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
Coastal and Estuarine Land Conservation Program

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EXECUTIVE SUMMARY

Climate change effects on ecosystems and ecological dynamics are causing conservation professionals to re-evaluate current conservation strategies. To be better prepared for landscapes of the future, it is prudent to evaluate how the targets of conservation projects might be affected by changing climatic conditions. On the practical side, evaluating how the changing climate might affect a conservation project's targets helps us to adapt to the possible changes by having a long-term management framework in place which anticipates the possible futures. However, there exists a gap between theory and practice in incorporating climate considerations into conservation strategies (Poiani et al. 2011).

This voluntary guide document is part of a multi-phased effort to systematically consider climate change impacts in the implementation of NOAA Office of Ocean and Coastal Resource Management land acquisition activities, specifically the Coastal and Estuarine Land Conservation Program (CELCP). This guide aims to lessen the gap between theory and practice and should be viewed as an iterative process as CELCP learns how to better support applicants and state CELCP leads and as the fields of climate science and conservation strategies continue to evolve.

This voluntary step-by-step guide was developed for the purposes of assisting CELCP applicants in considering potential climate change effects on proposed projects and to assist state CELCP leads in incorporating climate change considerations into state CELC plans. The following methodology is based on the scientific method and draws on existing guidelines for conservation. It is one approach for a conservation project to consider how climate impacts might affect the project's conservation targets and how to develop a long-term plan that addresses these impacts. There are seven steps:

Step 1: Identify conservation targets

Step 2: Identify key ecological attributes

Step 3: Identify existing non-climate stressors on key ecological attributes

Step 4: Identify projected climate stressors/impacts

Step 5: Evaluate climate effects on conservation targets

Step 6: Identify long-term management goals and objectives

Step 7: Formulate a long-term management plan

Each step is summarized below. A complete description of each step is provided in the body of the guide, including why each step is important, how to accomplish each step, and examples of each step's outcome as well as online resources for users who would like more information.

Step 1: Identify conservation targets

It is important to identify clear conservation targets, as conservation targets are the decisional basis for setting goals, implementing conservation actions, and measuring project effectiveness (CMP 2007).

Step 2: Identify key ecological attributes

Understanding how key ecological processes and components (collectively termed as "ecological attributes") support your conservation targets is valuable in highlighting stressors that will have the most significant effect on the conservation targets. It also helps illuminate how changing climatic conditions might fundamentally affect your conservation targets.

Construct a conceptual ecological model, or a qualitative relationship diagram, that will help you to visualize how your conservation targets are connected to the ecological processes and components within the natural system relevant to the project's geographical scale.

Step 3: Identify existing non-climate stressors on key ecological attributes

Add non-climate stressors currently acting upon your key ecological attributes to the conceptual ecological model constructed in Step 2. Then, determine non-climate stressors' effects on your conservation targets by indicating how those non-climate stressors would affect key ecological attributes and downstream elements.

Step 4: Identify projected climate stressors/ impacts

Review the climate impacts reports for your region to familiarize yourself with the projected climate stressors. Some reports give projections of precipitation and temperature scenarios, while others go beyond climate scenarios and project the possible cascade of ecological impacts.

Step 5: Evaluate climate effects on conservation targets

Assessing how projected climate stressors might affect your conservation targets and existing non-climate stressors is critical to project design, planning, and long-term management. Keep in mind that this guide describes a qualitative assessment.

Step 6: Identify long-term management goals and objectives

While not all conservation projects are "climate adaptation" projects, all conservation projects should anticipate and be able to adapt in a timely manner to shifting climatic conditions. Identifying long-term management goals and objectives in the context of potential climate effects is useful for formulating long-term management plans that effectively reduce non-climate stressors on key ecological attributes and conservation targets and increase long-term resilience of the targets.

Step 7: Formulate a long-term management plan

Long-term management plans that are based on considerations of potential climate effects on conservation targets allow you to better prepare for the environmental changes ahead and take timely actions to increase the viability and resilience of your conservation targets. The planning horizon for your long-term management plan should match the time horizon you used for assessing potential climate change impacts.

The method of assessing potential climate change effects on conservation targets described in this guide is a systematic and qualitative approach with the use of a conceptual ecological model as the main assessment tool. Using a conceptual ecological model helps to better visualize and communicate the ecological dynamics of a conservation project.

It is important to note that, every few years, the guide user should check for updates in projections of climate effects and scenarios as well as new documentation of ecological responses to climate stressors. The updated information will allow the user to determine whether there are any changes to the status of the climate effects originally assessed for the project. The updated information will also allow the user to adjust the project's long-term management plan accordingly.

INTRODUCTION

Observations of global climate over the past decades have documented that climatic conditions have been shifting (IPCC 2007, USGCRP 2009, Glick et al. 2011). Regardless whether the changing climatic conditions are man-made or due to natural variability, the fact remains that habitats and species distribution are also changing; synergy and dynamics within and between ecosystems are altering in response to the observed changes (USGCRP 2009, Glick et al. 2011). These ecosystem responses have important implications for land conservation, especially in the coastal zone.

Coastal areas historically have been the preferred geography for human settlements and development, and coastal ecosystems are one of the most degraded natural systems because of this social trend. Climate change is forecasted to exacerbate current environmental degradation and further alter coastal landscapes, as coastal areas and ecosystems are some of the more vulnerable places to climate change (U.S. EPA 2009). For example, coastal hazards such as inundation, storm events, and storm surges have been increasing in magnitude (U.S. EPA 2009).

To be better prepared for landscapes of the future, it is prudent to evaluate how the targets of conservation projects might be affected by changing climatic conditions. These evaluations will help to determine how the resilience of a project may be increased and/or how a project may contribute to the wider system's (e.g., watershed, coastal ecosystem) resilience.

On the practical side, evaluating how the changing climate might affect a conservation project's targets helps us to adapt to the possible changes by having a long-term management framework in place which anticipates the possible futures.

Background

In a multi-phased effort to more systematically consider climate change impacts in the implementation of programmatic activities, NOAA NOS Office of Ocean and Coastal Resource Management (OCRM) and NMFS Office of Habitat Conservation jointly released a "Programmatic Framework for Considering Climate Change Impacts in Coastal Habitat Restoration, Land Acquisition, and Facility Development Investments" in May 2010 as Phase I. This guide document is part of Phase II efforts to systematically consider climate change impacts in the implementation of OCRM land acquisition programmatic activities, specifically the Coastal and Estuarine Land Conservation Program (CELCP).

Audience

This step-by-step guide was developed for the purposes of assisting CELCP applicants in considering potential climate impacts on proposed projects and assisting state CELCP

leads in incorporating climate considerations into state Coastal and Estuarine Land Conservation plans. CELCP protects coastal lands for the purposes of aesthetics, recreational, historical, as well as ecological and conservation (see CELCP FFO, V. Application Review Information, A. Evaluation Criteria); thus, the language used in this guide is purposely broad to encompass all potential CELCP projects.

CELCP applicants are state and local government agencies working in the coastal zone, often in critical partnerships with local land trusts or national non-profit organizations. Since CELCP applicants encompass a wide spectrum of organizational capacity and focus, this guide aims to be of use to all. Further, due to the broad yet precise language used in the guide, this guide can be of use to practitioners in the conservation or restoration fields both within and beyond the coastal zone. For restoration professionals, simply replace the word "conservation" with "restoration."

State CELCP leads are state employees who oversee their states' CELCP activities, including drafting state CELC plans, and correspond directly with NOAA CELCP management. A number of states have already started to incorporate climate change considerations into their state CELC plans. For other states who are interested in folding potential climate change impacts into state CELC plans, this guide offers a method to assess how climate change might affect existing conservation targets, values, ecological attributes, project areas, etc. For a list of the CELCP leads in your state, see http://coastalmanagement.noaa.gov/land/media/celcpstateleadcontacts.pdf

Scale

This guide aims to work at the project level for both CELCP applicants assembling CELCP grant proposals and state CELCP leads folding potential climate change impacts into state CELC plans. The definition of "project" and the scale of "project level," therefore, differ depending on the user applying this guide. For example, "project" for CELCP applicants may refer to a parcel or a number of related parcels in a relatively limited geographic area. For state CELCP leads, "project" may refer to the planning effort of developing conservation plans and goals of the coastal zone. Due to the broad language and the linear and systematic approach, this guide can be applied to conservation (or restoration) efforts from the parcel level to larger geographic scales, e.g., a reserve or a watershed.

Use

CELCP applicants may use the method described in this guide for CELCP applications to assess how climate change might affect their proposed projects. State CELCP leads may use the described method to fold climate change considerations into existing state CELC plans. This guide is for reference only and is not to be interpreted as the only method CELCP applicants/state CELCP leads can use to consider climate impacts in their project proposals/state CELC plans.

This guide outlines a seven-step process for considering how potential climate impacts may affect a project's conservation targets. Ideally, this guide should be used in the

project planning and design phases to assess potential climate impacts before a project progresses further – so that any adjustments to the project scope may be made. This guide also can be used after a project has been formulated or implemented to consider potential climate impacts for the purpose of planning long-term management actions.

This guide utilizes a "conceptual ecological model" as the main tool to assess potential climate change impacts on a conservation project's targets. Conceptual ecological models integrate current understanding and facilitate communication of a system's dynamics (Gross 2007). Conceptual ecological models are non-quantitative planning tools for identifying key system components, linkages and processes, as well as drivers and stressors on the natural systems and the ecological effects of these stressors (Mitchell et al. 2006, Ogden et al. 2005). Due to the non-quantitative nature, the level of detail of a conceptual ecological model is dependent on the project's purposes and the preparer's biological background.

Scope and common challenges

Taking into account the changing climate's ecological effects on a conservation project makes logical sense. Yet, there exists a gap between theory and practice in incorporating climate considerations into conservation strategies (Poiani et al. 2011). Currently available conservation strategic frameworks that include protocols for considering climate impacts, such as climate vulnerability assessments, are often either at a high strategic level or highly resource intensive. These conservation frameworks, while of perfect scientific sense, are not practical to the vast majority of conservation professionals.

This guide aims to address this gap and some of the common challenges to climate adaptation. Addressing this gap will be an iterative process as CELCP learns how to better support applicants and state CELCP leads in climate considerations and as the fields of climate science and conservation strategies continue to evolve.

One major challenge is the lack of data at scales relevant to decision making, including the lack of localized climate projections and potential localized ecological responses (Lavendel 2003, Glick et al. 2009). Climate impact reports and projections are usually at large regional or national scales, where projections are highly generalized. Moreover, climate impact reports have varying focus (e.g., "by sector") and do not necessarily contain projections relevant to a specific project. This guide balances idealism and realism by asking users to use large regional climate projections in addition to, where available, more localized information.

More informational challenges include the inability to predict non-linear climate impact rates and time horizons of ecosystem thresholds or ecological tipping points. There are also uncertainties regarding how species' roles and assemblages might change and alter habitat structure or biological communities (Fuller 2011 pers. comm., Lavendel 2003). This guide takes into account the reality of the evolving knowledge and scientific understanding of climate impacts and is flexible enough for users with all levels of climate impacts

assessment expertise to reach the final step in the guide.

Other challenges include information about management options and lack of resources for implementing management responses (Glick et al. 2009). Moreover, stressors and drivers that ecologically affect a conservation project are often offsite and thus out of the influence of the actual project (Fuller 2011, pers. comm.). Institutional challenges include short planning horizons, the reliance on historical trends to drive management decisions, and the lack of political will (Glick et al. 2009).

This guide recommends an approach for conservation project planners to integrate potential climate effects into their long-term management plans to more sustainably manage their targets. In addition, the planning horizon for these long-term management plans should be consistent with the time horizon used for assessing potential climate change effects. This guide assists users with formulating such long-term management plans and recommends that users adapt the way they design, plan, and manage conservation projects to the changing climate.

STEP-BY-STEP METHODOLOGY

Step 1: Identify conservation targets

What does your project aim to conserve?

EXAMPLES: populations of a particular species, a type of habitat, a specific geographic area, habitat connectivity, opportunities for habitat migration, refugia for a particular species or biological community, a wetland's water filtration capacity, etc.

WHY: It is important to identify clear conservation targets, as conservation targets are the decisional basis for setting goals, implementing conservation actions, and measuring project effectiveness (CMP 2007).

HOW: For CELCP applicants, since land acquisition for conservation purposes is often opportunistic, the process of identifying conservation targets may involve assessing existing values on the parcel and their relationship to the conservation priorities set out in state CELC plans. Defining specific conservation targets would involve identifying existing values that advances your respective state's CELCP priorities (See Figure 1).

For state CELCP leads, conservation targets would be the types of lands or values and project areas to be protected as identified in Section II of the state CELC plans.

RESOURCES:

For a copy of your state's CELC Plan: http://coastalmanagement.noaa.gov/land/media/CELCPplans_web.pdf

For more details on conservation targets, see:

Open Standards for the Practice of Conservation, Conservation Measures Partnership, p. 8.

http://www.conservationmeasures.org/wp-content/uploads/2010/04/CMP_Open_Standards_Version_2.0.pdf

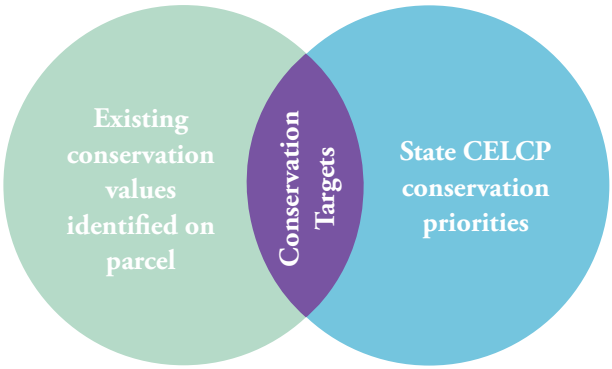

Figure 1. Schematics of identifying conservation targets for a parcel/CELCP proposal.

Step 2: Identify key ecological attributes

What are the key ecological processes/components supporting your conservation targets?

EXAMPLES: Sediment transport; hydrologic regime; habitat connectivity; opportunities for habitat migration, etc.

WHY: Once conservation targets are identified, it is critical to keep in mind the ecological forces underpinning those targets. Understanding how these key ecological processes and components 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.

HOW: To identify the key ecological processes and components, developing a conceptual ecological model of the conservation targets can be helpful. A conceptual ecological model maps out a number of ecological processes and components that influence the conservation targets as well as the linkages and relationships between those ecological attributes. Based on the developed ecological model, the ecological processes and components that are key to sustaining the conservation targets will be ones that influence a myriad of other attributes related to the conservation targets (Parrish et al. 2003). In other words, key ecological attributes are ones that, if altered, will affect a number of other ecological attributes and will significantly undermine the sustainability of the conservation targets.

It is important to note here that the scale of your conceptual ecological model should be consistent with the scale of your project. Conceptual ecological models may be developed based on broad ecological concepts (see Figure 2 on the next page) or detailed technical information.

For CELCP applicants, conceptual ecological models would include conservation targets identified on the parcel (Outcome of Step 1) and the ecological attributes, either on-site or off-site, that affect the targets. For CELCP proposals whose conservation targets are recreational, aesthetics, or historical, ecological models can be used to elucidate how changes to the parcel's ecological processes and components might affect the recreational, aesthetics or historical goals. For instance, would changes in vegetation composition affect a particular recreation activity? Would changes in sediment transport affect access?

For state CELCP leads, conceptual ecological models would include the conservation targets identified in the state CELC plans and the ecological attributes (either within or beyond the coastal zone) that affect the targets.

Hypothetical Ecological Model

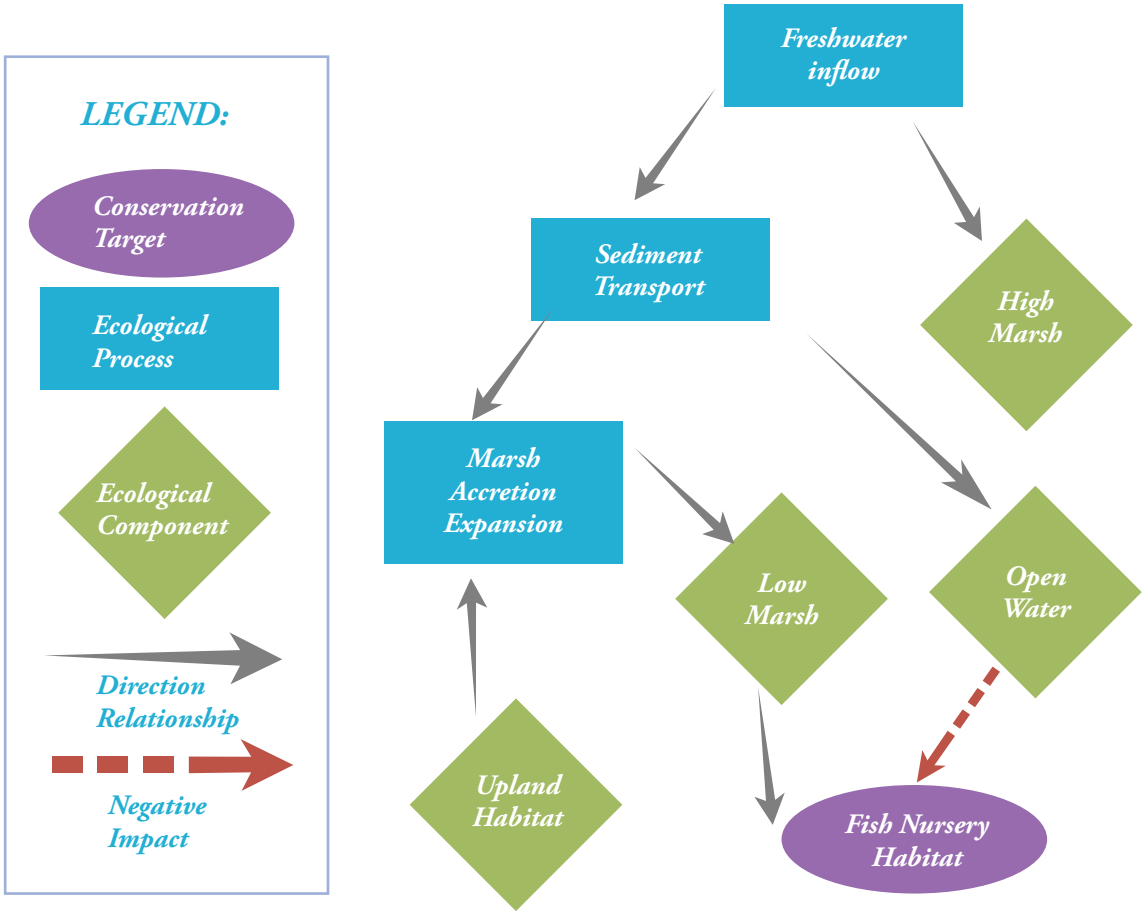

Figure 2. Hypothetical ecological model of coastal wetland system

In this hypothetical conceptual ecological model, solid arrows indicate a direct relationship between the connected attributes. The dashed arrow indicates a negative effect: i.e., "Open Water" is not conducive to "Fish Nursery Habitat." You can choose your own labeling convention (e.g., shapes and arrows) for your model.

In this model, "Freshwater Inflow" is a key ecological process because it drives sediment transport, which is connected to many other attributes, either directly or indirectly. "Sediment Transport" is also a key ecological process, as it has a cascading effect on the conservation target of fish nursery habitat. The key ecological component is "Low Marsh," as it directly supports the conservation target of fish nursery habitat. These identified key ecological attributes suggest that the management of freshwater inflow, sediment transport, and low marsh extent would be crucial in maintaining the availability of fish nursery habitat in this hypothetical system.

RESOURCES:

For more information on conceptual models, see:

- Developing Conceptual Models for Monitoring Programs, Gross 2007, US NPS. http://science.nature.nps.gov/im/monitor/docs/Conceptual_modelling.pdf
- Are We Conserving What We Say We Are? Measuring Ecological Integrity within Protected Areas, Parrish et al. 2003, pp 853-855 http://science.nature.nps.gov/im/monitor/meetings/NARSEC_2007/docs/Parrish_etal_2003.pdf
- Conceptual Models, Mitchell et al. 2006, US NPS.
- (includes sections on terrestrial, wetland, aquatic and intertidal resources) http://science.nature.nps.gov/im/units/netn/downloads/Phase3/Appendix_Conceptual_Models.pdf
- Role of Conceptual Ecological Models in Identifying Ecological Indicators, Charlotte Harbor National Estuary Program.
- http://www.chnep.org/projects/climate/CEMexplanation.pdf
- The Use of Conceptual Ecological Models to Guide Ecosystem Restoration in South Florida, Ogden et al. 2005. http://www.evergladesplan.org/pm/recover/recover_docs/cems/cem_use_of_cems.pdf

For examples of standard key ecological attributes, see:

- Standard Key Ecological Attributes, The Nature Conservancy. http://www.conservationgateway.org/file/standard-key-ecological-attributes

(The download is an excel file)

Step 3: Identify existing non-climate stressors on key ecological attributes

What are the non-climate stressors of concern affecting the key ecological processes and components underpinning your conservation targets?

EXAMPLES: pollution, anthropogenic habitat fragmentation, alterations to hydrologic regime, alterations to sediment transport, invasive species, etc.

WHY: In order to sustain conservation targets' viability, key ecological attributes must be managed and conserved (Parrish et al. 2003). Identifying non-climate related stressors affecting key ecological processes and components is the first step in the management of key ecological attributes and is valuable in understanding the root causes of any changes to your conservation targets.

Stressors include physical, biological or chemical perturbations to a natural system (Mitchell et al. 2006). Changing climate conditions can also cause disturbance to natural systems. There is need to distinguish between non-climate related stressors and climate-related stressors, as these two types of stressors may require different management approaches. For example, in-stream habitat degradation caused by pollution or diverted stream flow (non-climate stressors) may require pollution control measures or restoration of stream flow, while in-stream habitat degradation caused by salinity intrusion from sea-level rise (climate-related stressor) may require management approaches that protect in-stream habitats elsewhere to allow species migration or dam removal to increase freshwater flow to counter salinity intrusion.

HOW: For both CELCP applicants and state CELCP leads, in the ecological model you developed in Step 2, take a look at the identified key ecological processes and/or components (Outcome of Step 2). Are there non-climate stressors (physical, biological, or chemical perturbations) currently acting upon those key ecological attributes?

Add the identified non-climate stressors to your ecological model and examine whether there are any changes to relationships existing between the connected elements. Work through the chain of events to determine the effect of the non-climate stressors on your conservation targets. See Figure 3 on the next page as an example.

A non-climate stressor of "Channelization Upstream" was added to the hypothetical ecological model developed in Step 2. In this hypothetical diagram, the ecological effects of channelized upstream were considered only as they pertain to freshwater inflow and sediment transport.

Hypothetical Ecological Model

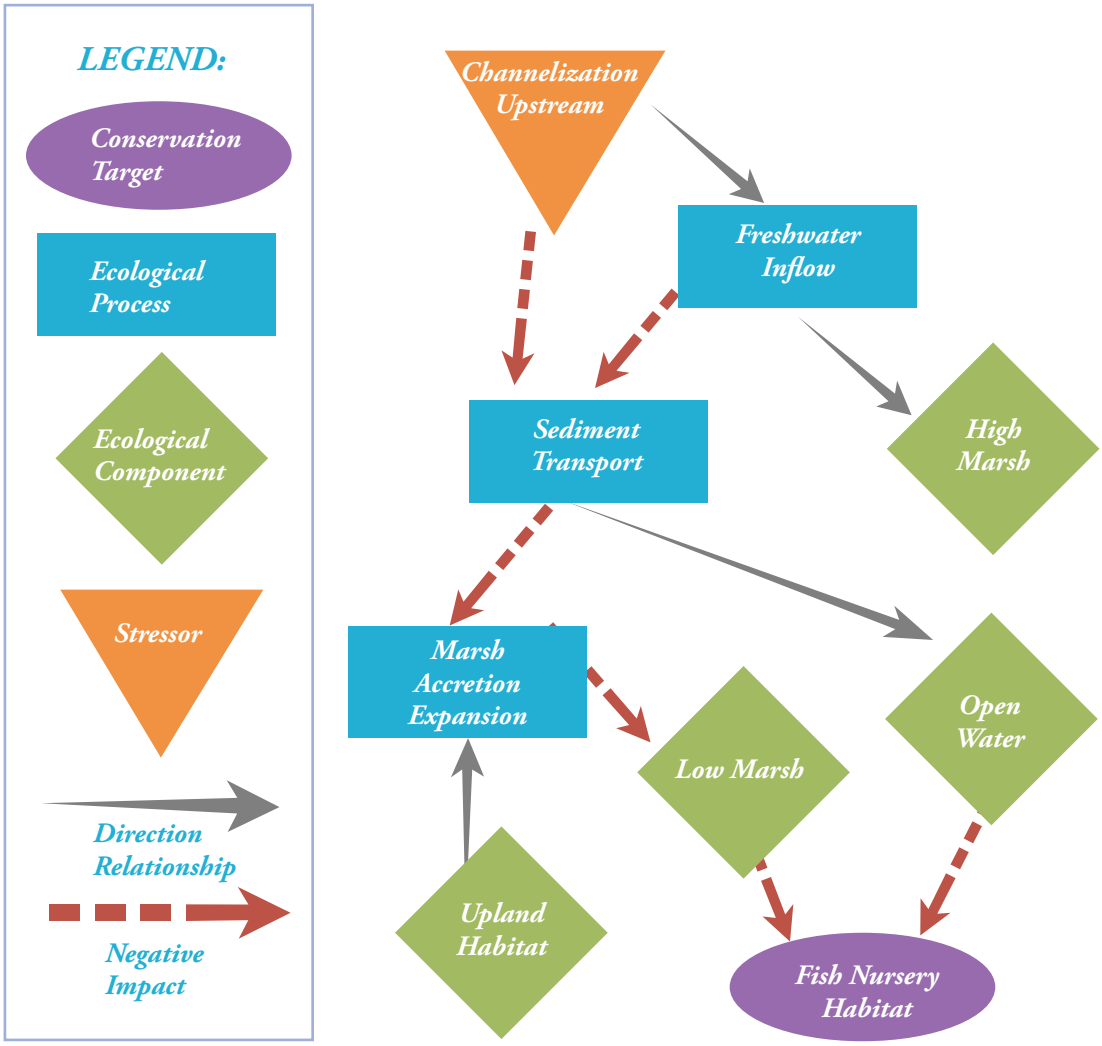

Figure 3. Hypothetical ecological model of coastal wetland system with stressor added

Channelization alters freshwater inflow by increasing the rate of input; this is indicated by a solid arrow, as channelization did not reduce (negatively affect) the amount of freshwater inflow. The increased rate of freshwater input, in turn, has a negative effect on sediment transport due to the faster water carrying the available sediments to new sites; this is indicated by a dashed arrow.

The channelized streambed reduces the amount of sediment available for transportation downstream into the marsh system. Channelization's effect on sedimentation transport is thus negative, indicated by a dashed arrow. Reduced sediment input allows the extent of open water to increase (denoted by a solid arrow), which reduces the amount of fish nursery habitat in the marsh system. This reduction in the amount of sediment input also has a negative effect on marsh accretion/expansion (denoted with a dashed arrow), which in turn has negative effects on the extent of low marsh (another dashed arrow). As the last step of the cascade, the reduced area of low marsh has negative effects (dashed arrow) on the availability of fish nursery habitat, which is the conservation target in this model.

One management approach for this non-climate stressor may be to restore the channelized reach into a more natural form to reestablish pre-disturbance sediment transport regime.

For CELCP applicants whose conservation targets are historical, recreational, or aesthetics, this hypothetical model may still apply. How would the historical, recreational, or aesthetics values be affected should the fauna and flora on the parcel change?

RESOURCES:

For examples of potential stressors, see:

- The Active River Area: A Conservation Framework for Protecting Rivers and Streams, Smith et al. 2008, The Nature Conservancy. p. 45 and Appendix A http://www.conservationgateway.org/sites/default/files/ASFPM_TNC_Active_River_%20Area.pdf

- Potential stressors in the coastal ecosystems of the Pacific Northwest and associated ecological, economic, and social impacts, Washington Department of Nature Resources. http://www.dnr.wa.gov/Publications/psl_ac_nearshore_potential_stressors.pdf

Step 4: Identify projected climate stressors/ impacts

What are the projected potential climate stressors for your area?

EXAMPLES: changes in precipitation; changes in temperature; changes in the magnitude and frequency of extreme weather events; relative sea level change, etc.

WHY: After non-climate stressors on your conservation targets' key ecological attributes have been identified, it is important to familiarize yourself with the projected climate stressors for your area. Identifying the projected climate stressors is the first step in determining how the changing climate may affect your project's key ecological processes and components and ultimately your conservation targets. Identified projected climate stressors may also explain changes to the system unexplained by non-climate stressors, thus furthering the understanding of your project's ecology.

HOW: Review the climate impacts reports for your region to familiarize yourself with the projected climate stressors for your region. Some reports give projections of precipitation and temperature scenarios, while others go beyond climate scenarios and project the possible cascade of ecological impacts.

The use of climate impacts reports or projections appropriate for your project will depend on your conservation targets and your organization's capacity for analyzing climate impacts. For example, if your organization has limited ability to model how increasing precipitation might influence your conservation targets, consulting a regional climate impacts report that has already hypothesized ecological impacts from increasing precipitation will provide you with a general idea of potential changes to your project without requiring your organization to conduct rigorous modeling and quantitative analyses. On the other hand, if your organization has relatively robust ability to conduct modeling and other quantitative analyses of climate impacts, doing so will enable you to determine potential climate impacts that are more specific to your project. If your organization has limited capacity but would like to conduct more robust analyses, leveraging partners with larger capacity may be an option.

As you are reviewing the projected climate stressors for your area, keep in mind the time horizons for the climate impact projections. Time horizons for potential climate impacts are useful in project design and planning as well as the development of a long-term management plan. The time horizon for which to consider potential climate impacts for your project may depend on your conservation targets and the ecology of your project.

For CELCP applicants, please use the Regional Reports[1] from U.S. Global Change Research Program (USGCRP) at: http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts

[1] Islands Regional Report includes both the Pacific and the Caribbean Islands.

The systematic use of USGCRP Regional Reports among CELCP project proposals provides common ground for considering the potential climate impacts between projects. In addition, because some of these regions can be large and the projected climate impacts can be highly generalized, it is important that the climate impacts projected by these regional reports are verified by local or state level information if information at such levels is available. Sources for local or state level climate impact information include universities, non-profit organizations, and state natural resource departments.

CELCP applicants should also use the time horizon of 50 years for considering potential climate impacts on their projects, for consistency with other federal programs/agencies (NOAA Restoration Center 2011). While appropriate time horizons do vary among projects, the systematized use of the same time horizon, again, provides common ground for considering how climate impacts might affect different projects.

For state CELCP leads, choose time horizons of at least 50 years.

RESOURCES:

For more climate impacts information and projections, see:

USGCRP Global Climate Change Impacts in the U.S, coastal reports:

- Coasts (2009), http://www.globalchange.gov/images/cir/pdf/coasts.pdf
- Estuaries (2008), http://downloads.climatescience.gov/sap/sap4-4/sap4-4-final-report-Ch7-Estuaries.pdf.
- Gulf Coast (2003), http://www.usgcrp.gov/usgcrp/Library/nationalassessment/gulfcoast/gulfcoast-complete.pdf

U.S. Fish and Wildlife Service climate change impacts by region:

- Northeast, http://www.fws.gov/northeast/climatechange/
- Southeast, http://www.fws.gov/southeast/climate/facts.html
- Midwest, http://www.fws.gov/midwest/climate/
- Pacific Southwest, http://www.fws.gov/cno/climate.html
- Pacific Northwest, http://www.fws.gov/pacific/Climatechange/changepnw.html
- Pacific Islands, http://www.fws.gov/pacific/Climatechange/changepi.html

U.S. Environmental Protection Agency:

- Coastal Sensitivity to Sea-level Rise: A Focus on the Mid-Atlantic Region (2009), http://epa.gov/climatechange/effects/coastal/ccsp_partI.html

Step 5: Evaluate climate effects on conservation targets

How might your conservation targets and the existing non-climate stressors change over time, under the projected climate stressors/impacts?

EXAMPLES: sea-level rise causing salt-intrusion into freshwater habitats; increased temperature allowing invasive species to better compete with native species; droughts reduce stream inflow affecting habitats downstream, etc.

WHY: Examining how projected climate stressors might affect your conservation targets and existing non-climate stressors is critical to project design, planning, and long-term management. Shifts in species and habitat distributions and alterations in ecological synergies in response to the changing climate have already been documented (Poiani et al. 2011). It is prudent to incorporate projected climate stressors/impacts into conservation projects to anticipate potential changes to the project's ecology and better sustain the conservation targets. As the Canadian hockey player Wayne Gretzky said, "I skate to where the puck is going to be, not where it has been."

HOW: For CELCP applicants and state CELCP leads, to evaluate the effects of projected climate stressors/impacts on your conservation targets, add the identified climate stressors/impacts (Outcome of Step 4) as new stressors to the ecological model developed in Step 3. Determine how the newly added climate stressors might affect the key ecological attributes identified in Step 2. See Figure 4 on the next page as an example.

	Existing non-climate stressors on key ecological attributes (Outcome of Step 3)
+	***Projected climate stressors/ impacts (Outcome of Step 4)***
	Potential climate impacts on your project's ecology and conservation targets (Outcome of Step 5)

In addition, as the science of climate projection modeling continues to improve and as more data are collected, it is imperative to check updated climate impacts and scenarios and new documentation of ecological responses every few years. The updated information will allow you to determine whether there are any changes to the status of the climate impacts originally considered for your project: Are the climate impacts progressing at the rate originally projected? Are there any previously marginally-relevant climate impacts becoming more influential on your project's ecology? The updated information will also allow you to adjust the project's long-term management plan accordingly.

In this hypothetical ecological model, the identified projected climate stressor/impact is "Sea-Level Rise." "Sea-Level Rise" is added to the ecological model along with its linkages and relationships to other elements in the model. Sea-level rise has a negative effect on "Low Marsh," as indicated with a dashed arrow. This negative effect of sea-level rise coupled with the negative effect of reduced sediment transport on low marsh have amplified the shrinking low marsh's negative impact on the conservation target of "Fish Nursery Habitat," as indicated with the larger dashed arrow. Sea-level rise has a positive effect on the extent of "Open Water" and amplifies the negative effect "Open Water" has on fish nursery habitat, again denoted with the larger dashed arrow.

Outcome of Step 5: The climate stressor/impact of sea-level rise has an overall effect on the project's ecology by exacerbating the non-climate stressor of upstream channelization and increasing the magnitude of low marsh loss, which ultimately diminishes the availability of fish nursery habitat at a greater rate.

For state CELCP leads revising state CELC plans to include potential climate change effects on state CELCP priorities, this is your last step in this guide. Incorporate the findings of this step (i.e., Outcome of Step 5) into the existing CELCP priorities for the state (Section II of the state CELC plans).

RESOURCES:

For a list of potential climate impacts on estuarine systems, see:

- Synthesis of Adaptation Options for Coastal Areas, Climate Ready Estuaries, U.S. EPA, pp 2 – 4.

http://www.epa.gov/climatereadyestuaries/downloads/CRE_Synthesis_1.09.pdf

Step 6: Identify long-term management goals and objectives

What are your project's long-term goals and objectives for the identified conservation targets, especially with the potential climate effects on the conservation targets and existing non-climate stressors (Outcome of Step 5) in mind?

EXAMPLES: For the hypothetical ecological model example used in this guide, the goal would be to maintain sufficient amount of low marsh for fish nursery habitat, taking into consideration that the extent of low marsh for fish nursery habitat is likely to decrease due to both the non-climate and climate stressors. The objectives would be: 1. Restore favorable sediment transport for marsh accretion and expansion within 10 years, which would address the non-climate stressor; and 2. Provide opportunity for low marsh migration for the next 50 years, which would adapt the project to the potential climate effects.

WHY: While not all conservation projects are "climate adaptation" projects, all conservation projects should anticipate and be able to adapt in a timely manner to the changing climatic conditions. Integrating potential climate effects into long-term management goals and objectives allows you to take management actions to adapt to the changing climate. In other words, identifying long-term management goals and objectives in the context of potential climate effects is useful for formulating long-term management plans that effectively reduce non-climate stressors on key ecological attributes and conservation targets and increase long-term resilience of the targets.

For CELCP applicants, because project selection priority is given to CELCP proposals that "can be effectively managed and protected in terms of land stewardship and/or need for restoration or enhancement" (see CELCP FFO, V. Application Review Information, A. Evaluation Criteria), developing long-term management plans in the context of potential climate impacts may improve a project proposal's ratings as climate change considerations become systematically incorporated into CELCP.

For state CELCP leads, long-term management plans are not a required component of state CELC plans.

HOW: Your goal for your project is your desired end state for your conservation targets and should advance your state's CELCP priorities. If your analysis from the previous steps suggests that your conservation targets may be affected by projected climate stressors/impacts, it may be in the project's long-term interest to reflect the potential climate effects in the goals. Take a look at the identified conservation targets (Outcome of Step 1) and the potential climate effects on the conservation targets and the non-climate stressors (Outcome of Step 5). What would be the desired state of your conservation targets by the end of the time horizon you selected (50 years for CELCP applicants) in Step 4?

Your objectives are specific statements of what your project will do to achieve the goals. Your objectives are based on your hypotheses of your project's ecology and how to achieve the goals. Your hypotheses are, in turn, based on your analysis from the previous steps. Thus, your objectives may involve the key ecological processes and components identified in Step 2 and how they relate to your conservation targets. What are the non-climate and climate stressors acting upon key ecological attributes and conservation targets? What are the mitigation options for non-climate stressors? What are the management options to increase the conservation targets' sustainability in the context of both non-climate and climate stressors?

RESOURCES:

For more details on goals and objectives, see:

- Open Standards for the Practice of Conservation, Conservation Measures Partnership 2007. pp 13 – 17 and Annex 2.

http://www.conservationmeasures.org/wp-content/uploads/2010/04/CMP_Open_Standards_Version_2.0.pdf

For a list of potential management goals for estuaries, see:

- Synthesis of Adaptation Options for Coastal Areas, Climate Ready Estuaries, U.S. EPA, pp 4 – 21.

http://www.epa.gov/climatereadyestuaries/downloads/CRE_Synthesis_1.09.pdf

Step 7: Formulate a long-term management plan

What would you need to do over the long-term to maintain the viability of your conservation targets?

EXAMPLE: For the hypothetical ecological model example used in this guide, the loss of low marsh from both the non-climate and climate stressors may be the greatest threat to the conservation target of fish nursery habitat. With the long-term management goal of maintaining sufficient amount of low marsh, the long-term management plan may include measuring the area of low marsh every three years to make sure that the initial actions of restoring the channelized reach and the protection of marsh migration opportunities are achieving the goal. The long-term management plan would also include other management options to pursue should monitoring reveal that the sufficient amount of low marsh is not being maintained.

WHY: Long-term management plans that are based on considerations of potential climate effects on conservation targets allow you to better prepare for the environmental changes ahead and take timely actions to increase the viability and resilience of your conservation targets.

HOW: Long-term management plans should include efforts to increase the resilience of your conservation targets, such as management options to reduce existing non-climate stressors and options to mitigate climate stressors, if possible. The planning horizon for your long-term management plan should match the time horizon you used for assessing the potential climate change impacts.

For CELCP applicants, your long-term management plan should include three crucial elements:

1. Some form of monitoring plan to track the progression of your conservation targets' responses to potential climate effects, with monitoring parameters that would provide information on any changes to your project's key ecological attributes and magnitude of existing stressors;

2. A range of management options and strategies to adapt to the changing conditions and adjust your management actions in a timely manner; and

3. Periodic reviews of the most updated climate stressors/impacts projections and documentation of relevant ecological responses so that the climate and ecological information on which you base your management decisions are up-to-date.

RESOURCES:

For more information on management options and strategies to adapt your project to the changing climate, see:

- A New Era for Conservation: Review of Climate Change Adaptation Literature, Glick et al. 2009, pp. 46 – 51 (coasts and estuaries adaptation strategies).

http://www.nwf.org/~/media/PDFs/Global%20Warming/Reports/NWFClimateChangeAdaptationLiteratureReview.ashx

- Climate Change Adaptation Strategies for Resource Management and Conservation Planning, Lawler 2009, pp. 81 – 86 and 89 – 92.

http://courses.washington.edu/cfr590/climatechange/Lawler.2009.pdf

- Designing Conservation Strategies for Climate Adaptation, Mawdsley 2011, pp. 504 – 507.

http://onlinelibrary.wiley.com/doi/10.1002/wcc.127/pdf

- Conservation Action Planning Guidelines for Developing Strategies in the Face of Climate Change, The Nature Conservancy, Appendix 2.

http://www.conservationgateway.org/sites/default/files/CC%20CAP%20Guidance%20Document%20version%20October%2022-%202009-v1.pdf

- Synthesis of Adaptation Options for Coastal Areas, Climate Ready Estuaries, U.S. EPA, pp 4 – 21.

http://www.epa.gov/climatereadyestuaries/downloads/CRE_Synthesis_1.09.pdf

CONCLUSION

Coastal areas and ecosystems are vulnerable to various impacts of climate change. In order for coastal conservation projects and strategies to better achieve and sustain their goals, potential effects of climate change on coastal conservation targets need to be taken into account. The method of assessing potential climate change effects on conservation targets described in this guide is a systematic and qualitative approach. The use of a conceptual ecological model as the main assessment tool helps to better visualize and communicate the ecological dynamics of a conservation project.

It is important to note that, every few years, the guide user should check updated climate effects and scenarios as well as new documentation of ecological responses to climate stressors. The updated information will allow the user to determine whether there are any changes to the status of the climate effects originally assessed for the project. The updated information will also allow the user to adjust the project's long-term management plan accordingly.

Likewise, OCRM will keep abreast of climate change science and the newest developments of climate adaptation strategies and update this guide as appropriate.

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, which 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: All impacts that may occur given a projected change in climate, without considering adaptation. Residual impacts: 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 most important to monitor (CMP 2007).

Conservation target – An element of biodiversity at a project site, which can be a species, habitat/ecological system, or ecological process that a project has chosen to focus on (CMP 2007).
NOTE: Depending on the scale to which you are applying this guide, your "project site" might be a parcel, a reserve, a watershed, or an entire coastal zone.

Ecological components – Any part of an ecosystem, including individuals, populations, communities, and the ecosystem itself (http://www.epa.gov/oswer/riskassessment/glossary.htm).

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 – is the key to the development and implementation of sustainable ecological management (Steffen et al. 2009).

Ecological synergy – Synergy means working together and refers to the phenomenon in which two or more discrete influences or agents acting together create an effect greater than that predicted by knowing only the separate effects of the individual agents. Ecological synergy describes positive symbiosis (Steffen et al. 2009).

Key Ecological attribute (processes and components) – The key ecological attributes of any conservation target include not only its biological composition (and crucial patterns of variation in this composition over space) but also the biotic interactions and processes (including disturbance and succession dynamics), environmental regimes and constraints (again including disturbance dynamics), and attributes of landscape structure and architecture that sustain the target's composition and its natural dynamics (Parrish 2003).

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 2007).

Project – A set of actions undertaken by a defined group of practitioners – including managers, researchers, community members, or other stakeholders – to achieve defined goals and objectives (CMP 2007).

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 – Stressors are 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 et al. 2006).
Non-climate stressors are stressors not caused by climate change; climate stressors are stressors that are caused by climate change.

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 (http://www.epa.gov/oswer/riskassessment/glossary.htm).

ACRONYMS

NOAA National Oceanic and Atmospheric Administration
NOS National Ocean Service
NMFS National Marine Fisheries Service
OCRM Office of Ocean and Coastal Resource Management
CELCP Coastal and Estuarine Land Conservation Program

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