CONSERVATION SCIENCE
THE NATURE CONSERVANCY

Conservation Action Planning Guidelines for Developing Strategies in the Face of Climate Change

October 2009

The Nature Conservancy

Protecting nature. Preserving life.™

This document was prepared by The Nature Conservancy's Central Science Division and is based on methods tested at the September 2009 Climate Adaptation Clinic held in Salt Lake City, Utah.

Revision Date: 10/22/2009

Table of Contents

Introduction and Use of Guidelines

The methodology outlined in these guidelines was developed by The Nature Conservancy to assist twenty existing conservation projects adapt their current strategies to climate change. These projects were part of the 2009 Climate Adaptation Clinic (i.e., Climate Clinic), held September 1-3, 2009 in Salt Lake City, Utah. The original guidance, tools, and methods developed specifically for the Climate Clinic were tested by the twenty projects during the three day workshop. These significantly revised guidelines reflect the learning and insights gained from the application of the original guidance at the Climate Clinic and can be used more broadly in our Conservation Action Planning efforts.

Methods for incorporating climate change in our conservation strategies and actions will be evolving rapidly over the coming months and years. As more projects apply this version of the guidelines to their work and test other methods and tools, additional lessons will be learned. Thus, these guidelines should be treated as a "work in progress" with future drafts reflecting our dynamic learning.

Audience

The guidance described in this document follows The Nature Conservancy's primary project planning methodology – Conservation Action Planning or CAP. CAP is the Conservancy's version of the Open Standards for the Practice of Conservation which is widely used across the conservation community. See www.conservationmeasures.org.

This guidance is written for conservation practitioners who are already familiar with CAP and should be used in conjunction with basic CAP methods and tools.

Readers are expected to have a fundamental understanding of Conservation Action Planning and its component parts and tools (e.g., establishing conservation targets, determining key ecological attributes, viability and threat assessments, situation analysis, CAP Excel Workbook, Miradi, etc). If practitioners do not have experience with CAP, this guidance may be of limited value because it draws on but does not explain the basic principles, methods, and existing tools.

See Appendix 1 for additional CAP resources and references.

Intended Use

These guidelines are intended to help answer the question: *How can we improve project-based strategies and actions given the realities of conservation in a changing climate?*

The guidelines are intended to help conservation practitioners more systematically and explicitly take into consideration the potential impacts of climate change on their conservation strategies and actions. The methods were originally written for and tested by projects that already had a basic conservation action plan but that did not adequately consider the potential impacts of climate change in their original plan. Thus, the guidance is best applied to existing projects that have an understanding of their conservation purpose, challenges, and opportunities but that have not yet systematically considered climate change. These guidelines will help practitioners consider the potential effects of climate change and adjust their strategies and actions accordingly. These guidelines also may be useful for project teams just beginning to develop their conservation plan who want to incorporate climate change impacts from the start. However, please keep in mind that the guidelines have not been tested or fine-tuned for this specific application. A team that is just beginning project planning should apply the basic CAP process while taking into consideration the suggestions outlined in this paper.

Scale

Conservation Action Planning methods and tools can be applied to conservation projects at any scale or scope. During the 2009 Climate Clinic, an earlier version of these guidelines was applied to projects at vastly different scales with general success – from smaller site-based projects of tens of thousands of hectares to regional scale projects of tens of millions of hectares. Selecting the scale at which to develop a CAP and/or assess the potential impacts of climate change is an ongoing issue and is part of the emerging dialogue related to climate adaptation planning and the evolution of the Conservancy's core planning methods. A thorough discussion of these issues is beyond the scope of this document. See Appendix 1 for additional resources that address planning scale and climate adaptation.

Step 1 – Understand the Potential Ecological Impacts of Climate Change

It is important to take the time and effort to understand how exposure to climate change might impact the ecology of your project. The foundational components of focal conservation targets and the key ecological attributes (KEAs) developed for each conservation targets provide an excellent place to start to gain an understanding of the potential ecological impacts of climate change. Here are some suggestions for organizing this investigation:

A. Carefully review the key ecological attributes (KEAs) for your conservation targets to ensure that they represent your current best thinking.

B. See if there are journal articles written on the potential impacts of climate change on your conservation targets (and their habitats) and/or key ecological attributes.

Tips

- You can type in Google Scholar (http://scholar.google.com/schhp?ie=UTF-8&hl=en&tab=ws) "climate change" "sagebrush;" or
- TNC staff can search the online journals available from ConserveOnline when logged in as a user (http://conserveonline.org/scientificjournals.html); or
- You can try the "web of knowledge" feature to search for peer-reviewed papers. This feature can also be found on ConserveOnline in the journals section (http://conserveonline.org/scientificjournals.html), but note, you need to be a TNC staff person logged into your ConserveOnline account to use it.

C. Explore Climate Wizard (http://www.climatewiz.org/) – you can understand some of the basics of projected temperature and precipitation changes for your project geography using this tool.

D. Find the academic and agency experts who are studying the impacts of climate change on your geography, conservation targets (and their habitats), or other relevant aspects of your project. Talk to these experts and ask them questions about how they think climate change will impact the conservation targets (and their habitats), viability, and threats.

E. You should also examine range or distribution maps of your conservation targets if possible. Such maps will indicate if ecosystems or species of focus are within the center or at the edge of their range and may suggest whether the conservation target will remain in your project area under projected climate changes.

Tips

- NatureServe's Explorer has range information as well as biological information and literature on rare species, plant communities, and ecological systems for the United States and Canada (http://www.natureserve.org/explorer/).

- NatureServe's InfoNatura has similar information for animals and ecosystems of Latin America (http://www.natureserve.org/infonatura/).
- You may also want to check with your state Natural Heritage Program or country Conservation Data Center for more local data.

F. We recommend considering the potential effects of climate change using a 50-year time frame. Fifty years aligns with outputs from many climate simulation models, represents enough time for impacts to occur, and is still a reasonable time frame to consider conservation actions. Model projects for a longer time horizon such as 100 years include more uncertainty and developing conservation actions for this time frame may be too unrealistic. However, if you feel a different time frame is more appropriate, be sure to document what time frame you chose and why.

Step 2 – Formulate Specific Ecological “Hypotheses of Change”

Once you have a sense of how climate change might impact your project, you can translate that information into specific *hypotheses of change* – that is, how you think climate change will specifically impact your conservation targets and their key ecological attributes. These hypotheses of change are essentially statements about the “vulnerability” of the system – the combination of “exposure” and inherent “sensitivity” of the ecology of the focal conservation targets. Although you can make a comprehensive list of these potential impacts, it will be important to carry forward a shorter list (e.g., up to eight) when assessing the level of threat and ultimately, developing strategies.

A. Using what you learned in Step 1, develop hypotheses of change based on your list of key ecological attributes. These should focus on what you think the most significant changes will be to your conservation targets. These need to be specific – see examples in Table 1. Make sure to explicitly link the hypothesis of change to the key ecological attribute.

Tips

- Examples of hypotheses of change from projects that participated in the Climate Clinic can be found at: http://conserveonline.org/workspaces/climateadaptation/documents/climate-change-project-level-guidance.

B. We recommend using a 50-year time frame for developing hypotheses of change for reasons described above. However, if you feel a different time frame is more appropriate, document what time frame you chose and why.

C. Some of your conservation targets or key ecological attributes may not be significantly affected by climate change. It is also possible that you will need to add new key ecological attributes or revise the original ones.

D. If you have a long list of hypotheses of change, select a subset (e.g., up to eight) to carry forward based on those you anticipate being most “likely” to occur, and/or those that pose the greatest potential threat, and/or those that might also cause deterioration to other KEAs (i.e., a chain reaction effect).

E. Projects at the Climate Clinic found it very helpful to develop a conceptual ecological model (e.g., box and arrow diagram or picture representing ecological relationships). Having this model provided a graphic aid to help understand and communicate the potential ecological impacts of climate change on the conservation targets and develop hypotheses of change.

Tips

- Examples of conceptual ecological models from projects that participated in the Climate Clinic can be found at: http://conserveonline.org/workspaces/climateadaptation/documents/climate-change-project-level-guidance.

F. Because of the significant uncertainty associated with changes in climate variables, it is more realistic to identify a range of change rather than an absolute value (see Table 1). In some cases you will have a decent estimate of the range of projected changes in climate variables and in some cases you will not. When you do not know the specifics, use placeholders that identify the likely direction if not the quantitative range of expected change in your hypotheses (e.g., “+x-y degrees”).

G. Finally, it may be helpful to list any specific high-priority “science needs” related to the uncertainty associated with climate change impacts. These science needs can then be turned into key action steps later in the process if appropriate.

Table 1. "Hypotheses of change" in key ecological attributes due to climate change.

Conservation Target	Climate Factors	Likelihood of Climate Impact	Key Ecological Attribute	Hypothesis of Change	Likelihood of Ecological Change[1]	Comments, Notes, Key Sources/References
Mangrove ecosystem	Sea level rise (+x-y meters)	Virtually certain	Erosion-deposition sediment regime	Predicted increase in sea level will modify *erosion-deposition regime* resulting in loss of mangrove in existing areas and potential for mangrove to establish in adjacent upslope areas.	Virtually certain	Add comments or notes, and key sources of information and/or literature references as needed.
Patch coral reef ecosystem	Ocean temperature (+2-4 degrees C)	Very likely	Live coral cover	Predicted increase in ocean temperatures will reduce *live coral cover* for patch coral reef ecosystem.	Very likely	
Riparian ecosystem	Snowmelt (-20-40%)	Uncertain	Hydrologic flow regime	Significantly reduced snow pack will alter the spring and summer *hydrologic flow regime* for riparian ecosystem.	Virtually certain	
Wet meadows	Temperature (+3-4 degrees C mean annual)	Uncertain	% cover and composition of species	Hotter annual temperatures will reduce soil moisture and thus significantly impair *% cover and composition of species* in wet meadows.	Likely	
Tropical dry forest ecosystem	Temperature (+x-y degrees C) & precipitation (+number of dry months)	Very Likely	Intensity, frequency, and extent of fires (i.e., fire regime)	Higher mean annual and summer temperatures and lower and/or unequally distributed precipitation will increase *intensity, frequency, and extent of fires* for tropical dry forest ecosystem.	Likely	
Rare, endemic amphibian species	Temperature (+2-5 degrees C) & precipitation (-10-20% average summer)	Likely	Extent of summer breeding habitat	Increased temperature and decreased precipitation will significantly reduce the *extent of summer breeding habitat* of rare, endemic amphibian species in temperate life zones.	Uncertain	

[1] Rank this likelihood factor with the assumption that the climate impact does in fact occur.

Step 3 – Explore Potential Human Responses to Climate Change

The impacts of climate change will be both direct and indirect. In some cases, human responses to climate change will be more important than the direct effects themselves. This step of the process asks you to explore the potential human responses to climate impacts (e.g., building hard shoreline structures in response to sea level rise; building dams to store scarce water). Starting with the ecological hypotheses of change, start to define potential actions that human communities most connected to these ecological systems are likely to take that may affect the integrity and long term viability of the ecological systems or species. Take into consideration that human responses may also be gains for conservation (e.g., government hazard planning agencies and insurance companies respond to increased threat of coastal flooding by considering a shift to buying out residents of flood prone areas rather than providing funds for rebuilding).

A. The conceptual ecological models recommended for developing hypotheses of change in Step 2 can also be expanded beyond ecological factors to gain a better understanding of the range of socio-economic and cultural resources at risk and the potential human responses. Amend your model to show human interactions including population densities, location of infrastructure, areas of significance for human livelihoods, and/or important cultural features.

B. Start with understanding the human responses to climate change impacts (e.g., hypotheses of change) that are <u>most likely</u> to occur and that are most likely to elicit a significant human response.

C. Census data may be useful to understand expected population changes in your project area. Government census bureaus also have projections of economic growth and expected growth trends. Such projections may not be borne out if the climate impacts on a region are severe, but knowing which areas are projected to have more development and larger populations will help you identify areas where human intervention is most likely.

D. Purposefully identify and talk to non-traditional academic, agency, NGO, or other partners to deepen and refine your understanding of the human response to climate change. Potential partners might include local business leaders, utility and infrastructure planners and engineers, economic development experts, coastal zone management officials, public health officers, agricultural development experts, and so forth. In some cases, these experts will have model projections or scenarios of human responses to climate change that will be informative in your planning efforts.

Tips

- TNC's Hudson River Estuary Program has initiated a long-term climate planning process built around non-traditional stakeholder involvement. The Rising Waters Project has brought together more than 160 regional representatives, including emergency responders, railroad companies, waterfront business owners, insurers, wastewater treatment plant operators, government agencies, environmental groups, and others. The final report of the project is available at: http://www.nature.org/wherewework/northamerica/states/newyork/science/art23583.html

- A comprehensive assessment tool is available to help project planners and managers integrate climate change adaptation into community-level projects: the Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) http://www.cristaltool.org/.

F. The literature and available tools on the human dimensions of climate change is rich and growing quickly. Much of it originates in the international development community. You can use Google Scholar, TNC's online journals, and "web of knowledge" as described in Step 1. The information you gather in this step will be used to identify and rank direct and indirect threats from climate change and ultimately to develop adaptation strategies, so target your search accordingly.

Tips

- The U.S. Agency for International Development increasingly focuses on adaptation measures to assure that their development projects are sustainable. Several manuals that may be useful for conservation planners are available at the USAID web site (www.usaid.gov). These include: "Adapting to Climate Variability and Change: A Guidance Manual for Development Planning," "Adapting to Coastal Climate Change: A Guide Book for Development Planners," and "Financing Climate Adaptation and Mitigation in Rural Areas of Developing Countries."

Step 4 – Determine Which Climate-Induced Threats are MOST Critical to Address

Completing the previous three steps has hopefully provided you with a better understanding of the potential ecological impacts from climate change and the potential human responses to those impacts. Now you will ask the question "how bad are the potential impacts and/or human responses, and which ones are most critical and need to be addressed now?"

A. Start with the detailed threats assessment and ranking (i.e., stresses and sources of stress) from your original CAP and revisit your rankings based on what the climate impact analysis revealed. This entails *including new stresses and sources of stress AND re-ranking existing stresses and sources of stress with the added or exacerbated effects of climate change.*

B. Be as specific as possible in describing your climate-related sources of stress (e.g., do not list "climate change"). Be sure to include the potential human responses that you discovered in Step 3 in your evaluation and ranking process. The most important hypotheses of change should be incorporated into re-ranking existing threats and the identification of new threats.

C. The recommended time frame in a standard CAP threats assessment is 10 years (and longer for some threats like invasive species). We recommend using a 50-year time frame for assessing the direct and indirect threats from climate change for reasons discussed previously. If you feel a different time frame is more appropriate, document what time frame you chose and why. *Caveat*: A longer time horizon for climate change threats is needed to assess their full impact. However, using different time horizons to determine which threats warrant attention for strategy development is largely untested and warrants additional evaluation. Until then, make sure the basis of all threat ranking is clearly documented so that appropriate strategies can be developed for both near- and long-term critical threats.

D. It may also be useful to rank each threat <u>with</u> and <u>without</u> climate change impacts (using a 50-year time frame) to fully understand the added impacts of climate change.

E. If you are developing a new conservation action plan, the CAP Excel Workbook and Miradi offer the traditional TNC stress and sources threat ranking approach and a simplified threat ranking approach which focuses on sources only. Both approaches flow from the viability analysis where sources of stress are assumed to be impacts to KEAs. In either method, you can build in climate-based sources of stress along with other human responses from your analysis. The primary differences when considering climate change from the current threats assessment in CAP are (a) use a 50-year time horizon to capture the potential impacts from climate change, and (b) capture the "most likely" changes identified in your specific hypotheses of change when defining and ranking threats.

F. The overall goal of this step is to determine the 1-3 MOST CRITICAL threats to address with adaptation strategies. It will be difficult to impossible to adequately address all potential threats, so you must develop a priority list. Your final list of most critical sources of stress could be a confirmation or exacerbation of already existing critical threats or brand new ones.

Step 5 – Evaluate if Potential Climate Impacts Fundamentally Change the Project

Before investing the time and energy in developing and evaluating adaptation strategies, we suggest you take a moment to reflect on whether there are any potential climate impacts that fundamentally change your project's definition. Reflect on the series of probing questions below to determine if your project or conservation targets need major adjustments at this juncture.

A. *Step back and review your threats assessment and determine if any of your conservation targets are on the brink of acceptable viability.* In many conservation projects some conservation targets are already on the brink of acceptable viability. The added impacts from climate change may push these ecosystems or species into unacceptable health. You must try to honestly assess what it will take to conserve or restore these ecosystems and species in the face of climate change and in some cases decide to discontinue these efforts.

B. Any changes to the conservation targets in a project CAP are likely to have important implications for both ecoregional/regional assessments as well as other project CAPs since planning efforts at multiple scales and places are often linked or influenced by one another. Changes in CAP conservation targets or project scope should be communicated to these other efforts and plans where appropriate.

Probing Questions

- **Do you need to add a new conservation target due to climate change?**
  - A significant ecosystem or species is expected to expand into the project area.
  - A common ecosystem or species in the project area is expected to become rare.
- **Do you need to adjust any of your existing conservation targets due to climate change?**
  - An important nested target is expected to be impacted differently than the ecosystem which supports it (i.e., nested target unviable/broader system viable, or nested target viable/broader system unviable).
  - The specific composition of the ecosystem as currently defined may not be viable with climate impacts, but the broader system type may persist with an unknown composition (e.g., unlikely to sustain a "beech-maple forest" but can sustain a "hardwood forest" with the precise composition not necessarily beech-maple over the long term).
- **Do you need to adjust the project scope or boundary due to climate change?**
  - If there are clearly more resilient areas or more resilient examples of the conservation target in or nearby the project area (e.g., "refugia," cooler and/or wetter), these might be the primary focus of future conservation efforts and the project scope might need to be expanded (or contracted) to include (only) these resilient areas.
  - The project boundary could be adjusted to facilitate expansion and/or contraction along a trajectory of change (e.g., such as "up the mountain").
- **Do you need to consider a current conservation target elsewhere due to climate change?**
  - Your climate impact and KEA/threats analyses indicate there are more resilient occurrences elsewhere in the ecoregion or region.

    - You can envision a more feasible and/or less expensive strategy to conserve this conservation target elsewhere in the ecoregion or region (e.g., more available resources, fewer constraints, or better management environment).
- **Do you need to remove a conservation target due to climate change?**
    - You cannot envision a reasonably feasible strategy/outcome to maintain target viability nor can you adjust the project scope or boundary.
    - The conservation target will no longer need focus because of likely expansion due to climate change. Assess whether this target should be removed or become a nested target.

Step 6 – Develop Adaptation Strategies and Evaluate their Feasibility and Cost

With information from the previous five steps, you should now be ready to consider what actions are necessary to address the most important impacts of climate change or resulting human responses. Again, these threats must be of significant magnitude and scope to warrant action.

A. Fundamentally, adaptation strategies are no different than other strategies that are developed to improve viability or decrease threats. See the basic CAP resources and materials for additional advice and best practices on developing strategies.

B. Use all available materials and information for this step: hypotheses of change (Step 2); high-priority or key "science needs"; analysis of human responses (Step 3); threats assessment (Step 4); situation analysis from your initial CAP process; list of objectives and strategic actions from your initial CAP process.

C. Just as you revisited your threats analysis in light of this new information, you will need to revisit your situation analysis with the information you have assembled. A helpful step in developing adaptation strategies is to diagram your analysis of the threats and opportunities identified with climate change. A situation diagram captures your answers to questions such as: "What is driving this threat? Who is most involved? Why are they doing this? Who stands to gain or lose if this threat isn't addressed?" in a visual box-and-arrow flow chart. The act of "mapping" the factors, drivers, and relationships may help you clarify stakeholders, relationships, and other context issues and illuminate important linkages and possible points of intervention to influence the conservation situation. Methods for conducting a situation analysis and developing a situation diagram are outlined in the basic CAP methods and tools.

D. Follow standard CAP guidelines for developing objectives and strategic actions, including developing measurable objectives, strategic actions, action steps, and indicators. *Remember, as with any conservation strategy, the strategic actions need to be at a sufficient scope and scale to address the threats imposed by climate change or the human responses to climate change*.

E. Measurable objectives should derive from key ecological attribute indicator ratings and the hypotheses of change. They should represent a quantitative and measurable statement of "success" for that conservation target based on its viability or threat reduction. For example: "*By 2025, ensure "good" base flows in summer so that no sections of the Blue River go dry (approximately 50-75 CFS) in dry years." "By 2020, eliminate the use of habitat-damaging fishing gear in key coral and sponge gardens and known crab nursery areas."*

F. This step includes refining or enhancing *existing* objectives and strategic actions or developing *new* adaptation objectives and strategic actions. The framework below presents seven broad categories (Appendix 2 has examples) of conservation and management strategies specific to climate adaptation to stimulate your thinking (Kareiva et al. 2009).

- **Protect key ecosystem features**
  Special management protections or actions are applied to the structural characteristics, organisms, or areas that are particularly important to the resilience of the overall system.
- **Reduce anthropogenic stresses**
  Through management, minimize anthropogenic stressors (e.g., pollution, overfishing, development) that hinder the ability of species or ecosystems to withstand a stressful climatic event.
- **Representation**
  Management actions focused on ensuring diversity within a specific biodiversity entity (species or ecosystem) to increase the likelihood that some variations may be more suited to the new climate.
- **Replication**
  Ensure there are "multiple bets in a game of chance" by focusing on the continued viability of more than one example of each ecosystem or species.
- **Restoration**
  In many cases natural intact ecosystems have some resilience to extreme events. Restoring various components of natural ecosystems can help increase their resilience.
- **Refugia**
  Actions aimed at the management of physical environments that are less affected by climate change than other areas, thus ensuring a "refuge" from climate change.
- **Relocation**
  Management action focused on human-facilitated transplantation of organisms from one location to another in order to bypass a barrier.

G. The Strategy Ranking Tool in Appendix 3 (which was adapted from existing tools in the CAP Workbook and Miradi) can be used to rank each adaptation strategy.
   a. Benefits are the estimated degree to which the strategy will lead to the desired outcome, that is, threat abatement leading to improvement in viability of key ecological attributes and conservation targets.
   b. Feasibility reflects the probability of success and includes five ranked factors: *ease of implementation, lead individual or institution*, *institutional support*, *ability to motivate key constituencies*, and *the ability to secure necessary funding*.
   c. Cost is estimated as an approximate order of magnitude number of dollars for 10 years (i.e., one time costs + annual costs/year). This will require teams to consider whether anticipated costs are needed consistently over 10 years or staged as climate impacts ramp up over time.

H. During this assessment, it is useful to make note of any new key capacities you believe will be needed for new strategies (to be used later in developing an implementation plan) such as new TNC staff skills, buy-in from leaders, etc.

I. The last part of this step is to integrate any new strategies and actions related to climate change into the core components of your existing conservation action plan. The adaptation strategies and their cost/benefits should be evaluated with and prioritized against the list of objectives, strategies, and actions you already have outlined or are implementing. As in any conservation plan, only a few priority strategies can be implemented. You will need to take a look at how potential adaptation strategies stack up against other important strategies and what new opportunities climate change creates. Again, use the cost/benefits information to help you rank and develop a priority list.

Step 7 – Develop Measures, Implement, Adapt and Learn

Once you have developed climate adaptation strategies and they are integrated into the rest of the strategies and actions for the project, you will need to develop appropriate measures and monitoring, and an implementation plan.

A. Our standard CAP process has many methods and tools for developing measures – including developing indicators and monitoring methods to track key indicators over time (e.g., "results chains"). This guidance includes both biological/ecological information as well as short- and long-term activities that are part of an implementation plan.

B. Because of the inherent uncertainty associated with climate change, it will be wise to track certain ecological factors to determine if climate impacts are occurring as predicted. Often, climate or ecological data collected by partners can be used relatively easily and cost effectively to track conservation targets or threats. You will likely need to supplement available data with data specific to address the effectiveness of strategies. See Appendix 1 for a recent paper on developing a cost effective monitoring program (Montambault et al. 2009).

C. In addition to ecological data, it may be important to track some basic social information, including how humans are responding to climate change. Again, look for information and data that is already being collected by partners.

D. This is stating the obvious, but no strategy is complete without details on implementation – Who, What, Where, When, How Much. Again, guidance and tools for developing and tracking strategy implementation is available as part of the standard CAP methods and tools.

E. You may also want to communicate to practitioners, partners, managers, and other stakeholders to let them know how your project plan has changed as a result of incorporating potential climate impacts. Some of this communication may be directly related to your adaptation strategies and will part of your action steps, but updating your plan to incorporate climate impacts may also offer other more general communication opportunities.

F. It will be valuable to update your CAP workbook or Miradi file with the results of this analysis and upload the new plan to ConPro. This should include (a) annotating the project description to explain how the project has specifically considered climate change, and identify which parts of the CAP will require additional updating as a result; and (b) uploading your hypotheses of change to your ConPro record as an "Associated File." Also consider making your project public in ConPro if it is not already, to ensure that all important partners and stakeholders can view the updated plan.

G. Adapting and learning are a critical step in our basic CAP methodology and take on heightened importance given the uncertainty associated with climate change. As the final step in this guidance, develop a structured, reoccurring process for reviewing your measures and using that information for adapting and learning (at least annually if not more frequently). This includes both within your project team as well as some attention to sharing lessons learned with a broader audience.

Appendix 1: Selected Additional Resources

Literature Cited

Kareiva, P., Enquist, C., Johnson, A., Julius, S.H., Lawler, J., Petersen, B., Pitelka, L., Shaw, R., and West, J. (2009). Synthesis and Conclusions, Chapter 9. In *Preliminary review of adaptation options for climate-sensitive ecosystems and resources: Final Report, Synthesis and Assessment Product 4.4.*
http://downloads.climatescience.gov/sap/sap4-4/sap4-4-final-report-Ch9-Synthesis.pdf

Montambault, J.R., Groves, C., Kareiva, P. 2009. Improving conservation practice by investing in monitoring strategy effectiveness. Conservation Measures Working Paper #2. The Nature Conservancy, Arlington, Virginia.
http://conserveonline.org/workspaces/cbdgateway/documents/conservation-measures-working-paper-2

Climate Adaptation

TNC's Climate Adaptation workspace on ConserveOnline has many additional resources:
http://conserveonline.org/workspaces/climateadaptation/

- Information on the 20 projects that participated in the 2009 Climate Adaptation Clinic
- Information on other TNC climate adaptation projects
- Web-based seminars and discussions in preparation for the 2009 Climate Adaptation Clinic
- Climate adaptation reports and other web resources
- Climate adaptation bibliography
- Information on Climate Wizard

Draft working paper on considering climate change adaptation in regional scale conservation planning: Game, E., C. Groves, M. Anderson, M. Cross, C. Enquist, E. Girvetz, A. Gondor, K. Hall, J. Higgins, R. Marshall, K. Popper, and S. Shafer. 2009. Incorporating climate change adaptation into regional conservation assessments. The Nature Conservancy Draft Working Paper. Arlington, VA. For a copy of the most recent draft email Eddie Game (egame@tnc.org).

Recent publication aimed at revising State Wildlife Action Plans for climate change that contains many resources, literature cited, case studies, and links to other information:
Association of Fish & Wildlife Agencies. 2009. Voluntary guidance for states to incorporate climate change into State Wildlife Action Plans & other management plans. Available at: http://www.fishwildlife.org/pdfs/Climate%20Change-Wildlife%20Action%20Plan%20Guidance%202009.pdf

Two especially helpful documents were published in 2009 by the independent Commission on Climate Change and Development (organized by the Swedish government). One addresses risk analysis and building adaptive capacity at the local level. The other deals with disaster risk reduction in developing countries. They are available at: http://www.ccdcommission.org/home.html

The Millennium Ecosystem Assessment has prepared several synthesis reports on climate change impacts that may provide insights into potential human responses. Though basic, the report "Ecosystems and Human Well-Being: Opportunities and Challenges for Business and Industry" has graphical information on ecosystem services that might be affected by climate change and associated risks and opportunities for different sectors. These reports, along with others, are available at: http://www.millenniumassessment.org/en/index.aspx.

CAP

An electronic version of this document can be found at: http://conserveonline.org/workspaces/climateadaptation/documents/climate-change-project-level-guidance.

All the basic principles and methods for CAP are outlined in detail in the CAP Handbook. The CAP Handbook is available in three languages.

- http://conserveonline.org/workspaces/cbdgateway/cap/resources/2/1/handbook (English)
- http://conserveonline.org/workspaces/cbdgateway/cap/resources/2/portuguese_manual (Portuguese)
- http://conserveonline.org/workspaces/cbdgateway/cap/resources/2/2/Manual_PCA_Spanish.pdf (Spanish)

The Conservation by Design Gateway (http://conserveonline.org/workspaces/cbdgateway/) contains extensive information and many additional resources on CAP. This includes information on planning software, CAP guidance and presentations, sample CAPs, announcements and news, the CAP coaches network, and advanced materials for coaches and facilitators.

The Gateway's CAP page can be accessed directly at: http://conserveonline.org/workspaces/cbdgateway/cap/index_html

You can find guidance and tools for developing strategy effectiveness measures at: http://conservationgateway.org/measures

New Conservation Measures Working Paper on developing a monitoring program: Montambault, J.R., Groves, C., Kareiva, P. 2009. Improving conservation practice by investing in monitoring strategy effectiveness. Conservation Measures Working Paper #2, The Nature Conservancy, Arlington, Virginia. Available at: http://conserveonline.org/workspaces/cbdgateway/documents/conservation-measures-working-paper-2

Appendix 2: Climate Adaptation Approaches for Biodiversity Conservation

This appendix was excerpted and condensed from:

Kareiva, P., Enquist, C., Johnson, A., Julius, S. H., Lawler, J., Petersen, B., Pitelka, L., Shaw, R., and West, J. (2009). Synthesis and Conclusions, Chapter 9. In *Preliminary review of adaptation options for climate-sensitive ecosystems and resources: Final Report, Synthesis and Assessment Product 4.4.*

http://downloads.climatescience.gov/sap/sap4-4/sap4-4-final-report-Ch9-Synthesis.pdf

1. Protect key ecosystem features

Special management protections or actions are applied to the structural characteristics, organisms, or areas that are particularly important to the resilience of the overall system.

Examples

- Facilitate natural adaptation through management practices that shorten regeneration times and promote interspecific competition.
- Promote connected landscapes to facilitate species movements and gene flow, sustain key ecosystem processes and protect critical habitats.
- Remove barriers to upstream migration in rivers and streams.
- Use wildland fire, mechanical thinning, or prescribed burns where it is documented to reduce the risk of unusually severe fires.
- Maintain natural flow regime through dam flow releases.
- Protect tidal marshes from erosion with oyster breakwaters and rock sills and thus preserve their water filtration and fisheries enhancement functions.
- Adapt protection zones as locations of critical habitat change with climate.
- Design protected areas with dynamic boundaries and buffers to protect breeding and foraging habits of highly migratory and pelagic species.
- Monitor ecosystems and have rapid-response strategies to assess ecological effects of extreme events.
- Protect critical areas such as nursery grounds, spawning grounds, and areas of high species diversity.

2. Reduce anthropogenic stresses

Through management, minimize anthropogenic stressors (e.g., pollution, overfishing, development) that hinder the ability of species or ecosystems to withstand a stressful climatic event.

Examples

- Use early detection and rapid response to non-native invasive species.
- Work with watershed coalitions to reduce or eliminate pollution.
- Manage water storage and manage or reduce human water withdrawals.
- Purchase or lease water rights to enhance flow management options.
- Develop storm water infrastructure to reduce severe erosion.
- Conduct integrated management of nutrient sources and wetland treatment of nutrients to limit hypoxia and eutrophication.
- Prohibit bulkheads and other engineered structures on estuarine shores; Remove structures that harden coastlines.
- Manage overfishing and excessive inputs of nutrients, sediments and pollutants.
- Implement integrated coastal and watershed management.

3. Representation

Management actions focused on ensuring diversity within a specific biodiversity entity (species or ecosystem) to increase the likelihood that some variations may be more suited to the new climate.

Examples

- In forests, modify genetic diversity guidelines to increase the range of species, maintain high effective population sizes, and favor genotypes known for broad tolerance ranges.
- With projected decreases in water resources, manage for drought- and heat-tolerant species and populations. With less certain projections, manage for a variety of species and genotypes with a range of tolerances to low soil moisture and higher temperatures.
- Allow the establishment of non-native species locally which will help maintain native biodiversity or enhance ecosystem function overall.
- Plant or introduce desired species after disturbances or in anticipation of loss.
- Expand the boundaries of protected areas to increase variation in species.
- Increase genetic diversity through plantings or by stocking fish.
- Increase physical habitat heterogeneity in channels to support diverse biotic assemblages.
- Establish reserves for the purpose of maintaining high genetic diversity.
- Include entire ecological units to maintain ecosystem function and resilience.

4. Replication

Ensure there are “multiple bets in a game of chance” by focusing on the continued viability of more than one example of each ecosystem or species.

Examples

- Spread risks by increasing ecosystem redundancy and buffers.
- Replicate populations and gene pools of desired species.
- Provide redundant refuge types to reduce risk to trust species.
- Establish special protection for multiple headwater reaches that support keystone processes or sensitive species.
- Replicate reefs along a depth gradient to allow fish and crustaceans to survive when depth-dependent environmental degradation occurs.
- Ensure protection of replicated estuaries along flyways for migrating shorebirds.

5. Restoration

In many cases natural intact ecosystems have some resilience to extreme events. Restoring various components of natural ecosystems can help increase their resilience.

Examples

- Use the paleological record and historical ecological studies to revise restoration goals so that selected species will be tolerant of anticipated climate.
- Where appropriate after large-scale disturbances, reset succession and manage for asynchrony at the landscape scale by promoting diverse age classes and species mixes, a variety of successional stages, and spatially complex and heterogeneous vegetation structure.
- Use native vegetation and debris to minimize soil loss after fire or vegetation dieback.
- Conduct river restoration projects to stabilize eroding banks, repair in-stream habitat, or promote fish passages from areas with high temperatures and less precipitation.
- Restore important native species and remove invasive non-natives.
- Direct estuarine restoration to places where the restored ecosystem has room to retreat as sea level rises.
- Consider mangrove restoration to protect shoreline, expand nursery habitat, and release tannins and other compounds that may reduce photo-oxidative stress in corals.

6. Refugia

Actions aimed at the management of physical environments that are less affected by climate change than other areas, thus ensuring a "refuge" from climate change.

Examples

- Use paleological record and historical ecological studies to identify environments buffered against climate change, which would be good candidates for long-term conservation.
- Create or protect refugia for valued aquatic species at risk to the effects of early snowmelt on river flow.
- Plant riparian vegetation to provide fish and other organisms with refugia.
- Protect river reaches where they contain naturally occurring refugia.
- Create side-channels and adjacent wetlands to provide refugia during droughts and floods.
- Restore oyster reefs along a depth gradient to provide shallow water refugia for mobile species such as fish and crustaceans to retreat to in response to climate-induced deep water hypoxia/anoxia.
- Identify and protect areas observed to be resistant to climate change effects.
- Establish dynamic Marine Protected Areas defined by large-scale oceanographic features such as oceanic fronts where changes in types and abundances of organisms often occur.

7. Relocation

Human-facilitated transplantation of organisms from one location to another in order to bypass a barrier.

Examples

- Establish or strengthen long-term seed banks to create the option of re-establishing extirpated populations in new/more appropriate locations.
- Assist in species migrations.
- Facilitate long-distance transport of threatened endemic species.
- Facilitate interim propagation and sheltering or feeding of mistimed migrants, until suitable habitat becomes available.
- Establish programs to move isolated populations of species of interest that become stranded when water levels drop.

Appendix 3: Strategy Ranking Tool

This tool is to help assess the benefits, feasibility, and costs of potential adaptation strategies to address threats related to climate change. It is adapted from similar ranking tools in the CAP Workbook and Miradi.

Strategy: ____

Benefits

If successfully implemented at the necessary scale, to what degree will the strategy lead to the desired outcome – i.e., threat abatement leading to improvement in projected key ecological attribute(KEA)/indicator ratings for your conservation target(s).

- ❒ **Very High – the strategy will rescue a conservation target from the brink of imminent loss.**
  - Makes a substantial contribution to effective, enduring improvement for one or more KEAs projected to be Poor.

- ❒ **High – the strategy will move a conservation target's projected KEA from Fair to Good, or make an important contribution towards preventing imminent loss.**
  - Makes a substantial contribution to effective, enduring improvement for one or more KEAs projected to be Fair. OR
  - Makes an important (but not full) contribution for one or more KEAs projected to be Poor.

- ❒ **Medium – the strategy will make an important contribution toward improving a Fair KEA, or will "buy time" for a conservation target.**
  - Makes an important (but not full) contribution to effective, enduring improvement for one or more KEAs projected to be Fair.
  - Would not assure effective, enduring improvement, but would temporarily or partially abate the threat that leads to the projected Poor or Fair KEA.

- ❒ **Low – the strategy will make a relatively small contribution towards improving a KEA or "buying time."**

Feasibility

How likely is successful implementation of the strategy at the necessary scale, considering the following key success factors: (1) relative ease of implementation; (2) availability of an experienced lead individual; (3) institutional support; (4) the ability to motivate key constituencies; (5) the ability to secure necessary funds.

❒ **Very High – the strategy is relatively straightforward and all key success factors are attainable.**

❒ **High – the strategy is somewhat complex but most key success factors are attainable.**

❒ **Medium – the strategy is very complex with many hurdles or uncertainties, but most key success factors are attainable, <u>or</u> the strategy is straightforward or somewhat complex but two key success factors are doubtful.**

❒ **Low – three or more key success factors are doubtful.**

Cost

What is the total estimated cost – an order of approximation (e.g., "how many zeros") – of implementing the strategy at the necessary scale over a 10-year time horizon, including staff time and direct costs. Do not count costs that will be covered by new funding sources that are completely non-discretionary (i.e., they can only be spent on this particular strategy; those are in effect "free" dollars). Figure the full cost of one FTE, including salary, benefits, expenses and overhead @ $100,000/year.

❒ **Very High** **~$ 5,000,000+** (e.g., 2 FTE for 5 years plus $5,000,000 direct costs)

❒ **High** **~$ 2,000,000** (e.g., 1 FTE for 10 years plus $1,000,000 direct costs)

❒ **Medium** **~$ 500,000** (e.g., 0.5 FTE for 10 years plus $100,000 direct costs)

❒ **Low** **~$ 100,000** (e.g., 0.25 FTE for 5 years plus $25,000 direct costs)

Overall Strategy Rank = *f* (Benefits, Feasibility, Cost) – see charts next page:

Benefits = Very High

Cost \ Feasibility	Very High	High	Medium	Low
Very High	Very High	High	High	Medium
High	Very High	Very High	High	Medium
Medium	Very High	Very High	Very High	High
Low	Very High	Very High	Very High	***High***

Benefits = High

Cost \ Feasibility	Very High	High	Medium	Low
Very High	High	Medium	Medium	Low
High	High	High	Medium	Low
Medium	Very High	High	High	Medium
Low	Very High	Very High	High	High

Benefits = Medium

Cost \ Feasibility	Very High	High	Medium	Low
Very High	Medium	Low	Low	Low
High	Medium	Medium	Low	Low
Medium	High	Medium	Medium	Low
Low	Very High	High	Medium	Medium

Benefits = Low

Cost \ Feasibility	Very High	High	Medium	Low
Very High	Low	Low	Low	Low
High	Low	Low	Low	Low
Medium	Medium	Low	Low	Low
Low	High	Medium	Low	Low