation target – A biological or ecological feature (e.g., species, habitats, ecological processes, or other entities) that is the focus of one's conservation attention (Stein and others 2014).

Ecological processes – Actions or events that shape ecosystems. Understanding ecological processes—whether they are natural disturbances like fire or ongoing processes like nutrient cycling or carbon sequestration—are the key to the development and implementation of sustainable ecological management (Steffen and others 2009).

Key supporting attributes – All aspects of a [conservation] target's biology or ecology that if present, define a healthy target, or if missing or altered, would lead to the outright loss or extreme degradation of that target over time (CMP 2013).

Monitoring plan – The plan for monitoring your project. It includes information needs, indicators, and methods, spatial scale and locations, timeframe, and roles and responsibilities for collecting data (CMP 2013).

Resilience – The amount of change or disturbance that can be absorbed by a system (e.g., an organism, population, community, or ecosystem) before the system is redefined by a different set of processes and structures (i.e., the ecosystem recovers from the change or disturbance without a major phase shift) (US CCSP 2008).

Stressor – Physical, chemical, or biological perturbations to a system that are either foreign to that system or natural to the system but applied at an excessive or deficient level. Stressors cause significant changes in the ecological components, patterns, and processes within natural systems. Examples include water withdrawal, pesticide use, timber harvesting, trampling, land use change, and air pollution (Mitchell and others 2006). *Non-climate stressors* are stressors not caused by climate change. *Climate stressors* are stressors that are caused by climate change. Note that these two broad categories of stressors can and do interact.

Threat – See *stressor*. In this guide, the term is generally used interchangeably with "stressor."

Uncertainty – Imperfect knowledge concerning the present or future state of the system under consideration; a component of risk resulting from imperfect knowledge of the degree of hazard or of its spatial and temporal distribution (*www.epa.gov/risk*).

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Appendices

Appendix 1: Climate Adaptation Guidance Documents and Websites

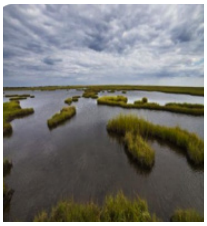
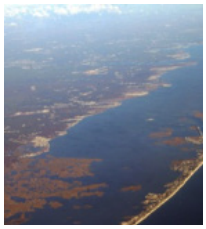
(See "References" section for complete information on publications listed here.)

Reference	Audience	Resources or Assets of Interest	Geographic Focus
The Nature Conservancy. 2009. *Conservation Action Planning Guidelines for Developing Strategies in the Face of Climate Change*. 26 pages.	Conservation community	Conservation projects	Any geographic area
U.S. Environmental Protection Agency (U.S. EPA). 2009. *Synthesis of Adaptation Options for Coastal Areas*. Climate Ready Estuaries Program. 25 pages.	Coastal managers	Natural resources	Coastal areas and estuaries
National Oceanic and Atmospheric Administration (NOAA). 2010. *Adapting to Climate Change: A Planning Guide for State Coastal Managers*. 132 pages.	Coastal managers that are developing and implementing adaptation plans to reduce the impacts of climate change	Natural resources and the built environment	Coastal areas
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. 168 pages.	Fish and wildlife professionals and other conservation practitioners	Natural resources	Any geographic area
National Oceanic and Atmospheric Administration (NOAA). 2012. *Voluntary Step-by-Step Guide for Considering Potential Climate Change Effects on Coastal and Estuarine Land Conservation Projects*. Office of Ocean and Coastal Resource Management (OCRM). 31 pages.	Applicants of the Coastal and Estuarine Land Conservation Program (CELCP) and state CELCP leads	Land conservation	Coastal areas
Conservation Measures Partnership. 2013. *Open Standards for the Practice of Conservation*. 51 pages.	Conservation community	Conservation projects	Any geographic area
Stein, B.A., P. Glick, N. Edelson, and A. Staudt. 2014. *Climate-Smart Conservation: Putting Adaptation Principles into Practice.* National Wildlife Federation.	Conservation community and natural resource practitioners	Natural resources	Any geographic area

Reference	Audience	Resources or Assets of Interest	Geographic Focus
U.S. Environmental Protection Agency (U.S. EPA). 2014. *Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans*. Climate Ready Estuaries. EPA Office of Water. 119 pages.	Managers of environmental resources, especially organizations with a coastal or watershed focus	Natural resources and the built environment	Coastal areas and watersheds
U.S. Climate Resilience Toolkit, *https://toolkit.climate.gov*	Conservation and community and municipalities	Natural resources and the built environment	Any geographic area
Land Trust Alliance Climate Change Toolkit, *www.climatechange.lta.org*	Conservation community	Natural resources	Any geographic area
National Fish, Wildlife and Plants Climate Adaptation Strategy (NFWPCAS), *www.wildlifeadaptationstrategy.gov*	Natural resource managers and other decision makers at all levels of government	Natural resources	Any geographic area

Appendix 2: Habitat Features That Benefit Coastal Risk Reduction

(U.S. Army Corps of Engineers 2013)

NATURAL AND NATURE-BASED FEATURES AT A GLANCE				
				
Dunes and Beaches	Vegetated Features (e.g., Marshes)	Oyster and Coral Reefs	Barrier Islands	Maritime Forests/ Shrub Communities
Benefits/Processes Breaking of offshore waves Attenuation of wave energy Slow inland water transfer	**Benefits/Processes** Breaking of offshore waves Attenuation of wave energy Slow inland water transfer Increased infiltration	**Benefits/Processes** Breaking of offshore waves Attenuation of wave energy Slow inland water transfer	**Benefits/Processes** Wave attenuation and/or dissipation Sediment stabilization	**Benefits/Processes** Wave attenuation and/or dissipation Shoreline erosion stabilization Soil retention
Performance Factors Berm height and width Beach slope Sediment grain size and supply Dune height, crest, and width Presence of vegetation	**Performance Factors** Marsh, wetland, or SAV elevation and continuity Vegetation type and density Spatial extent	**Performance Factors** Reef width, elevation, and roughness	**Performance Factors** Island elevation, length, and width Land cover Breach susceptibility Proximity to mainland shore	**Performance Factors** Vegetation height and density Forest dimension Sediment composition Platform elevation
General coastal risk reduction performance factors include: Storm surge and wave height/period, and water levels				

*Vegetated features include salt marshes, wetlands, and submerged aquatic vegetation (SAV).

Appendix 3: Summary of Climate Change Phenomena, Potential Coastal Impacts, and Consequences

(Modified from NOAA 2010, pages 8-11, and U.S. EPA 2009, pages 2-4.)

Climate Change Phenomena	Potential Impacts	Potential Consequences
Increasing air temperature	• Heat waves • Drought • Wildfire • Invasive species • Shift in species ranges • Phenological changes • Loss of sea ice • Reduction in snowpack	• Illnesses, injuries, and loss of life • Decline in quantity and quality of freshwater • Loss or damage to coastal property or infrastructure • Economic loss (property or revenues) • Loss, degradation, or shift of habitat or ecosystem, and of the ecosystem services they provide
Increasing water temperature	• Coral bleaching • Pathogens and disease • Hypoxia • Harmful algal blooms • Invasive species • Phenological changes • Shift in aquatic species ranges	• Decreased water quality • Economic loss (property or revenues) • Species impairment • Loss, degradation, or shift of habitat or ecosystem, and of the ecosystem services they provide
Rising sea levels	• Coastal inundation • Erosion, altered sediment transport • Storm surge flooding • Rising water tables • Saltwater intrusion • Increases in nonpoint source pollution	• Loss of or damage to coastal property and infrastructure • Loss of beach or shoreline access • Conversion of freshwater to saltwater • Decline in water quality from increased movement of sediments and toxic pollutants, or failed septic tanks • Loss of cultural resources • Population displacement/migration • Illnesses, injuries, and loss of life • Economic loss (property or revenues) • Loss, degradation, or shift of habitat or ecosystem, and of the ecosystem services they provide
Fluctuating Great Lakes water levels	• Water loss • Bluff erosion • Hypoxia • Harmful algal blooms • Invasive species	• Decline in quantity and quality of freshwater • Water dependent coastal infrastructure impairment • Loss of or damage to coastal property or infrastructure • Navigational challenges • Reduced access to waterfront facilities • Public trust conflicts • Economic loss (property or revenues) • Loss, degradation, or shift of habitat or ecosystem, and of the ecosystem services they provide

Climate Change Phenomena	Potential Impacts	Potential Consequences
Increasing storm intensity / frequency (in both tropical and temperate places)	• Flooding • High winds • High waves (storm surge) • Erosion, altered sediment transport • Salinity shifts • Increased rainfall/ precipitation and associated runoff	• Loss of or damage to coastal property and infrastructure • Injuries and loss of life • Decline in quality of freshwater • Decline in water quality from increased movement of sediments and toxic pollutants • Economic loss (property or revenues) • Loss, degradation, or shift of habitat or ecosystem, and of the ecosystem services they provide
Increasing precipitation	• Coastal flooding • Erosion, altered sediment transport • Salinity shifts • Increased runoff	• Loss of or damage to coastal property and infrastructure • Illnesses, injuries, and loss of life • Decline in water quality from increased movement of sediments and toxic pollutants • Economic loss (property or revenues) • Loss, degradation, or shift of habitat or ecosystem, and of the ecosystem services they provide
Decreasing precipitation	• Drought • Wildfire • More concentrated nonpoint source pollution • Salinity shifts	• Loss of or damage to coastal property and infrastructure • Illnesses, injuries, and loss of life • Decline in quantity and quality of freshwater • Economic loss (property or revenues) • Species impairment • Loss, degradation, or shift of habitat or ecosystem, and of the ecosystem services they provide
Ocean and coastal acidification	• Decrease in pH of seawater • Reduced calcium carbonate for calcifying organisms	• Species impairment, particularly in corals and shellfish • Loss, degradation, or shift of habitat or ecosystem, and of the ecosystem services they provide • Economic loss (harvests or revenues)

*This includes both tropical and extratropical (cold-season) storms.

Appendix 4: Adaptation Strategies, Definitions, and Examples

(Modified from Stein and others 2014, pages 121 and 127.)

Adaptation Strategy	Definition	Examples
Reduce non-climate stresses	Minimize localized human stressors (e.g., pollution) that hinder the ability of species or ecosystems to withstand or adjust to climatic events.	Work with municipalities, planners, developers, and watershed groups to implement land use or stormwater best management practices to reduce nonpoint sources of pollution. Remove structures that harden the coastline to allow inland migration.
Protect key ecosystem features	Focus management on structural characteristics, organisms, or areas that represent important "underpinnings" or "keystones" of the current or future system of interest.	Update protections for critical zones and habitats as their locations shift. Maintain natural flow regimes to protect species in downstream river reaches. Manage functional species groups to maintain the health of the ecosystem.
Ensure connectivity	Protect, restore, and create landscape features (e.g., land corridors, stream connections) that facilitate movement of water, energy, nutrients, and organisms among resource patches.	Design protected area networks of resilient habitats connected by currents (marine) or linear corridors (terrestrial). Remove barriers to upstream migration in rivers and streams or passage across roads or other obstacles on land.
Restore structure and function	Rebuild, modify, or transform ecosystems that have been lost or compromised, in order to restore desired structures (e.g., habitat complexity) and function (e.g., nutrient cycling).	Enhance the natural capacity of rivers and floodplains to buffer climate change impacts through creation or restoration of riparian buffers or setback policies for infrastructure. Restore habitats where the restored ecosystem can adapt to sea level rise. Regenerate species that can adapt.
Support evolutionary potential	Protect a variety of species, populations, and ecosystems in multiple places to bet-hedge against losses from climate disturbances, and where possible manage these systems to assist positive evolutionary change.	Manage for a variety of species and genotypes with tolerances to low soil moisture and high temperatures. Distribute species over a range of environments according to modeled future conditions.

Adaptation Strategy	Definition	Examples
Protect refugia	Protect areas less affected by climate change, as sources of "seed" for recovery (in the present) or as destinations for climate-sensitive migrants (in the future).	Create side-channels and wetlands as refugia during droughts and floods. Identify sites that are suitable as habitat under future conditions as areas for restoration or planting of "neo-natives."
Relocate organisms	Engage in human-facilitated transplanting of organisms from one location to another in order to bypass a barrier (e.g., urban area).	Move isolated populations of target species that become stranded. Relocate species or re-introduce species bred in captivity to restored habitat or refugia.

NOTES

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