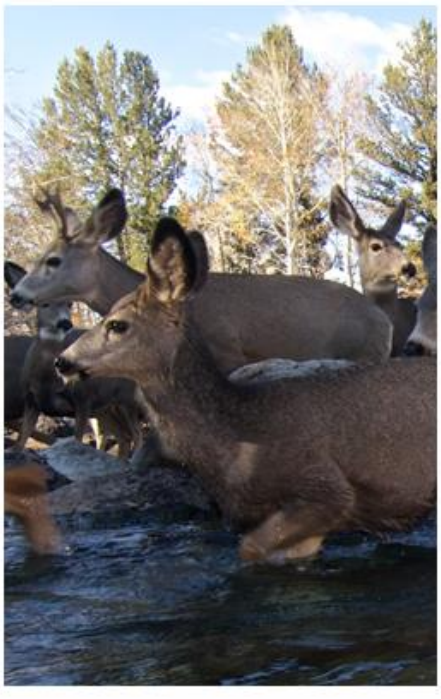
REPORT TO THE SECRETARY OF THE INTERIOR

Advisory Committee on Climate Change and Natural Resource Science

March 30, 2015

Advisory Committee on Climate Change and Natural Resource Science

This report was prepared by the Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS or the Committee) with facilitation and logistical support from the Meridian Institute (http://www.merid.org/). The Committee was chartered by the Department of the Interior (DOI) in September 2012 to advise the Secretary of the Interior on the establishment and operations of its National Climate Change and Wildlife Science Center (NCCWSC) and the Climate Science Centers (CSCs). The Committee is a federal advisory committee comprising representatives of federal agencies; state and local governments, including state membership entities; nongovernmental organizations, including those whose primary mission is professional/scientific and those whose primary mission is conservation and related scientific and advocacy activities; American Indian tribes and other Native American entities; academia; individual landowners; and business interests.

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Acronyms and Abbreviations

ACCCNRS – Advisory Committee on Climate Change and Natural Resource Science

BIA – Bureau of Indian Affairs

CLU R&D – Climate and Land Use Change Research and Development Program, USGS

CSC – Climate Science Center

DNR – Department of Natural Resources

DOC – Department of Commerce

DOI – Department of the Interior

EO – Executive Order

FACA – Federal Advisory Committee Act

FWS – Fish and Wildlife Service

FTE – full time equivalent

LCC – Landscape Conservation Cooperatives

MOU – Memorandum of Understanding

NCCWSC – National Climate Change and Wildlife Science Center

NGO – nongovernmental organization

NOAA – National Oceanic and Atmospheric Administration

NPS – National Park Service

RISA – Regional Integrated Sciences and Assessments

TKs – Traditional Knowledges

U.S. – United States

USDA – U.S. Department of Agriculture

USGS – U. S. Geological Survey

Executive Summary

The Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS or the Committee) advises the Secretary of the Interior on the operations and partnerships of the National Climate Change and Wildlife Science Center (NCCWSC) and Climate Science Centers (CSCs).[1]

The Committee commends the United States (U.S.) Geological Survey (USGS) and U.S. Department of the Interior (DOI) on the establishment of the NCCWSC and CSCs. The NCCWSC and CSCs fill a vital role by linking with universities and other partners and working with resource managers to plan, assess, and co-produce the scientific information and tools needed to manage the risks of climate change to help conserve fish, wildlife, and their habitats as well as other natural and cultural resources.

In addition, the Committee would like to recognize USGS and DOI for significant accomplishments since the inception of the NCCWSC and CSCs, including establishing eight CSCs; developing stakeholder-informed science agendas for each of them; taking a scientific focus on the impacts of projected climate change on fish, wildlife, and their habitats, as well as other natural and cultural resources; emphasizing the scientific needs of resource managers and decision makers; drafting a regionally derived national science agenda; and allocating over $93 million in funding for climate adaptation research projects.

At its first meeting in September 2013, the Committee identified topics on which it would like to provide input and formed four work groups to advance its work between meetings and to develop recommendations for the Committee's consideration. They are:

- Actionable Science Work Group
- Refining the Role of the NCCWSC and CSCs in the Climate Science Decision Support Landscape Work Group
- Tribal and Indigenous Peoples Matters Work Group
- Program Evaluation Work Group

In this report, the Committee offers nine recommendations regarding the co-production of actionable science, encouraging coordination and collaboration within DOI and with partners, engaging tribal and indigenous peoples, and program evaluation. These recommendations are summarized below.

[1] The U.S. Geological Survey (USGS) is a federal bureau of the U.S. Department of the Interior (DOI). The NCCWSC is headquartered at USGS and manages the eight DOI CSCs.

Recommendation 1: **The Committee recommends that the Secretary clarify that co-production of actionable science is the core programmatic focus of the NCCWSC-CSC enterprise. Co-production entails more than providing tools and information in a one-way flow from the NCCWSC and CSCs to users; it includes longer-term processes and relationship building to frame questions, develop research plans, and ensure the appropriate use of information to improve management of natural and cultural resources in a changing climate.**

Recommendation 2: **The Committee recommends that the NCCWSC and CSCs prioritize the expertise and tools necessary to conduct outreach and engagement to co-produce actionable science.**

Recommendation 3: **The Committee recommends that the NCCWSC and CSCs strengthen mechanisms to communicate, coordinate, and collaborate with nonfederal decision makers and partners, including states, tribes, and nongovernmental partners.**

Recommendation 4: **The Committee recommends that the Secretary direct the NCCWSC and the CSCs, and encourage their federal counterparts who provide climate science and decision support at the regional and national levels (e.g., Department of Commerce National Oceanic and Atmospheric Administration Regional Integrated Sciences and Assessments, U.S. Department of Agriculture Regional Climate Hubs, DOI Landscape Conservation Cooperatives, etc.), to increase coordination of operations and promote complementarity of efforts.**

Recommendation 5: **The Committee recommends that USGS increase leveraging and coordination of research, products, and communications between the NCCWSC-CSC enterprise and climate science research entities from other USGS programs.**

Recommendation 6: **The Committee recommends that the Secretary direct the NCCWSC and CSCs to strengthen efforts to coordinate their activities with other DOI bureaus, including, but not limited to, the U.S. Fish and Wildlife Service, the U.S. National Park Service, the Bureau of Indian Affairs, and the U.S. Bureau of Reclamation. In particular, the Committee recommends that the Secretary direct the NCCWSC and CSCs to enhance coordination with the DOI Landscape Conservation Cooperatives and direct the two efforts to jointly communicate their respective roles and responsibilities and how they intend to work together.**

Recommendation 7: **The Committee recommends that the Secretary direct DOI to undertake concerted efforts to support the engagement of tribes and indigenous peoples in federal climate-related science investments, including building their capacity to access and benefit from the services provided by the CSCs, Landscape Conservation Cooperatives, and NCCWSC.**

Recommendation 8: **The Committee recommends that the NCCWSC and CSCs promote the use of both Western science and traditional knowledges[2] of tribal and indigenous peoples when providing decision makers with relevant information.**

Recommendation 9: **The Committee recommends that the NCCWSC use a four-part framework for evaluating the CSCs that addresses: (1) institutional development; (2) actionable science; (3) capacity building; and (4) partnerships.**

The Committee looks forward to continuing to advise USGS and DOI on the ongoing work of the NCCWSC and the CSCs. Next steps for the Committee include providing additional input to the NCCWSC on its Science Agenda; coordinating with the Landscape Conservation Cooperative (LCC) National Council; customizing the CSC evaluation framework as needed for application to the NCCWSC; convening a Downscaling Work Group to frame the issue(s) associated with downscaling climate change models to local or regional areas; and receiving reports and providing input on implementation of the recommendations contained in this report.

[2] While this report expressly addresses traditional knowledges held by tribal and indigenous peoples (See Section IV), it is acknowledged that the insights, innovations and practices of individuals around the world gained through on-the-ground experience can also contribute to the development of climate adaptation strategies and measures.

I. Introduction

The Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS or the Committee) was chartered by the United States (U.S.) Department of the Interior (DOI) in September 2012 to advise the Secretary of the Interior on the establishment, operations, and partnerships of the National Climate Change and Wildlife Science Center (NCCWSC) and Climate Science Centers (CSCs).[3]

As defined in the ACCCNRS charter, the Committee's duties include:

A. Advising on the contents of a national strategy identifying key science priorities to advance the management of natural resources in the face of climate change.
B. Advising on the nature, extent, and quality of relations with and engagement of key partners at the regional CSC level.
C. Advising on the nature and effectiveness of mechanisms to ensure the identification of key priorities from management partners and to effectively deliver scientific results in useful forms.
D. Advising on mechanisms that may be employed by the NCCWSC to ensure high standards of scientific quality and integrity in its products, and to review and evaluate the performance of individual CSCs, in advance of opportunities to re-establish expiring agreements.
E. Coordinating as appropriate with any federal advisory committee established for the DOI Landscape Conservation Cooperatives (LCCs).

The Committee is a federal advisory committee comprising representatives of federal agencies; state and local governments, including state membership entities; nongovernmental organizations, including those whose primary mission is professional/scientific and those whose primary mission is conservation and related scientific and advocacy activities; American Indian tribes and other Native American entities; academia; individual landowners; and business interests. (For a glossary of terms, see Appendix I; for the ACCCNRS charter, see Appendix II; for a list of Committee members and alternates, see Appendix III.)

This report summarizes the work of the Committee and its four work groups during and between its first four in-person meetings (September 18-19, 2013, January 22-23, 2014, June 10-11, 2014, and September 17-18, 2014). This first report includes initial recommendations to the Secretary of the Interior and USGS related to items B, C, and D from its list of duties above, as well as eight appendices that include background about the Committee and documents produced by or for the Committee. During its first year, the Committee also provided initial

[3] The U.S. Geological Survey is a federal bureau of the U.S. Department of Interior (DOI). The NCCWSC is headquartered at USGS and manages the eight DOI CSCs.

input on item A, which is documented in meeting summaries.[4] The Committee is in the process of developing in-depth input on the NCCWSC Science Agenda. In addition, the Committee plans to address item E on its list of duties by coordinating with the LCC National Council[5], which was established in 2014.

Recommendations are organized according to the Committee's four work group topics, not in order of priority. Each recommendation is directed to the person or entity responsible for carrying it out. Recommendations that cut across DOI bureaus or other federal agencies are directed to the Secretary of the Interior, those specific to USGS are directed to USGS, and those that focus on the NCCWSC and CSCs are directed to the NCCWSC. The recommendations and supporting materials for the recommendations contained in this report represent the consensus of all members of the Committee.

Resource managers need reliable, relevant, and useful information to make decisions about how to manage the impacts of a changing climate on fish, wildlife, and their habitats, and on cultural resources. **The Committee commends USGS and DOI on establishing the NCCWSC and CSCs. The NCCWSC and CSCs fill a vital role by linking with universities and other partners, and working with resource managers to plan, assess, and co-produce the scientific information and tools needed to manage the risks of climate change to help conserve biodiversity as well as other natural and cultural resources.**

In addition, the Committee commends USGS and DOI on the significant accomplishments since the establishment and initial implementation of the NCCWSC and CSCs, and recommends continued support and growth of these units and their operations. The NCCWSC-CSC enterprise now includes eight CSCs with stakeholder-informed science agendas. The NCCWSC and CSCs take a scientific focus on the impacts of projected climate change on fish, wildlife, ecosystems, and other natural and cultural resources, and emphasize the scientific needs of decision makers and resource managers. A regionally derived national science agenda has been drafted and over $93 million allocated for climate adaptation research projects. Linkages with universities and other partners, initial staffing, and science planning for the CSCs and their operations have been undertaken with a strategic view toward meeting regional needs in collaboration with other science providers in the region.

[4] The ACCCNRS meeting summaries can be found at https://nccwsc.usgs.gov/acccnrs.
[5] The LCC Council, though not a federal advisory committee, provides national-level coordination and support for the Landscape Conservation Cooperatives.

In the foundational documents[6] for the NCCWSC and CSCs, emphasis is given to the importance of the following goals:

- Meet the scientific needs of decision makers and resource managers
- Foster partnerships aggressively
- Maximize resources for science
- Utilize the strengths of both universities and government
- Focus on ecosystems, not jurisdictions

To fulfill the five duties listed in its charter and support the five goals of the NCCWSC and CSCs, the Committee reviewed NCCWSC and CSC documents, received presentations from and engaged in dialogue with staff from the NCCWSC and three CSCs, and formed four work groups to advance the work of the Committee between meetings and to develop recommendations for the Committee's consideration. The work groups are:

- Actionable Science Work Group
- Refining the Role of the NCCWSC and CSCs in the Climate Science Decision Support Landscape Work Group
- Tribal and Indigenous Peoples Matters Work Group
- Program Evaluation Work Group

In this report, the Committee has organized the information and recommendations from each work group into sections, with cross references where appropriate.

II. Actionable Science

A. Introduction

For the NCCWSC and CSCs to work effectively with and meet the climate science needs of its partners and stakeholders, it is important that the mission(s) of these interrelated entities are clear and clearly communicated to those who may need climate science, tools, and services. It is also important that mechanisms exist through which the NCCWSC and CSCs can learn about the needs of partners and stakeholders. In this section, the Committee makes recommendations to clarify the scope of the NCCWSC's and CSCs' respective missions, and to reinforce the focus on actionable science and the co-production of information needed by managers.

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[6] NCCWSC Proposed 5-Year Strategy (2009-2014). (2009). Retrieved January 12, 2015, from https://nccwsc.usgs.gov/sites/default/files/documents/other/NPD%20Report%20FINAL.pdf; Providing Science for Climate Adaptation: The National Climate Change and Wildlife Science Center and DOI Climate Science Centers, 2011 Progress Report. (2011). Retrieved January 12, 2015, from https://nccwsc.usgs.gov/sites/default/files/documents/other/Progress%20Report_FINAL%2002-06-12.pdf

The NCCWSC and CSCs constitute a network and serve as "boundary organizations" (i.e., organizations that bridge and broker knowledge between scientists and decision makers, and often carry out related research aimed at facilitating effective interaction between these groups; see Appendix I). The network consists of the NCCWSC, serving as both a central hub and a national research node, and eight CSCs serving as the regional nodes. Each CSC is a partnership between USGS and university-based consortia selected through a competitive process.[7] Each CSC is co-directed by a senior staff person from USGS and a person from the consortium. Stakeholder committees at each CSC provide bridges to additional partners, who advise on management-driven science priorities. Both the NCCWSC and the CSCs are strengthening partnerships with other organizations and networks (e.g., the LCCs), and building on significant interactions with a variety of governmental and nongovernmental institutions. These partnerships and interactions are the emerging functional arrangements of the "boundary organization" aspect of the mission of the NCCWSC and CSCs.

The central node of this network, the NCCWSC, was established in 2008 through a Congressional appropriation to the USGS.[8] Based on this legislation, USGS and the DOI defined its mission as follows:

> **The mission of the NCCWSC is to provide natural resource managers with the tools and information they need to develop and execute management strategies that address the impacts of climate change on fish, wildlife, and their habitats.[9]**

The CSCs were created from 2010 through 2012, based on an extensive public-private dialogue and planning process[10] through a 2010 secretarial order[11] issued by Secretary Ken Salazar. The mission of the CSCs is as follows:

> **The mission of the DOI Climate Science Centers is to provide natural and cultural resource managers with the tools and information they need to develop and execute management strategies that address the impacts of climate change on a broad range of natural and cultural resources.[12]**

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[7] The exception was the Alaska Climate Science Center, which is implemented in cooperation with the University of Alaska – Fairbanks (UAF). UAF was selected non-competitively and provides linkages to other University of Alaska units.

[8] Department of the Interior, Environment, and Related Agencies Appropriations Bill, H. R. 110-187 (2008).

[9] Science within NCCWSC. (n.d.). Retrieved January 12, 2015, from https://nccwsc.usgs.gov/nccwscScience

[10] The Wildlife Society and Ecological Society of America. (2009). USGS National Climate Change and Wildlife Science Center: Final Report on Outreach and Recommendations. Bethesda, MD: The Wildlife Society.

[11] Secretarial Order No. 3289,issued by Secretary Ken Salazar, February 22, 2010, http://www.fws.gov/home/climatechange/pdf/SecOrder3289.pdf

[12] About the Climate Science Centers. (n.d.). Retrieved January 12, 2015, from http://www.doi.gov/csc/about.cfm

In the next section, the Committee focuses on the need to affirm a clear overarching mission for the entire enterprise.

B. Recommendations Regarding Refining the Mission of the NCCWSC and CSCs

Recommendation 1: **The Committee recommends that the Secretary clarify that co-production of actionable science is the core programmatic focus of the NCCWSC-CSC enterprise. Co-production entails more than providing tools and information in a one-way flow from the NCCWSC and CSCs to users; it includes longer-term processes and relationship building to frame questions, develop research plans, and ensure the appropriate use of information to improve management of natural and cultural resources in a changing climate.**

The Committee sees the concept of "actionable science"— with its emphasis on meeting decision maker's needs—as core to the mission of both the NCCWSC and the CSCs.

Given the importance of the concept of "actionable science" as a core service provided by the NCCWSC and CSCs, the Committee agreed on the following definition:

> **Actionable science provides data, analyses, projections, or tools that can support decisions regarding the management of the risks and impacts of climate change. It is ideally co-produced by scientists and decision makers and creates rigorous and accessible products to meet the needs of stakeholders.**

Although it is theoretically possible for actionable science to be produced by scientists working alone, co-production is a more reliable route to developing decision-relevant information for addressing complex societal problems such as adapting to and managing the risks of climate change. Co-production also increases the likelihood that the target audiences will see value in the product and use it because involvement and responsibility generally instill a vested interest. In this context, products include new science and tools as well as syntheses of existing information.

In addition to co-production of actionable science, which the Committee believes should be the primary objective of the NCCWSC and CSCs, there are instances where fundamental science may be needed to improve the quality or relevance of actionable science or to improve its ability to meet the needs of decision makers. Where NCCWSC-CSC funding is provided for these needs, ties to demand-side users should be maintained throughout, consistent with co-production values. When the NCCWSC becomes aware of a need for fundamental science, the Committee encourages the NCCWSC to communicate this need to other research funders[13] to encourage their support when the work is aligned with their missions.

[13] Other research funders include, but are not limited to, USGS's Climate and Land Use Change Research and Development Program, other USGS programs, and other federal agencies.

The Committee recognizes that scientists and decision makers can find it challenging to co-produce science for a number of reasons, including lack of clear, agreed upon, and familiar steps for engaging with one another; different areas of expertise, terminology, and goals; lack of channels for communication;[14] and time constraints. To provide guidance to the NCCWSC and CSCs regarding the co-production of actionable science, the ACCCNRS has developed a how-to guide, "Guiding Principles and Recommended Practices for Co-Producing Actionable Science" (Appendix IV). The guide's primary audiences are NCCWSC and CSC staff and the decision makers and resource managers with whom they work. Secondary audiences include other relevant decision makers, stakeholders, funders, creators, and users of actionable science.

The five guiding principles for co-producing actionable science are:

1. Actionable science is most reliably co-produced by scientists and decision makers or resource managers working in concert. For some projects or programs, other stakeholders and funders may also be engaged.
2. Start with a decision that needs to be made. The research needs, which are rarely known (and almost never clearly specified) in advance, must be identified collaboratively and iteratively.
3. Give priority to processes and outcomes over stand-alone products.
4. Build connections across disciplines and organizations, and among scientists, decision makers, and other stakeholders.
5. Evaluate co-production products, processes, and the actionability of the science.

This approach recognizes that actionable science is not only actionable information, but also includes longer-term processes and relationship building to help ensure the appropriate use of that information. Thus, in contrast to many research endeavors, the NCCWSC and CSCs offer services, not just products. This emphasis on services requires significant investment to develop and maintain interpersonal interactions among scientists, decision makers, and users (including downstream users) of the scientific information. Deploying these services efficiently and effectively also requires building connections across disciplines, and among other organizations engaged in related efforts. The budgets for the programs and individual projects, project evaluations, and staff incentives and evaluations should reflect commitment to this mission.

The Committee recognizes that it can take time to refine mission statements and therefore recommends that while this is being done, the NCCWSC and CSCs continue and enhance their efforts to work with resource managers to co-produce actionable science, as described in the how-to guide in Appendix IV. To this end, and building on Recommendation 1, the NCCWSC should distribute this how-to-guide to all NCCWSC and CSC staff. This guide should also be distributed to other relevant DOI staff, partners, and interested stakeholders. Recommended practices outlined in the guide provide mechanisms to engage natural resource managers and

[14] Sometimes scientists reach out and do not receive a response, and vice versa.

decision makers from states, tribes, and nongovernmental organizations (NGOs) in the process of defining science priorities and producing actionable science.

Recommendation 2: **The Committee recommends that the NCCWSC and CSCs prioritize the expertise and tools necessary to conduct outreach and engagement to co-produce actionable science.**

The Committee identified a need for greater investment in the often time-intensive activities of outreach and support for improved coordination and communication to co-produce actionable science. These increased investments in supporting or leading coordination efforts and co-producing synthesis products will help build stakeholder capacity to appropriately use information, and leverage the work underway or planned at other climate service entities.

Recommended Practices:

1. As a top priority, the NCCWSC and CSCs should allocate resources to support and foster tools for regional coordination, and make existing climate science more readily available and/or useable to natural resource managers and decision makers.
2. The NCCWSC and CSCs should initiate and participate in ongoing science-management dialogues with partners and stakeholders to understand their needs for climate science, and support their access, understanding, use, and interpretation of climate science.

To enhance the efforts and effectiveness of all CSCs working with partners to co-produce actionable science, CSCs should continue to share tools, techniques, and lessons learned about working with partners at their regular meetings. In addition, the NCCWSC and the CSCs should continue efforts to identify issues that cut across regions and on which they can work together. One example of an opportunity for multiple CSCs to work with partners to co-produce actionable science is updating State Wildlife Action Plans. A network-wide evaluation could then be conducted to compare the efficacy of different partner engagement processes. Similarly, CSC assistance with peer review of these plans may help promote long-term partnerships with state wildlife managers.

The co-production of actionable science is a relatively new approach to informing and supporting climate adaptation decision making. Because the NCCWSC and CSCs are among the few laboratories for this important work in the United States and globally, their work provides an essential opportunity to identify and document best practices for the co-production of actionable science. To inform and strengthen its application to climate adaptation decision making within and beyond the NCCWSC and CSCs, the Committee strongly encourages the NCCWSC to conduct an assessment of the lessons learned from the practice of actionable science co-production carried out by all of the CSCs. Such an assessment should include key lessons, illustrative examples, and exemplary processes and products. It should be made available beyond the CSCs so other actionable science co-production efforts can benefit from it. This assessment could offer the opportunity to draw on lessons learned to improve the practice of co-production of actionable science across the NCCWSC and CSCs, as distinguished from the

need to provide a framework for evaluating the effectiveness of CSCs, which is recommended in Section V.

Recommended Assessment:
The NCCWSC should, in close collaboration with CSCs, support a comprehensive, independent assessment of the practice and outcomes of actionable science and co-production of knowledge across the NCCWSC and CSCs to determine where and under what conditions it is most effective in meeting decision maker's needs. This broad social science research should be undertaken under the auspices of the NCCWSC Science Agenda, should focus on the co-production initiatives operating out of CSCs, and should be established swiftly so metrics of monitoring and evaluation are incorporated at the front end of the co-production process. The most important goal of this research would be to advance the collective understanding of these practices and, most importantly, to guide future activities of the NCCWSC and CSCs and other climate service providers.

III. Strengthening Coordination and Collaboration

A. Introduction

As the sense of urgency surrounding the need to address global climate change has increased, the number of federal and non-federal programs designed to provide climate science and decision-support services has rapidly expanded. While the need for these services is both vast and urgent, the rapid development of these programs, and the ever-expanding list of potential partners in these endeavors, suggests a pressing need for significant investments in coordination. A recent review by Bierbaum et al.[15] documents many of these service providers in the context of illustrating progress toward implementation of adaptation actions. As these programs mature, it is vitally important to be efficient in investments, and to take steps to ensure that needs for decision-relevant information are being met and that information is being communicated in appropriate ways to the many and varied users of this information.

Of particular interest with respect to coordination at regional scales, four federal initiatives have been developed to provide regionally focused outreach to stakeholders on data, tools, and approaches to updating decision making in response to climate-related risks. These are the National Oceanic and Atmospheric Administration (NOAA) Regional Integrated Sciences and Assessments (RISAs), DOI CSCs and LCCs and, most recently, the U.S. Department of Agriculture (USDA) Regional Climate Hubs. Beginning in 1995, NOAA began building its

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[15] Bierbaum, R., Smith, J. B., Lee, A., Blair, M., Carter, L., Chapin III, F. S., Fleming, P., Ruffo, M., Stults, S., McNeeley, S., Wasley, E., and Verduzco, L. (2013). A comprehensive review of climate adaptation in the United States: More than before, but less than needed. *Mitigation and Adaptation Strategies for Global Change* 18:361-406.

network of RISA teams to provide support to decision makers managing the risks of climate variability and change. By 2010, NOAA was supporting the current network of 11 teams. From 2008 through 2012, the CSC and LCC networks were created with a focus on supporting and connecting partners and stakeholders engaged in addressing climate change in the context of ecosystem and natural resource management. There are currently 8 CSCs and 22 LCCs servicing every U.S. state and associated U.S. trust territories. In 2013, USDA launched seven Regional Climate Hubs with the goal of delivering information to farmers, ranchers, and forest landowners to help them adapt their practices to climate change. In addition to these four programs, many other entities within the federal agency community provide science and science translation services, and many directly fund and produce science and operate important observation networks. With so many science and decision-support providers, there is a great need to clarify the roles and strengths of various federal programs, coordinate efforts, minimize the potential for redundancy, and identify and address unmet stakeholder needs.

Even though there are many entities that provide science and other services related to improving the ability of tribes and their partners to incorporate climate risks into their resource management efforts, the Committee believes demand far exceeds the capacity of the NCCWSC and CSCs. The Committee commends the Secretary's recent decision to create and fund tribal liaison positions to support increased tribal engagement in CSC activities and provide a means to better address matters that may not align closely with USGS funding constraints related to fish, wildlife, and ecosystems.

As states, tribes, local governments, and other entities increasingly seek to initiate planning or local actions to promote climate adaptation, the need to increase funding for the NCCWSC and CSCs will become more acute. In particular, many Committee recommendations call for the NCCWSC and CSCs to do more, especially more personnel-intensive activities like coordination and outreach with tribes and stakeholders. Although better coordination and leveraging may save some costs, fully implementing the recommendations in this section will likely require increased funding.

To enhance its understanding of the landscape of providers of climate-related information for decision makers, the Committee conducted an inventory of the major functions and providers of climate science and decision-support services by federal, state, and tribal governments and academic, nonprofit, private, and other entities. The process and findings of this inventory are described in Appendix V.

In recognition of the important role decision makers play in the co-production of actionable science, the recommendations in the following sections focus on outreach to and engagement and coordination with decision makers. The Committee divided these recommendations into three groups. First, the Committee recommends improving coordination between the NCCWSC and CSCs and nonfederal partners. It then offers recommendations on coordination and collaboration with other federal efforts at the national and regional scales. Finally, the Committee focuses on the need to improve coordination and collaboration among related efforts within USGS and DOI. While the Committee recognizes service to tribal governments

and a variety of stakeholder communities as the primary role of the enterprise, attention to coordination and cooperation across the range of federal efforts, and within DOI efforts, are key steps toward the NCCWSC-CSC enterprise's goal of "fostering partnerships aggressively"[16] across all entities involved in the provision of climate-related decision support.

B. Recommendations to Improve Coordination with States, Tribes, and Non-Federal Partners

Recommendation 3: **The Committee recommends that the NCCWSC and CSCs strengthen mechanisms to communicate, coordinate, and collaborate with nonfederal decision makers and partners, including states, tribes, and nongovernmental partners.**

In its review of the climate-related decision-support landscape, the Committee identified a wide range of nonfederal organizations (states, tribal governments and organizations, NGOs, academic institutions, businesses) that are actively engaged in providing and/or using various types of decision-support services in managing climate change impacts. This section addresses strategies and opportunities to improve coordination and strengthen engagement with these partners in developing and using data, tools, and other climate-related decision support services.

The Committee recognizes that the NCCWSC and CSCs have mechanisms to invite input on climate science needs from nonfederal partners, including this Committee and the CSC Stakeholder Advisory Committees. This Committee is a multi-stakeholder federal advisory committee chartered under the Federal Advisory Committee Act (FACA),[17] which provides guidance and input on the overall NCCWSC-CSC enterprise. CSC stakeholder advisory committees are regional bodies, focused on the climate science needs identified by resource managers in their respective regions. However, since the CSC advisory committees are not federal advisory committees—and the cost and administrative inflexibility of federal advisory committees has led to a firm decision by USGS *not* to make them into federal advisory committees—representation on the CSC committees is limited to government representatives (federal, state, local, tribal). Thus, other means must be used for CSCs to coordinate with nongovernmental partners (including landowners) and jointly prioritize development of climate science products and tools. Even for states and tribal governments, which can participate on the CSC stakeholder advisory committees, there are likely to be far more interested participants than can be accommodated on the committees.

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[16] Providing Science for Climate Adaptation: The National Climate Change and Wildlife Science Center and DOI Climate Science Centers, 2011 Progress Report. (2011). Retrieved January 12, 2015, from https://nccwsc.usgs.gov/sites/default/files/documents/other/Progress%20Report_FINAL%2002-06-12.pdf

[17] Federal Advisory Committee Act, P.L. 92-463; 5 U.S.C. App. (1972).

Strengthening advisory mechanisms is important for states because of their many shared and closely related resource management responsibilities with DOI. Further, the Committee emphasizes the importance of increasing communication and outreach to tribal governments, due to the sovereign status of tribes, their responsibilities to manage tribal lands, and the trust relationship tribes have with the federal government that DOI has primary responsibility to fulfill. This special relationship is the subject of Section IV of this report. In many cases, nongovernmental organizations, private sector entities, tribes, and states develop their own datasets and tools for addressing climate change, thus coordination is also a key goal of improved communication. The Committee suggests three practices to help the NCCWSC and CSCs strengthen and enhance existing mechanisms to engage with states, tribes, and nongovernmental partners.

Recommended Practices:

1. The NCCWSC should provide guidance to CSCs regarding when and how they can communicate, collaborate, and coordinate with nongovernmental stakeholders without triggering Federal Advisory Committee Act concerns.
2. Each CSC and the NCCWSC should articulate and implement plans for identifying the primary audience(s) for their products and services, and implement prioritized communication plans for exchanging information on data needs and key decision points with federal resource managers, states, tribal governments, and nongovernmental partners.
3. Each CSC and the NCCWSC should articulate a strategy for communicating and collaborating with partners who provide climate-related tools or data and are working in the same geographic region and/or engaging the same tribal governments or key stakeholder groups to complement and align with each other in meeting the needs of decision makers.

C. Recommendations to Improve Coordination of Federal Climate Science Decision Support Providers

Recommendation 4: **The Committee recommends that the Secretary direct the NCCWSC and the CSCs, and encourage their federal counterparts who provide climate science and decision support at the regional and national levels (e.g., Department of Commerce National Oceanic and Atmospheric Administration Regional Integrated Sciences and Assessments, U.S. Department of Agriculture Regional Climate Hubs, DOI Landscape Conservation Cooperatives, etc.), to increase coordination of operations and promote complementarity of efforts.**

A clear challenge for the CSCs and the NCCWSC is to clarify their roles, and coordinate with other federal efforts to meet climate-related information needs. Specifically, the NCCWSC-CSC enterprise should expand efforts to coordinate operations with the Department of Commerce NOAA RISAs, USDA Regional Climate Hubs, and DOI LCCs. In addition, the Secretary should work with her counterparts in other federal agencies to clarify and document their roles and responsibilities; how they will coordinate their climate and climate change science programs

and avoid duplication of efforts; and that they will interact with national working groups (e.g., the National Fish, Wildlife and Plant Climate Adaptation Strategy Joint Implementation Work Group and the Climate Change and Water Working Group) and regional partnerships and organizations. The Committee recommends that this proposal be coordinated with the Interagency Council on Climate Preparedness and Resilience.

Recommended Practices:

1. The NCCWSC/CSCs should implement regional agreements (e.g., memoranda of understanding or operating agreements) with federal agencies and state and tribal governments or associations (e.g., the Western Governors' Association), as needed, to facilitate synergistic efforts on topics that span a range of sectors, and/or to share resources and staff across agency lines. For some agencies, the lack of such agreements and mechanisms appear to be a major barrier to co-funded projects, sharing employees, and other cooperation and coordination activities.
2. Federal agencies should develop consistent messaging across agencies and centers to stakeholders that clearly describes the roles of the various entities within the climate science decision support landscape and how they coordinate with one another.
3. The NCCWSC/CSCs should form or join existing technical multi-organization work teams or committees for select, priority topic areas to ensure that NCCWSC and CSC projects are well coordinated with other climate science decision support entities, reflect the best state-of-the-science methods, and are developed and delivered in ways that can effectively meet the needs of decision makers. The Committee expects that the geographic scope of these teams would match the scope of the NCCWSC or individual CSCs, with the NCCWSC focusing on national work teams, and CSCs joining or initiating work groups in their regions. These work groups may be geographical or topical (i.e., focused on drought, or planning for sea level rise), and should match with needs expressed by stakeholders.
4. At regional and national scales, the NCCWSC, with involvement from the CSC network, should participate in existing working groups and establish regional working groups that bring together program managers of the NOAA Climate Program Office and RISAs, the LCC Network, USDA Regional Climate Hubs, NCCWSC/CSC programs, and other relevant, regional entities, to promote coordination on projects, funding, stakeholder engagement, and priorities for actionable science.

D. Recommendations to Improve Coordination within the NCCWSC-CSC Enterprise, within USGS, and within DOI

Recommendation 5: **The Committee recommends that USGS increase leveraging and coordination of research, products, and communications between the NCCWSC-CSC enterprise and climate science research entities from other USGS programs.**

The Committee suggests that investment in efforts to improve coordination within the NCCWSC-CSC enterprise, within USGS, and more broadly within DOI will strengthen the capacity and impact of all climate-related programs. Both the NCCWSC-CSC enterprise and other USGS programs, such as the Climate and Land Use Change Research and Development Program, need additional capacity to support research, climate science services, internal and external communication, and decision-making processes. Some additional capacity could be achieved through more effective coordination and communication among staff at the different programs, and this could be enhanced by direct investment in support for coordination (Recommendation 2 addresses the need to increase funding for communication, coordination, and synthesis). Specific ideas on how these programs can support each other, and in turn increase the impact of all USGS-supported work, include: (1) climate scientists and staff from other USGS programs can enhance the reach and usefulness of their research and science products by using the strong public, tribal, academic, and stakeholder networks developed by the NCCWSC-CSC enterprise; and (2) likewise, the NCCWSC and CSCs could gain stronger footing as climate-related decision support centers for the public, tribes, states, and stakeholder communities through increased coordination, advice, and support on projects and themes of mutual interest from the Climate and Land Use Change Research and Development Program and other USGS programs. See Box 1.

Box 1. Opportunities to be Gained from Coordination

The U.S. Geological Survey's (USGS) Climate and Land Use Change Research and Development (CLU R&D) Program recently announced the first maps and summaries of historical and projected temperature and precipitation changes for the 21st Century for each county in the continental United States (see http://www.usgs.gov/climate_landuse/clu_rd/nex-dcp30.asp). This project was developed by the USGS in collaboration with the College of Earth, Oceanic and Atmospheric Sciences at Oregon State University. During the same timeframe, several Climate Science Centers (CSCs), also under USGS, downscaled climate models to the local or regional levels (see http://cida.usgs.gov/gdp/).

These were not necessarily redundant efforts, but enhanced coordination and communication could have informed stakeholders of the need for multiple approaches, and the pros and cons of various methods. Missed opportunities include: (1) The NCCWSC-CSC enterprise could have helped distribute information to stakeholders; (2) USGS scientists could have advised the NCCWSC-CSC enterprise on climate downscaling projects and services they were considering over the past few years and those they funded; (3) CSCs and the CLU R&D Program could have directed their downscaled climate simulations and products toward a unified USGS website and similar map viewer and other applications; and (4) The NCCWSC-CSC enterprise and CLU R&D Program announcements could have supported each other by providing the public with cross referencing contextual information on the value and use of different downscaled climate model products.

Coordination of related efforts within and among USGS programs can increase effectiveness and efficiency, and also provide a clearinghouse and communications function useful to the public and resource managers. Increased capacity and/or management emphasis to support internal communication and coordination, and coordinated outreach for all USGS climate science projects would be required.

Recommended Practices:

1. The NCCWSC and CSCs should establish mechanisms to learn from each other, and share tools and techniques, thus increasing their impact in each region.
2. USGS should ensure that USGS climate scientists and staff from the NCCWSC-CSC enterprise and the Climate and Land Use Change Research and Development Program share annual work plans, participate in inter-bureau decision-making processes, and coordinate regular outreach activities throughout the year so that all programs are aware of related activities. Where appropriate, the NCCWSC and CSCs should leverage capacity in other USGS programs to maximize co-production of science and relevant products to their partners and stakeholders and reduce actual or perceived redundancy in efforts across programs within the USGS.
3. USGS should conduct an evaluation to identify mechanisms by which scientists from the Climate and Land Use Change Research and Development Program and other USGS programs can regularly share their expertise with the NCCWSC and CSCs and vice versa through, for example, project review processes and work teams.

Recommendation 6: **The Committee recommends that the Secretary direct the NCCWSC and CSCs to strengthen efforts to coordinate their activities with other DOI bureaus, including, but not limited to, the U.S. Fish and Wildlife Service, the U.S. National Park Service, the Bureau of Indian Affairs, and the U.S. Bureau of Reclamation. In particular, the Committee recommends that the Secretary direct the NCCWSC and CSCs to enhance coordination with the DOI Landscape Conservation Cooperatives and direct the two efforts to jointly communicate their respective roles and responsibilities and how they intend to work together.**

An independent panel organized by RTI International, the Ecological Society of America, and The Wildlife Society conducted a program review of the former USGS Biological Resources Discipline in 2009-10. Although USGS has since been reorganized, eliminating the discipline but not its functions, the program review remains useful. Among its relevant findings were: (1) the mission statements of DOI research organizations need to clearly reflect their research priorities and their relationships to the needs of DOI managers; (2) strategic planning is essential to deliver needed scientific knowledge, and (3) there is an ongoing need for external review.[18] These three points are essential to enhance coordination of the NCCWSC-CSC enterprise with the other DOI agencies. Additional actions to be carefully considered are listed below.

Recommended Practices:

1. DOI and USGS should coordinate messaging of related efforts within and among USGS programs and DOI bureaus. Coordinated messaging will help clarify the unique role of

[18] RTI International, Ecological Society of America, and The Wildlife Society. (2010). The Biological Resources Discipline Independent Evaluation Panel Report.

the NCCWSC-CSC enterprise and its relation to other USGS and DOI programs to decision makers and natural resource managers who are the target audiences (stakeholders) of the enterprise, while also raising the profile of all USGS- and DOI-based efforts.

2. DOI should coordinate development of a department-wide climate science strategy to guide and coordinate the efforts of DOI bureaus, identify opportunities for greater collaboration and synergy, and reduce unnecessary duplication. DOI bureaus should ensure that their science strategies and contributions to the DOI strategy reflect input from stakeholders and enhance coordination with other bureaus through consultation and the sharing and reviewing of annual and five-year science plans.
3. The NCCWSC should use the DOI-wide climate science strategy and the science plans of other bureaus to ensure that other agencies' needs are addressed in developing science plans for the NCCWSC and CSCs.

IV. Tribal and Indigenous Peoples Matters

A. Introduction

To provide Committee members with foundational information on climate change, indigenous peoples, and tribes, a Committee member prepared the report, "Indigenous Peoples and Climate Change: A Primer." Additionally, an informal group comprising two ACCCNRS Committee members, staff of indigenous governments and organizations, and experts with experience working with issues concerning traditional knowledges (TKs)[19],[20] developed the document, "Guidelines for Considering Traditional Knowledges in Climate Change Initiatives." As of early 2015, both are working documents being updated by the authors based on input from reviewers. Descriptions of the two reports and links to the full documents are below.

"Climate Change and Indigenous Peoples: A Primer," developed as an informational resource for ACCCNRS, covers three major topics: (1) the impact of climate change on tribal and indigenous peoples; (2) relationships between indigenous peoples and the federal government; and (3) the availability of funding to support the participation of indigenous peoples in federal climate initiatives. The executive summary of the primer is in Appendix VI, and the full document is available at https://climatetkw.wordpress.com/.

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[19] The plural term, traditional knowledges, is used to reflect that there are multiple sets of knowledge used by indigenous peoples.

[20] While this section expressly addresses traditional knowledges held by tribal and indigenous peoples, it is acknowledged that the insights, innovations and practices of individuals around the world gained through on-the-ground experience can also contribute to the development of climate adaptation strategies and measures.

"Guidelines for Considering Traditional Knowledges in Climate Change Initiatives" offers best practices for using traditional knowledges in climate change work, as well as criteria for reviewing grant proposals involving TKs. These guidelines have been developed for the Committee to examine the significance of traditional knowledges in relation to climate change and the potential risks to U.S. indigenous peoples of sharing their knowledge in federal and other nonindigenous climate change initiatives. The guidelines are provisional. The authors intend that they be used to inform the development of specific protocols in direct and close consultation with indigenous peoples. The executive summary of the traditional knowledges guidelines document is in Appendix VII, and the full document is available at https://climatetkw.wordpress.com/.

B. Recommendations Regarding Engagement of Tribal and Indigenous Peoples

Recommendation 7: **The Committee recommends that the Secretary direct DOI to undertake concerted efforts to support the engagement of tribes and indigenous peoples in federal climate-related science investments, including building their capacity to access and benefit from the services provided by the CSCs, Landscape Conservation Cooperatives, and NCCWSC.**

Recommended Practices:

1. The NCCWSC should distribute and promote the use of "Climate Change and Indigenous Peoples: A Primer" for orientation and basic information regarding federal relationships with tribal and indigenous peoples. Promoting the use of this document may include providing training, as appropriate, and as funds allow.
2. The NCCWSC should recognize and respect distinct political and legal relationships with the governments of tribal and indigenous peoples.
3. The NCCWSC should undertake efforts to implement the ACCCNRS's recommendation of January 2014: "DOI should support and participate in a meeting(s) to: (1) work with Tribal and Indigenous Peoples Leaders and staff to develop recommendations for improving tribal awareness of and participation in Climate Science Centers (CSCs) and Landscape Conservation Cooperatives (LCCs); and (2) identify high priority climate science focus areas to meet Tribal needs."[21] USGS is implementing this recommendation by convening a meeting of tribal representatives involved with CSCs and LCCs in 2015. The focus of the meeting should include developing recommendations for:
    a. Involving tribal leaders in the ongoing formation and implementation of strategies for use by the NCCWSC and CSCs in engaging with tribal and indigenous communities; and

[21] This recommendation is captured in the January 2014 ACCCNRS Meeting Summary, which is available at https://nccwsc.usgs.gov/sites/default/files/sites/default/files/images/ACCCNRS_Meeting_Summary_%28Jan_22-23_2014%29.pdf

   b. Describing how tribes and agencies might work together to address the need for consistent funding to build and sustain the capacity of tribal and indigenous communities to address climate-related activities, including a coordinated process to leverage resources to support participation in federal climate initiatives.
4. Recognizing limitations on DOI budget and staff resources, the NCCWSC and CSCs should rely heavily on tribally supported activities and functions to strengthen communication networks among tribal and indigenous peoples on matters pertaining to climate change, including information on opportunities for substantive participation and important developments.
5. The NCCWSC and CSCs should establish a coordinated training program for tribal staff on developing vulnerability assessments, adaptation plans, and implementation strategies, including training for specific regional and sectoral impacts (e.g., climate change aspects of water resources, wildlife, monitoring, emergency management).
6. Federal agencies should align federal climate-related initiatives to improve the ability of tribal and indigenous peoples to engage in these initiatives in a clear and consistent manner, increase awareness of training opportunities, and access climate science.
7. The NCCWSC and CSCs should encourage the use of informal local interactions to identify the needs and concerns of tribal and indigenous peoples relating to climate science. If requested by a tribal government, undertake tribal consultation in federal climate initiatives to mitigate and minimize the direct impacts of climate change on tribal interests and resources, avoid adverse impacts, and ensure that tribal values are incorporated into decision-making processes.
8. DOI should support the convening of a national tribal climate change adaptation forum to facilitate sharing of tribal expertise and experience with climate adaptation among tribes and federal and state partners.
9. The NCCWSC should coordinate the dissemination and exchange of information with the National Tribal Science Council and similar bodies on activities related to climate change.
10. DOI should invite substantive participation of the governments of tribal and indigenous peoples in the formation and implementation of climate policies and governance involving climate science.

Recommendation 8: **The Committee recommends that the NCCWSC and CSCs promote the use of both Western science and traditional knowledges of tribal and indigenous peoples when providing decision makers with relevant information.**

Recommended Practices:

1. The NCCWSC and CSCs should distribute and promote the use of the principles and measures set forth in the TKs Guidelines document (Appendix VII) for information about and strategies for accessing and employing traditional knowledges of tribal and indigenous peoples. Promoting the use of this document may include providing training, as appropriate, and as funds allow.

2. The NCCWSC and CSCs should invite tribal and indigenous peoples to synthesize existing TKs and make them (or the lessons learned from them) available to help inform actions and decisions relating to climate change in a manner appropriate to the knowledge systems (see Appendix VII).
3. Federal and state agencies and tribes should improve collaboration and communication among one another to overcome the current disconnect between federal climate adaptation efforts, Western science, traditional knowledges, and tribal needs.
4. Federal agencies should provide regular reports to tribal governments on efforts by federal climate change initiatives to engage tribal and indigenous peoples, access traditional knowledges, and appropriately consider such information in their research programs and agency decision making.
5. The NCCWSC should work with the ACCCNRS Tribal and Indigenous Peoples Matters Work Group members to ensure an appropriate distribution list for sending NCCWSC information to tribal partners, including the National Tribal Operations Council and the Regional Tribal Operations Committee.

V. Program Evaluation

A. Introduction

The NCCWSC and CSCs have the ambitious mission of co-producing actionable science to support efforts to prepare for and adapt to climate change. As the NCCWSC-CSC enterprise matures, it becomes important to evaluate how well its mission is being achieved and how effective the various parts of the enterprise are in supporting that mission. The Committee has begun by developing a framework for evaluating CSCs. This framework will be extended to address program evaluation needs of the NCCWSC (the national center). Evaluation of the regional CSCs is important to help USGS decide whether to renew or re-compete cooperative agreements with institutional hosts at the end of the current agreement period. The Committee recognizes that the CSCs' performance within their initial contract periods cannot be evaluated based on criteria that were not included in the original agreements. Moving forward, however, the Committee recommends that the evaluation framework described below be used when developing new CSC agreements and conducting future CSC evaluations.

The Committee proposes a four-part framework for evaluation of the CSCs, encompassing (1) institutional development; (2) actionable science; (3) capacity building; and (4) partnerships. Because of the focus on co-production of science, and on services provided to decision makers and other stakeholders, the committee recommends that this evaluation framework be executed through both internal and external reviews, including use of a well-designed survey to gather input from partners, stakeholders, and end users.

These four broad evaluation categories are briefly described below, and a list of possible evaluation measures for each category is suggested in Appendix VIII. The Committee created a

detailed logic model to help map the workflow and key outcomes of the regional centers, and this model informed the identification of evaluation measures and illustrative metrics. Although the Committee encourages use of all four evaluation categories and their subcategories, it expects that a smaller subset of measures will be selected for further development and application by USGS. USGS managers will need to ensure that any metric adopted is feasible and cost-effective to measure, and is informative for program management. The illustrative metrics in Appendix VIII are intended as a starting point for discussion rather than as final recommendations.

B. Recommendation Regarding Program Evaluation Framework for CSCs

Recommendation 9: **The Committee recommends that the NCCWSC use a four-part framework for evaluating the CSCs that addresses: (1) institutional development; (2) actionable science; (3) capacity building; and (4) partnerships.**

Collectively, these four evaluation categories cover many of the key processes, products, and outcomes important to the success of the CSCs. A list of possible measures for each evaluation category, key questions the measures are designed to address, and illustrative metrics where possible are provided in Appendix VIII. The measures are summarized here.

Institutional Development: These measures are intended to capture the overall health of the CSC as an institution, with an emphasis on planning processes, management and operations, finances, and institutional coordination. Evaluation subcategories include:

- Planning (strategic and annual)
- Management/Operations
  - Staffing
  - Physical Assets
- Finances
  - Grants Management
  - Budget
- Institutional Coordination
  - Between USGS and University Host
  - Among CSC Consortia Institutions
  - With other Federal Agencies

Actionable Science: These measures are intended to capture the performance of the CSC in providing relevant and useful scientific products and services, emphasizing the relevance, quality, processes, accessibility, and impact of science products and services carried out directly by the center and through its external grant funding. Evaluation subcategories include:

- Relevance
- Quality
- Processes, including co-production
- Accessibility
- Impact and efficacy

Capacity Building: These measures are intended to capture how well the CSC is doing in terms of building capacity for conducting and applying actionable science, with an emphasis on formal training (e.g., of graduate and post-doctoral students) and training and professional development offered to the broader community. Evaluation subcategories include:

- Formal Training
- Partner/Stakeholder Capacity Building
- Impact and efficacy

Partnerships: These measures are intended to capture how well the CSC is doing in terms of engaging and collaborating with partner organizations beyond the CSC consortium itself (which is included in institutional development), with an emphasis on breadth and scope of engagements and leverage. Evaluation subcategories include:

- Breadth and Scope of Engagements
- Leverage
- Outcomes

VI. Conclusion and Next Steps

In this report, the Committee recognizes the significant value of the NCCWSC and CSCs, and offers nine recommendations to build on their successes to date and strengthen their work going forward. The Committee's duties include advising USGS and DOI in five areas. Recommendations in this report address three of these five areas, including: advising on the nature, extent, and quality of relations with and engagement of key partners at the regional CSC level (Sections III and IV); advising on the nature and effectiveness of mechanisms to ensure the identification of key priorities from management partners and to effectively deliver scientific results in useful forms (Section II); and, advising on mechanisms that may be employed by the NCCWSC to ensure high standards of scientific quality and integrity in its products, and to review and evaluate the performance of individual CSCs, in advance of opportunities to re-establish expiring agreements (Section V).

Next steps for the Committee include:

- Addressing the Committee's two remaining duties by:
    - Advising on the contents of a national strategy identifying key science priorities to advance the management of natural resources in the face of climate change
    - Coordinating as appropriate with any federal advisory committee established for the DOI LCCs
- Customizing the CSC evaluation framework as needed for application to the NCCWSC
- Convening a Downscaling Work Group to frame the issue(s) associated with downscaling, and, if appropriate, draft a message or recommendation about a path forward for addressing this issue for the Committee's consideration
- Receiving reports on implementation of the recommendations contained in this report and providing feedback to USGS and DOI on the effectiveness of their implementation

The Committee has provided initial input on the contents of the NCCWSC Science Agenda, and has formed a work group to consult with the NCCWSC to develop an approach for soliciting additional input on the NCCWSC Science Agenda and priorities at the Committee's next meeting.

The last item on the list of Committee duties is to coordinate as appropriate with any federal advisory committee established for the DOI LCCs. DOI has not established a federal advisory committee for the LCCs, but the LCC Network has formed a national council, so the Committee plans to address this duty by coordinating with the LCC National Council.

The Committee expects that many aspects of the evaluation framework developed for the CSCs may serve well for evaluation of the NCCWSC. The Committee will examine whether additional factors should be considered in evaluating the NCCWSC, and will modify the evaluation framework if needed, based on its findings. In addition, the Committee will review the results of the CSC evaluations and provide advice to USGS and DOI based on these assessments.

The Committee would like to call the Secretary's attention to the difference in scope between the NCCWSC and the CSCs. Specifically, the intent of the CSCs is to support conservation of both natural and cultural resources in a changing climate, but the NCCWSC mandate is confined to wildlife and ecosystems. This creates a situation in which the "headquarters" entity, the NCCWSC, has a narrower mandate than its subunits, the CSCs. In practice, most CSC funding has been from USGS, so the CSCs have focused primarily on wildlife and ecosystems. Although the Committee has seen no evidence that this "scope inversion" has affected the effectiveness of the NCCWSC and CSCs, as the demand increases for activities related to cultural and other resources not primarily "fish, wildlife, and their habitats," there may be competition for staff and support resources. Because demand for services is already likely to exceed the capacity of the NCCWSC and CSCs, which indicates a need for transparent methods for prioritization, this situation may demand attention before long.

The ACCCNRS Charter is up for renewal in May 2015. USGS plans to examine the charter and update it as needed as part of this process. The Committee has asked USGS to add members from the business and large landowner sectors to the Committee.

Finally, the Committee wishes to conclude by once again recognizing USGS and DOI for taking important steps to begin working with resource managers to co-produce the scientific information and tools needed to manage the risks of climate change, help conserve biodiversity in a changing climate, and improve management of natural and cultural resources. The Committee looks forward to continuing to advise USGS and DOI on the work of this important enterprise.

Appendix I: Glossary of Key Terms

The following definitions are for the purposes of this report.

Actionable science – provides data, analyses, projections, or tools that can support decisions regarding the management of the risks and impacts of climate change. It is ideally co-produced by scientists and decision makers and creates rigorous and accessible products to meet the needs of stakeholders.

Boundary organization – as defined in Kirchhoff et al. 2013[1], an organization that bridges and brokers knowledge between scientists and decision makers, and often carries out related research aimed at facilitating effective interaction between these groups.

Consensus – In its Operating Procedures and Ground Rules[2], the ACCCNRS has defined consensus as no dissent. This document further states: If there is dissent on procedural matters, the Co-Chairs will make the decision, taking into account the views of Committee/Subcommittee members. If consensus is not possible on substantive matters, the record of the discussion will reflect the different points of view expressed and the underlying reasons for those differing views.

Cultural resources – As defined in National Park Service (NPS) Management Policies 2006, cultural resources are "an aspect of a cultural system that is valued by or significantly representative of a culture, or that contains significant information about a culture. A cultural resource may be a tangible entity, a cultural practice, or a natural resource. Tangible cultural resources are categorized as districts, sites, buildings, structures, and objects for the National Register of Historic Places, and as archeological resources, cultural landscapes, structures, museum objects, and ethnographic resources for NPS management purposes". Cultural resources are often classified as being of two broad types: (1) "*Archeological Resource* - any material remains or physical evidence of past human life or activities which are or archeological interest, including the record of the effects of human activities on the environment. An archeological resource is capable of revealing scientific or humanistic information through archeological research"; (2) "*Ethnographic Resources* - objects and places, including sites, structures, landscapes, and natural resources, with traditional cultural meaning and value to

[1] Kirchhoff, CJ, MC Lemos, and S Dessai. (2013). Actionable Knowledge for Environmental Decision Making: Broadening the Usability of Climate Science. Annual Review Environmental Resources 38:3.1-3.22.
[2] The ACCCNRS Operating Procedures and Ground Rules are available at https://nccwsc.usgs.gov/sites/default/files/files/1.4.2%20ACCCNRS%20Operating%20Procedures%20and%20Ground%20Rules.pdf.

associated peoples. Research and consultation with associated people identifies and explains the places and things they find culturally meaningful."[3]

Decisions Maker | Partner | Stakeholder

These three terms are grouped together because of their interrelation as noted in their definitions below.

Decision maker – a person or group that has decision-making authority over land and resources with whom actionable science is or could be co-produced. Some decision makers such as tribal leaders and state officials exercise sovereign rights over the lands they manage. Some decision makers may also be partners, but not all decision makers are automatically partners. All decision makers and partners are stakeholders.

Partner – an entity that works with and has signed an agreement or contract with the NCCWSC and/or CSCs to co-produce actionable science or other key products and services. Some partners may also be decision makers. All partners and decision makers are stakeholders.

Stakeholder – a person or group that is interested in and/or affected by the work of the NCCWSC and CSCs. Some stakeholders are decision makers and/or partners. However, not all stakeholders are decision makers or partners.

Decision-support services/science services – a set of services provided to support and facilitate use of science, e.g., convening of meetings to identify science needs, translation of science into lay terms, development of syntheses and decision-support tools, etc.

Downscaling – a method that derives local-to regional-scale information from larger-scale models or data analyses. In statistical downscaling, a statistical relationship is derived between observed local climate variables and predictors at the scale of global climate model output. Dynamical downscaling, or regional climate modeling, explicitly simulates the process-based physical dynamics of the regional climate system using a high-resolution, limited-area climate model.[4]

Enterprise – the NCCWSC and the CSCs.

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[3] National Park Service. National Park Service Management Policies 2006. (2006). Retrieved January 12, 2015, from http://www.nps.gov/policy/mp2006.pdf

[4] Intergovernmental Panel on Climate Change. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. (2007). Retrieved January 12, 2015, from https://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

Indian tribe or Tribe – any Indian or Alaska Native tribe, band, nation, pueblo, village or community that the Secretary of the Interior acknowledges to exist as an Indian tribe;[5] any Indian tribe, band, nation, or other organized group or community, including any Alaska Native village or regional or village corporation as defined in or established pursuant to the Alaska Native Claims Settlement Act,[6] which is recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians;[7] or a State recognized tribe.

Indigenous peoples – an inclusive term that encompasses Native Americans/American Indians, Alaska Natives, and Native Hawaiians. It is noteworthy that there are important historical and legal distinctions among the various terminologies (e.g., "American Indian" has historically been used when referencing members of federally-recognized tribes, and "indigenous peoples" is the inclusive term used in the United Nations Declaration on the Rights of Indigenous Peoples[8] (UNDRIP)). There is no fixed definition of indigenous peoples in international law, and it was not considered to be necessary for the adoption of UNDRIP, where it remains undefined, only referring to self-identification. As stated in Article 33 of UNDRIP, "Indigenous peoples have the right to determine their own identity or membership in accordance with their customs and traditions." The United Nations system uses general sets of indicators that taken collectively help to identify indigenous peoples. The most used set of indicators is contained in the "Study on the Problem of Discrimination against Indigenous Populations,"[9] a massive study undertaken by a Special Rapporteur that was initiated in 1972.

Partner – see grouped definition above following Decision Maker.

Resource manager – someone who coordinates the efforts of people to accomplish goals and objectives related to natural or cultural resources. Resource managers make decisions about which tools to use, how to allocate financial resources, and work with staff and stakeholders to develop and update resource management plans.

Secretary – Secretary of the Interior.

Stakeholder – see grouped definition above following Decision Maker

Traditional Knowledges – This term is customarily not defined due to the vast number definitions from different tribes and indigenous peoples. However, for this document, this term

[5] Indians, Title 25 U.S.C. § 479a.
[6] Alaska Native Claims Settlement Act, Pub. L. 92-203, 85 Stat. 688.; Public Lands, Title 43 U.S.C. § 1601.
[7] Indians, Title 25 U.S.C. § 450b.
[8] United Nations. (2008). *United Nations Declaration on the Rights of Indigenous Peoples.* United Nations.
[9] Martinéz Cobo, JR. (1987). Study of the problem of discrimination against indigenous populations. New York: United Nations.

is defined as: The diverse types of knowledge(s) and intimate, intergenerational understandings of interconnections between people and the environment that indigenous peoples have gained through thousands of years of living with the land, including learning how to prepare for and adapt to changes in order to survive. These understandings and rules of governance for their sharing are commonly referred to as Traditional Knowledge(s) or TKs.

User – A person or group that uses products developed by the NCCWSC and CSCs.

Western science – Western science does not have a universally accepted definition. It is characterized by the use of systematic study through observation and experimentation to try to find immutable relationships that explain the behavior of the physical and natural world and sharing through peer review and publication.

Appendix II: ACCCNRS Charter

Department of the Interior
U.S. Geological Survey

Advisory Committee on Climate Change and Natural Resource Science Charter

Committee's Official Designation. Advisory Committee on Climate Change and Natural Resource Science (Committee).

Authority. The Committee is in the public interest in connection with the responsibilities of the Department of the Interior (DOI) under Section 2 of the Reorganization Plan No. 3 of 1950 (64 Stat. 1262), as amended, and the Consolidated Appropriations Act of 2008, P.L. 110-161, Division F, Title I. The Committee is established in accordance with the provisions of the Federal Advisory Committee Act (FACA), as amended, 5 U.S.C. Appendix 2.

Objectives and Scope of Activities. The Committee advises the Secretary of the Interior on the establishment and operations of the U.S. Geological Survey (USGS) National Climate Change and Wildlife Science Center (NCCWSC) and the DOI Climate Science Centers (CSCs).

Description of Duties. The duties of the Committee shall include:

A. Advising on the contents of a national strategy identifying key science priorities to advance the management of natural resources in the face of climate change.

B. Advising on the nature, extent, and quality of relations with and engagement of key partners at the regional/CSC level.

C. Advising on the nature and effectiveness of mechanisms to ensure the identification of key priorities from management partners and to effectively deliver scientific results in useful forms.

D. Advising on mechanisms that may be employed by the NCCWSC to ensure high standards of scientific quality and integrity in its products, and to review and evaluate the performance of individual CSCs, in advance of opportunities to re-establish expiring agreements.

E. Coordinating as appropriate with any Federal Advisory Committee established for the DOI Landscape Conservation Cooperatives.

Official to Whom the Committee Reports. The Committee reports to the Secretary through the Director, USGS, or the Designated Federal Officer (DFO).

Support. The USGS will provide administrative and logistical support to the Committee.

Estimated Annual Operating Costs and Staff Years. The annual operating costs associated with supporting the Committee's functions are estimated to be approximately $500,000, including all direct and indirect expenses and .50 FTE staff year.

Designated Federal Officer. The DFO is a full-time Federal employee appointed in accordance with Agency procedures. The DFO will approve or call all Committee and subcommittee meetings, prepare and approve all meeting agendas, attend all Committee and subcommittee meetings, adjourn any meeting when the DFO determines adjournment to be in the public interest, and chair meetings when directed to do so by the Secretary.

Estimated Number and Frequency of Meetings. The Committee will meet approximately 2-4 times annually, and at such other times as designated by the DFO.

Duration. Continuing.

Termination. The Committee will terminate 2 years from the date the Charter is filed, unless, prior to that date it is renewed in accordance with the provisions of Section 14 of the FACA. The Committee will not meet or take any action without a valid current Charter.

Membership and Designation. The members of the Committee shall be composed of approximately 25 members from both the Federal Government, and the following interests:

- State and local governments, including state membership entities
- Non-governmental organizations, including those whose primary mission is professional/scientific and those whose primary mission is conservation and related scientific and advocacy activities
- American Indian tribes and other Native American entities
- Academia
- Individual landowners
- Business interests

Within these categories, it is expected that one or more individuals will be directly associated with Landscape Conservation Cooperatives (LCC), as Coordinator, Science Coordinator, or Steering Committee member. In addition, the Committee may include scientific experts, and will include rotating representation from one or more of the institutions that host the DOI Climate Science Centers.

Alternate members may be appointed to the Committee. Alternate members must be approved and appointed by the Secretary before attending meetings as representatives. Alternate members shall have experience and/or expertise similar to that of the primary member.

Members of the Committee will serve without compensation. However, while away from their homes or regular places of business, non-Federal members, including alternate members, engaged in Committee, or subcommittee business, approved by the DFO, may be allowed travel expenses, including per diem in lieu of subsistence, in the same manner as persons employed intermittently in Government service under Section 5703 of Title 5 of the United States Code.

Members may be appointed as regular Government employees, special Government employees, or representative members. Members appointed as special Government employees are required to file on an annual basis a confidential financial disclosure report.

Members will be appointed for 2 or 3 year terms. A vacancy on the Committee will be filled in the same manner in which the original appointment was made. Members serve at the discretion of the Secretary.

The Secretary will appoint the Committee Chair.

Ethics Responsibilities of Members. No Committee or subcommittee member will participate in any specific party matter including a lease, license, permit, contract, claim, agreement, or related litigation with the Department in which the member has a direct financial interest. In addition, the Department of the Interior will provide materials to those members serving as special Government employees, explaining their ethical obligations with which members should be familiar. Consistent with the ethics requirements, members will endeavor to avoid any actions that would cause the public to question the integrity of the Committee's operations, activities, or advice. The provisions of this paragraph do not affect any other statutory or regulatory ethical obligations to which a member may be subject.

Subcommittees. Subject to the DFO's approval, subcommittees may be formed for the purposes of compiling information or conducting research. However, such subcommittees must act only under the direction of the DFO and must report their recommendations to the full Committee for consideration. Subcommittees must not provide advice or work products directly to the Agency. The Committee Chair, with the approval of the DFO, will appoint subcommittee members. Subcommittees will meet as necessary to accomplish their assignments, subject to the approval of the DFO and the availability of resources. At least one subcommittee, to provide expert scientific advice to the Committee, will be established.

Recordkeeping. The records of the Committee, and formally or informally established subcommittees of the Committee, shall be handled in accordance with General Records Schedule 26, Item 2 or other approved Agency records disposition schedule. These records shall be available for public inspection and copying, subject to the Freedom of Information Act, 5 U.S.C. 552.

Signed, Secretary Salazar	September 25, 2012
Secretary of the Interior	Date

Appendix III: Members of the Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS)

Co-Chairs

- David Behar, co-chair, Climate Program Director, San Francisco Public Utilities Commission / Water Utility Climate Alliance

- Matthew Larsen, Associate Director Climate and Land Use Change, U.S. Geological Survey *(Co-chair, May 2013-May2014)*

- Sarah Ryker, acting co-chair, Deputy Associate Director, Climate and Land Use Change, U.S. Geological Survey

Academic

- Berrien Moore III, Vice President, Weather and Climate and Director, National Weather Center, University of Oklahoma (host to South Central CSC)
  Alternate: Paul Risser Chair and Chief Operating Officer, University Research Cabinet, University of Oklahoma (host to South Central CSC) (*Deceased July 10, 2014)*

- Bradley Udall, Senior Water and Climate Research Scientist/Scholar, Colorado Water Institute, Colorado State University (member of South West and North Central CSCs)
  Alternate: Richard Palmer, Professor and Chair, Department of Civil and Environmental Engineering, University of Massachusetts/Amherst (host, North East CSC), University of Colorado

Business Interests

- Jeffrey Williams, Manager, Climate Consulting, Entergy, Inc.
  Alternate: Rick Johnson, Manager, Corporate Environmental Operations, Environmental Strategy & Policy, Entergy, Inc.

Federal Government

- Gabriela Chavarria, Science Advisor, U.S. Fish and Wildlife Service (*Member, May 2013-July 2014*)
  Alternate: David Patte, Senior Advisor, Pacific Region, U.S. Fish and Wildlife Service (*Alternate, May 2013-December 2014)*

- Herbert C. Frost, Associate Director, Natural Resource Stewardship and Science, U.S. National Park Service (*Member, May 2013-July 2014)*
  Alternate: Leigh Welling, Chief Climate Change Response Program, U.S. National Park Service

- William Hohenstein, Director, Climate Change Program Office, U.S. Department of Agriculture
  Alternate: David Cleaves, Climate Change Advisor to the Chief, U.S. Forest Service, U.S. Department of Agriculture *(Alternate, May 2013-February 2015)*

- Richard Merrick, Chief Science Advisor, National Oceanic and Atmospheric Administration, Fisheries
  Alternate: Adam Parris, RISA Program Manager, National Oceanic and Atmospheric Administration *(Alternate, May 2013-February 2015)*

- Jeffrey Peterson, Senior Advisor, Office of Water, U.S. Environmental Protection Agency
  Alternate: Britta Bierwagen, U.S. Environmental Protection Agency

- Robert Pietrowsky, Director, Water Resources Institute
  Alternates: Jeffrey Arnold, Senior Climate Scientist, U.S. Army Corps of Engineers
  Paul Wagner, Senior Environmental Scientist, U.S. Army Corps of Engineers

Individual Landowners

- Larry Irwin, NCASI Fellow, National Council for Air and Stream Improvement, Inc.
  Alternate: Ben Wigley, Manager, Sustainable Forest Research, National Council for Air and Stream Improvement, Inc.

Non-Government Organizations

- Paul Beier, Regents' Professor, School of Forestry, Northern Arizona University, and Past President, Society for Conservation Biology
  Alternate: Malcolm Hunter, Libra Professor of Conservation Biology and Professor of Wildlife Ecology, Department of Wildlife Ecology, University of Maine (*Alternate, February-August 2014)*

- Clifford Duke, Director of Science Programs, Ecological Society of America

- Peter Frumhoff, Director of Science and Policy, Union of Concerned Scientists
  Alternate: Adam Markham, Director, Climate Impacts Initiative, Union of Concerned Scientists

- Kimberly Hall, Great Lakes Climate Change Ecologist, The Nature Conservancy
  Alternate: Chris Zganjar, Director of Application Analytics, The Nature Conservancy

- Lara Hansen, Founder, Chief Scientist, and Executive Director, EcoAdapt
  Alternate: Alessandra Score, Lead Scientist, EcoAdapt

- Noah Matson, Vice President for Climate Change and Natural Resources Adaptation, Defenders of Wildlife
  Alternate: Natalie Dubois, Defenders of Wildlife *(Alternate, May 2013-December 2014)*

- Bruce Stein, Director, Climate Change Adaptation, National Wildlife Federation
  Alternate: Douglas Inkley, Senior Wildlife Biologist, National Wildlife Federation

State and Local Government

- Ed Carter, Director, Tennessee Wildlife Resources Agency and the Southeastern Association of Fish and Wildlife Agencies
  Alternate: Bill Reeves, Chief of Biodiversity, Tennessee Wildlife Resources Agency

- Lynn Helbrecht, Climate Change Coordinator, Department of Fish and Wildlife, Washington, and the Western Association of Fish and Wildlife Agencies
  Alternate: Amber Pairis, Assistant Secretary for Climate Change, California Natural Resources Agency

- John O'Leary, State Wildlife Action Plan Coordinator, State of Massachusetts and the Northeast Association of Fish and Wildlife Agencies
  Alternate: Karen Bennett, Landscape Conservation Coordinator, Delaware Division of Fish and Wildlife and the Northeast Association of Fish and Wildlife Agencies

- John Sullivan, Director, Science Services, Wisconsin Department of Natural Resources and the Midwest Association of Fish and Wildlife Agencies (*Member, May 2013-November 2014)*
  Alternate: Karl Martin, Chief, Wildlife and Forestry Research Section, Wisconsin Department of Natural Resources and the Midwest Association of Fish and Wildlife Agencies *(Alternate, May 2013-July 2014)*

Tribal

- Ann Marie Chischilly, Executive Director, Institute for Tribal Environmental Professionals (ITEP), Northern Arizona University
  Alternate: Susan Wotkyns, Climate Change Program Manager, Institute for Tribal Environmental Professionals (ITEP), Northern Arizona University

- Gary Morishima, Technical Advisor to the Chairman, Quinault Nation
  Alternate: Robert Rohde, Principal Investigator, Karuk Tribe (*Alternate, February 2014-July 2014)*

Appendix IV: Actionable Science How-To-Guide

Guiding Principles and Recommended Practices for Co-Producing Actionable Science:
A How-To-Guide for DOI Climate Science Centers and the National Climate Change and Wildlife Science Center

Introduction

This how-to-guide is intended to help the staff of the U.S. Department of the Interior's Climate Science Centers and National Climate Change and Wildlife Science Center (CSCs and NCCWSC)— as well as the decision makers and resource managers with whom they work— effectively collaborate in developing scientific information that is useful and relevant to those who make decisions about how to conserve biodiversity and cultural resources in a changing climate. It was developed by the Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS or the Committee), an advisory panel to the Secretary of the Interior.

Actionable Science provides data, analyses, projections, or tools that can support decisions regarding the management of the risks and impacts of climate change. It is ideally co-produced by scientists and decision makers and creates rigorous and accessible products to meet the needs of stakeholders.

The mission of the CSCs and NCCWSC is to help Department of the Interior entities, partners, and stakeholders manage the risks of climate change in a way that conserves biodiversity as well as other natural and cultural resources.[1] The CSCs and NCCWSC provide actionable science, which the ACCCNRS defines as, "data, analyses, projections, or tools that can support decisions regarding the management of the risks and impacts of climate change. It is ideally co-produced by scientists and decision makers and creates rigorous and accessible products to meet the needs of stakeholders."

[1] Managing climate risks to biodiversity requires both adaptation and mitigation (i.e., reducing emissions); the focus of this document is on actionable *adaptation* science.

Most of the guide's content was adapted from four primary documents[2] augmented by the experiences of the ACCCNRS members and by case studies – many from the CSCs and NCCWSC – demonstrating the principles and practices of actionable science. Among federal agencies, the CSCs and NCCWSC are emerging as exemplars in the co-production of actionable science. The Committee hopes to propagate best practices, and increase the rate at which they spread and are improved.

This guide offers five guiding principles that apply both to the NCCWSC-CSC enterprise and to individual projects of CSCs or the NCCWSC. Each guiding principle is followed by one or more recommended practices at the project level. In most cases, the program implications are obvious; in other cases, recommended practices for programs are included.

Some of the recommended practices include details intended to translate a vague principle (e.g. "Identify research needs collaboratively and iteratively.") into concrete actions, (e.g., the issues to be addressed at a meeting). These details are illustrative rather than prescriptive. The intent is to provide concrete guidance that will fit a typical situation; users should strive to meet the spirit of these recommendations, and adapt the specific details to their situations.

Why Actionable Science Should be Co-Produced by Scientists and Users

As defined above, *actionable science* "is ideally co-produced by scientists and decision makers and creates rigorous and accessible products to meet the needs of stakeholders." Although actionable science can, theoretically, be produced by scientists working alone, co-production is a more reliable route to actionable science for complex societal problems such as adapting to climate change and managing the risks of climate change. Co-production is key to producing actionable adaptation science because:

- *Decision makers* bring insights that are needed to co-define scientific questions and methods, precisely define the planning issues to be addressed, explain the downstream analytical tools, and explain how they plan to use scientific information

[2] 1) National Research Council. (2009). Informing Decisions in a Changing Climate. Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.; 2) Science Policy Assessment and Research on Climate. (2010). Usable Science: A Handbook for Science Policy Decision Makers.; 3) Dilling, L, and MC Lemos. (2011). Creating usable science: opportunities and constraints for climate knowledge use and their implications for science policy. *Global Environmental Change* 21:680:689.; and 4) Kirchhoff, CJ, MC Lemos, and S Dessai. (2013). Actionable Knowledge for Environmental Decision Making: Broadening the Usability of Climate Science. *Annual Review Environmental Resources* 38:3.1-3.22.

to make decisions. They can explain the type of decisions that must be made, and the legal, political, social, and fiscal constraints affecting decision makers.

- *Scientists* bring insights that are needed to ensure that the science is appropriately developed and then applied in decisions. At the project level, scientists provide decision support services more often than decision-support products.[3] Actionable science is not only actionable information, but also a process for the appropriate use of that information.
- *Collaboration between scientists and decision makers is often needed to define the research goal, methods, and products*. It is not always obvious what type of research is needed. For example, scientists and users may want research to resolve uncertainty about climate change and its impacts. However, in some cases, uncertainty cannot be reduced and decision makers may not need more information about future climate and its impacts. Rather they may need information about which alternative adaptation strategies are most robust to uncertainty or which actions can best manage risk. Sustained collaboration is needed not only to specify the research goals, but also to plan how the science will be used, and identify the most useful formats to interject scientific understanding and scientific uncertainty into specific decisions. Scientists acting alone or decision makers acting alone could come to this realization, but synergy between scientists and decision makers is more likely to ensure that the right questions are asked and addressed, producing useful outcomes with fewer delays and at a lower cost. For example, some decision makers have requested vulnerability assessments for particular species, and scientists have produced such assessments. Unfortunately, in many cases the parties had not discussed how the assessments would be used, what decisions would be informed by the assessments, the inherent model uncertainties, the format of model outputs, and how uncertainty and format of the outputs would affect actionability. Actionable science might have been produced if scientists and decision makers had spent more time co-defining the problem and identifying how the information would be used. For example, the assessments could have been designed to identify the anthropogenic factors affecting the adaptive capacity of the target species and ecosystems in a way that would suggest an appropriate adaptation strategy.[4]

[3] National Research Council. (2009). Informing Decisions in a Changing Climate. Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.
[4] In short, Adam Smith's "invisible hand" does a poor job of regulating the supply of and demand for actionable science (SPARC 2010).

Effective and Sustainable Co-Production

Because both scientists and decision makers are essential to defining problems, developing approaches, making inferences, and guiding implementation, *ongoing* communication and relationships between the producers and users of information are central to producing actionable science. Effective information products are one result, but not the exclusive one, and they can rarely be produced by scientists and "handed off" to decision makers.

Co-production of actionable science is effective when:

- Scientists and decision makers engage in mutual learning that neither could have achieved alone, and when that engagement increases mutual understanding, respect, and trust as the parties work together.
- Interested stakeholders agree that the science products and processes led to (or could have led to) better decisions.

Co-production of actionable science is sustained when:

- Scientists, decision makers, and funders engage in attentive management to align the supply of actionable science with demand. Actionable science does not automatically occur whenever producers, users, and funders want it, but rather when these groups repeatedly interact in forums that are "owned" by all parties.[5]
- Scientists and program managers are rewarded for remaining engaged to ensure that decision makers make appropriate use of scientific information. Employers build co-production activities into job descriptions and staff reviews, and funders pay for these services.

Guiding Principles and Recommended Practices for Co-Producing Actionable Science

The five guiding principles for co-producing actionable science are presented here. They are paired with recommended practices, below.

1. Actionable science is most reliably co-produced by scientists and decision makers or resource managers working in concert.

2. Start with a decision that needs to be made.

3. Give priority to processes and outcomes over stand-alone products.

4. Build connections across disciplines and organizations, and among scientists, decision makers, and other stakeholders.

[5] Dilling, L, and MC Lemos. (2011). Creating usable science: opportunities and constraints for climate knowledge use and their implications for science policy. *Global Environmental Change* 21:680:689.

5. Evaluate co-production products, processes, and the actionability of the science produced by projects.

Guiding Principle #1: **Actionable science is most reliably co-produced by scientists and decision makers or resource managers working in concert.** For many projects or programs, other stakeholders and funders may also be engaged.

This overarching guiding principle underlies the other four guiding principles and recommendations.

Recommended Practice

1. Invest good will, respect, commitment, time, and resources to develop the interpersonal interactions that are critical to co-production.
    - The other recommended practices in this guide describe the actions needed to implement this overarching recommendation. Getting the relationships right – including relationships with downstream users – is crucial at every step of the project.

Guiding Principle #2: **Start with a decision that needs to be made.**

Research needs, which are rarely known (and almost never clearly specified) in advance, must be identified collaboratively and iteratively.

Recommended Practices

2. Decision makers: Approach scientists with a management need, goal, or problem, rather than a request for a product.
3. Scientists: Before suggesting specific products, make sure you understand the decision to be made, and the environment in which the decision will be made. Be open to a project that expands your research priorities and the types of products your team is comfortable producing.
    - Decisions about climate rarely hinge solely on more accurate predictions of impacts or assessments of vulnerability (although these can be important); most decisions require information on how well various options will reduce vulnerability and minimize risk. Although "project, assess, act" makes sense in many contexts, sometimes no-regret adaptation strategies can be devised that do not require projections. Even when projections are useful, they are almost never the end point.

Guiding Principle #2: Case Study
Wildlife Refuge Durability on the Eastern Seaboard

National Wildlife Refuges (NWRs) are charged with protecting critical habitat for federally threatened and endangered species. In the southeastern United States the challenge is no longer limited to the species, but has expanded to the land itself, which is becoming threatened and endangered because of climate change. In 2014, Northeast and Southeast CSC researchers began working with Blackwater, Alligator River, and Cape Romain NWR managers to co-develop information products intended to support management of these lands that would continue to meet the NWRs' missions for as long as possible under the threats of sea level rise, habitat loss, and saltwater intrusion.

See Maximizing the Social and Ecological Value of Coastal National Wildlife Refuges along the Atlantic Coast in the Face of Global Change Processes in Appendix IV-B.

4. Invest in at least one in-person meeting of several hours duration[6] to specify the decision to be made and reach consensus on the type of scientific information needed to support that decision.
   - Answer these questions before the in-person meeting:
     - What is the goal of the engagement (e.g., what need is the group attempting to meet)?
     - What timeframe is needed for completion?
     - Who are the stakeholders needed to begin the process?
   - Invite diverse stakeholders to the first meeting, including the key decision makers, scientists in the appropriate disciplines, implementers (those who would be tasked to apply the science), and (when appropriate) funders and other stakeholders.
     - The invitation should state the goal of the meeting, the agenda, and what issues are off the table.
     - Concerned stakeholders with different values and objectives should be invited. Stakeholders might include land owners, community groups, business interests or others who affect or are affected by adaptation actions.
   - At the first meeting produce a clear goal statement so that success can be assessed later. Refer to the goal statement throughout the process. If the goal must be revised during the process, seek concurrence of all parties for the change. Goals should be specific, measurable, achievable within time and budget constraints, and realistic.
   - To clarify, ask questions like these at the first meeting:[7]
     - What question is being addressed? What factors are included or excluded from consideration?
     - Who will use the scientific information (including downstream uses) and how will they use it?
     - In what form, process, or product will the data be most useful to the users?
     - Given that decisions must be made before the science can be "settled," what is a realistic expectation of what is possible and needed within the available time and budget?
     - What is necessary to make data accessible to all projected users? Who will own the data or other products? Where will the products reside? A third party may be the appropriate owner.
     - What would success look like for all parties?
     - What alternatives are available to achieve success? What is gained or lost by pursuing one alternative over another?
     - What variables does the decision maker care about? What resolution of data? What spatial extent? What level of precision is realistic, achievable, and adequate

[6] These details provide concrete (rather than generic) guidance that will fit a typical situation. Users should strive to meet the spirit of these recommendations, and adapt the specific details to their situation.
[7] Some questions may not apply in particular situations.

for the decision that must be made? If such precision is not feasible, should the project be abandoned or modified?
    - What is the planning time horizon? Is the planned time horizon appropriate? A decision about coastal infrastructure may depend crucially on whether sea level rise is projected for 50 years or 100 years.
    - How will uncertainty be addressed? To what extent can multiple projections (e.g., emission scenarios, general circulation models) bracket uncertainty?
5. For a large, complex project, engage a subset of key people to serve on a technical advisory group that will tweak goals, review key methodological decisions, and co-produce inferences. A smaller steering committee may be needed to manage the project calendar, products, and workflows.

Guiding Principle #3: Give priority to processes and outcomes over stand-alone products.

The National Research Council Panel on Strategies and Methods for Climate-Related Decision Support admonished producers of actionable science to "give priority to process over products".[8] This rhetorical overstatement was intended to nudge scientists away from their traditional focus on products that are "thrown over the transom."

Guiding Principle #3: Case Study Wisconsin Brook Trout in a Changing Climate

The Wisconsin Department of Natural Resources, which is tasked with protecting fish species, was concerned with the implications of climate change for the brook trout. To ensure the best possible outcome, researchers and managers in the Driftless area of Wisconsin, engaged stakeholders (governmental and nongovernmental organizations, academics, and community members) in two workshops to build an effective network for implementation, gather input on the design of actions, and instill a sense of ownership in the actions to be taken. This included beta testing an online tool (FishVis Mapper) for use in decision making. Nine public meetings and email surveys were used to gather information on habitat management issues, land acquisition recommendations, recreational preferences, and perceived future challenges.

See Brook Trout Vulnerability to Projected Climate Changes in Driftless Area Streams in Wisconsin in Appendix IV-B.

Giving priority to process does not mean that shabby products will be tolerated – there is a dire need for quality scientific products relevant to management and adaptation. Rather it points out that facts (scientific products) do not speak for themselves, but require guidance on the proper interpretation and use of science. A focus on process, outcomes, and adequate communication and interaction – including the right expertise and the funds to pay for it – must be explicitly built into project design from the beginning. An emphasis on process not only affirms that "good process leads to good product," it points out that decision- support *services* are fundamentally different from decision-support *products*.

[8] National Research Council. (2009). Informing Decisions in a Changing Climate. Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Recommended Practices

6. Scientists, decision makers, and stakeholders should discuss all important issues, including spatial extent, focal species or processes, resolution of data, key assumptions involved in the scientific models and approaches, appropriate data sources, and criteria involved in key steps. In addition to the initial meeting (Recommended Practice 4), these discussions will typically require additional in-person meetings:[9]
   - **Meeting 2:** Scientists explain the best scientific approaches (plural) to achieve the goal, discuss the key assumptions, data needs, and costs of each approach, and describe strengths and limitations (including uncertainties) of available data. All participants discuss these issues to reach consensus on one (or more) scientific approach that will be used. Pilot or demonstration work may be needed to evaluate competing approaches. **Meeting 3:** Draft scientific products are presented and discussed in relation to the stated goals. The meeting should occur early enough to allow time for significant adjustments if needed.
   - **Meeting 4** (Optional): It may be advisable to have a "rollout" meeting at which scientists describe the information and appropriate use of the information in decision making, and decision makers explain how they intend to use the information.
7. Decision makers: Explain to scientists how risk (not just climate-related risk) is evaluated and managed in your organization. Explain the specific decisions you need to make and the context in which decisions are made. Help scientists appreciate how you make informed decisions (not perfect decisions) despite uncertainty about current or future conditions and uncertainty about the outcomes of interventions. Describe how you manage uncertainty without eliminating it. Explain the limitations on your authority, and to whom you are accountable.
   - Don't expect scientists to hear you on the first try. Explain it again.
8. Scientists: Honestly convey the meaning of uncertainty in your results, but (respecting the fact that decisions must be made) clearly convey the main implications of your research. In addition to providing information, an equally important task is to provide clear guidance on appropriate use of that information.
   - Don't expect decision makers to hear you on the first try. Explain it again.
   - Work with decision makers to develop a decision tree or table describing the most appropriate way to apply the information in each decision-making context.

Guiding Principle #4: Build connections across disciplines and organizations, and among scientists, decision makers, and other stakeholders.

Decisions related to climate adaptation can require combining information on available technological and policy options at different scales of decision-making, and information on the

[9] The details can be modified for the particular situation. The point is to operationalize the general recommendation that "scientists, decision-makers, and stakeholders should discuss all important issues."

likely economic and societal costs and benefits of those options. This requires integration across disciplines, sectors, and scales. Linking information-producers and information-users is especially challenging because the cultures and incentives of science and practice are different, and those differences need to be respected.

Because they work in complex situations with multiple (and changing) decision makers, CSCs and NCCWSC serve an important role as "boundary organizations." A boundary organization is an entity that serves as a convener of science-producers, science users, and other affected parties, and as a translator and a facilitator of productive tension among these groups. Other exemplary boundary organizations relevant to managing risks of climate change include the Great Lakes Integrated Sciences and Assessments center[10] and other centers in the National Oceanic and Atmospheric Administration's Regional Integrated Sciences and Assessment program.

Guiding Principle #4: Case Study Crowd-Sourced Water Temperature Database

Stream condition is highly sensitive to climate change, with implications for not only water temperature but water quality, riparian condition, and species composition. To address the stream temperature piece of the puzzle in the northwestern United States, the NorWest project organized data collected by managers at dozens of resources agencies (federal, state, and local) in Oregon, Washington, Idaho, Wyoming, and parts of Montana, Colorado, Utah, and Nevada. The data was used to develop useful climate scenarios for local decision-making. This process not only created better information, but it also created a stronger social network for practitioners beyond their traditional jurisdictions.

See Developing High-Resolution Stream Temperature Forecasts in the Northwest United States from a Crowd-Sourced Database in Appendix IV-B.

Recommended Practices

9. Be explicit about the role of CSCs and NCCWSC as boundary organizations, and take steps to grow their capacity as boundary organizations.
    - Build support for boundary activities into the base funding of the CSCs and NCCWSC. Because these enterprises make commitments beyond the normal two- or three-year duration of individual projects, they should invest the time needed to establish trust and maintain good relationships with partner organizations.
    - Allocate money for travel and access to high-quality virtual-meeting facilities as needed to build a regional community of researchers and science users. Because each CSC has a broad geographic scope (especially compared with U.S. Geological Service Co-op Units, agricultural extension offices, Landscape Conservation Cooperatives, and some other boundary organizations), CSC staff will find it challenging to develop long-term relationships with managers and decision makers. Moreover, keeping up with leadership turnover in partner entities requires ongoing attention. But, because these long-term relationships are necessary for the success of projects and to generate the

[10] GLISA. (n.d.). Retrieved January 12, 2015, from http://glisa.umich.edu/

political support that will sustain the program, such expenses must be considered investments in the future of the NCCWSC-CSC enterprise.
- Train staff to serve as facilitators, conveners, and communicators.
- In some cases, it may be advisable to include another boundary organization in particular projects to increase the perception of objectivity, enhance outreach to new potential partners, advertise and translate products for diverse needs, or mediate disagreements between producers and users. This might be the case when a CSC or the NCCWSC lacks resources to tailor information to create value-added products, or lacks the trust of one or more users.

10. Scientists: Encourage a sense of ownership and engagement among decision makers and stakeholders. Because broad integrative assessments require an understanding of local environmental conditions and social processes, provide flexible guidance by which local knowledge and stakeholder values can be integrated with the information you provide.
    - Science is nothing more than an approach to knowledge that is transparent, evidence-based, logical, and open to correction. Make it easy for resource managers and decision makers to understand your key assumptions and the logical chain of your analyses. Your science is improved when you invite nonscientists to challenge your assumptions, provide local knowledge and other evidence, and offer alternative explanations.
    - Freely express your preferences. You increase your credibility by honestly disclosing your preferences, by insisting on transparency and rigor, and by being open to all evidence and inferences supported by evidence.
11. Decision makers: If multiple agencies are responsible for decisions, consider the following options:
    - Ask scientists to provide an array of scientific information, so that each agency has the information it needs to act independently.
    - Convene or participate in forums where multiple agencies can identify opportunities to use the information. In some cases, it may be appropriate to create interagency agreements or reorganizations to bridge divisions caused by different enabling laws, missions, procedures, budgets, and cultures; this requires motivation, initiative, innovation, and leadership.
12. Funders and users: Create incentives not only for CSCs, but also for academic scientists, to consider actionable science as a challenging and rewarding line of work. For example:
    - Issue a request for proposals to generate competing ideas to address important decisions. Encourage applicants to partner with CSCs or the NCCWSC.
    - To scale up across projects, commission the NCCWSC to synthesize recommendations relevant to your industry or agency, drawing on CSC and NCCWSC experience from relevant projects.
    - Use the guidelines in Appendix IV-A when issuing a request for proposals, and when evaluating submitted proposals.

Guiding Principle #5: Evaluate co-production products, processes, and the actionability of the science produced by projects.

Recommended Practices #13 and #14 focus solely on evaluations of particular projects.

Recommended Practices

13. Convene a meeting among scientists, decision makers, and selected stakeholders several months[11] after the contractual end of the project to determine how the recommended practices in this document (and practices used in the project) improved the project, and how the practices should be revised to better meet the goal of co-producing actionable science.
    - How well did scientists and decision makers specify the problem statement at the outset of the project? In retrospect, would different scientific information and processes have been more useful? What steps could have better set up the project at the outset?
    - Did the project give appropriate priority to process while also defining and delivering the right products? Was the process collaborative, communicative, and positive for both scientists and decision makers? Why or why not?
    - If scientists are providing continued (post contract) advice on the appropriate use of the information produced:
        - Was this continuing engagement properly budgeted in the project? Is the scientist appropriately rewarded in terms of salary, recognition by the employer, and the satisfaction of contributing to better decisions?
        - What practical steps could have been taken to provide better guidance on appropriate use of the scientific products?
    - Did the scientific information and process lead to better decisions (or was it capable of leading to better decisions, even if overriding constraints precluded a better decision)?
    - How should future projects be managed to better meet this goal?
    - What obstacles to collaboration were encountered in shaping the goals and final results?
    - Is the product being used in the way it was envisioned? If not, why not?

Guiding Principle #5: Case Study
South Bay Salt Pond Restoration Project

Restoration in the face of climate change can be tricky. Things cannot be returned to their past condition since the climate is no longer as it was, and the future has more change in store. This continual change requires a management plan that changes as conditions change. One approach is onsite monitoring and adaptive management, which is just what the South Bay Salt Pont Restoration Project chose to do. Through a phased implementation approach, managers are able to assess change as it happens and modify the restoration and management accordingly.

See South Bay Salt Pond Restoration Project in Appendix IV-B.

[11] This time frame is a suggestion. The key is to let enough time elapse so participants can provide meaningful answers to these questions. Many answers will not be evident until users have attempted to apply the new science to decisions and implementation actions.

- How does the project (products and processes) support the strategic plan of the CSC or the NCCWSC?
- Was a mechanism created to insert new information (new scientific results, or learning that occurred by observing the outcomes of decisions made using the products) so that later decisions can use the latest information?

14. Disseminate the lessons from the evaluation meeting.
    - Communicate with colleagues via CSC or NCCWSC seminars.
    - Communicate with colleagues in the broader professional community via presentations at scientific meetings (including those outside your discipline), publications, and reports.
    - Submit a short written report as per the recommendations on program evaluation in Section V, Program Evaluation, of the ACCCNRS Report.
15. Revise this How-To Guide.
    - After accumulating evaluations from individual projects (Recommended Practices 13 and 14), the NCCWSC should commission a revision of this guide to draw general lessons from evaluations of individual projects. The revision team should be vetted by the ACCCNRS and should include strong external reviewers and NCCWSC-CSC staff. Ideally, this effort should be subsumed under the Recommended Assessment described in Section II, Refining the Mission of the NCCWSC and CSCs, of the ACCCNRS Report.
    - The revision team should use the recommended practices described here to co-produce the revision.
    - The revision team should describe the extent to which CSC and NCCWSC staff engaged in ongoing sharing of lessons (e.g., Recommended Practice 14), and recommend how learning across the NCCWSC-CSC enterprise might be enhanced. Such enterprise-wide learning will help create an actionable science network that builds on the best of each unit.
    - To the extent possible, the review should evaluate the hypothesis that co-production is the best route to actionable science.

Appendix IV-A: How Funders Can Apply the Guiding Principles

The following questions are recommended for use in developing requests for proposals and in reviewing and evaluating proposals. These guidelines are intended for Climate Science Centers and National Climate Change and Wildlife Science Center (CSCs and NCCWSC) staff, and for partner agencies or industries wishing to fund co-production of actionable science.

Consider the Following Questions in Designing and Evaluating Project Proposals

What is the problem, question, or issue that the research needs to inform?

1. Has the need for a research product been articulated by users?
2. How will this research product be used by decision makers? If it will be used to inform a decision or action, explain specifically how it will be used to do so.
3. What activities or mechanisms are in place to ensure collaboration between those who will use this research (relevant decision makers) and the researchers conducting the project?
4. Does the project team have the appropriate expertise, or is there a plan to procure it, to effectively conduct the research activities?
5. What outreach is planned to disseminate the final product to those who need the information? Will users be trained on how to use the product? Will appropriate staff be assigned to make the products user friendly? What products are most useful to the users?
6. How will the project be evaluated for both process and product?

Guiding Principles for Co-Producing Actionable Science in Brief

1. Actionable science is most reliably co-produced by scientists, decision makers, managers, and implementers.

2. Start with a decision that needs to be made.

3. Give priority to processes and outcomes over stand-alone products.

4. Build connections across disciplines and organizations, and among scientists, decision makers, and other stakeholders.

5. Evaluate co-production products, processes, and the actionability of the science.

Appendix IV-B: Actionable Science Case Studies

These six case studies illustrate how the guiding principles can be incorporated into projects.

Developing and Applying Occupancy Models and Decision Frameworks for the Adaptive Management of Golden Eagles in Denali National Park

Guiding Principles for Co-Producing Actionable Science in Brief

1. Actionable science is most reliably co-produced by scientists, decision makers, managers, and implementers.

2. Start with a decision that needs to be made.

3. Give priority to processes and outcomes over stand-alone products.

4. Build connections across disciplines and organizations, and between scientists, decision makers, and other stakeholders.

5. Evaluate co-production products, processes, and the actionability of the science.

Co-Produce Actionable Science (Principle 1)
This project was initiated when biologists and managers from the National Park Service (NPS) started a collaborative process with scientists from the U.S. Geological Survey (USGS) in 2007. The goal was to develop an adaptive management strategy to deal with human disturbance of golden eagle nesting sites in Alaska's Denali National Park (Williams & Brown, 2012).

This project had involvement from the NPS inventory and monitoring coordinator for the Central Alaska Network, an NPS biologist responsible for the park's annual eagle monitoring program, a USGS Alaska Climate Science Center scientist, and two scientists from the USGS Patuxent Wildlife Research Center in Maryland (Williams & Brown, 2012).

Start with a Decision that Needs to Be Made (Principle 2)
The Denali National Park managers' objective is to maximize the number of golden eagle nesting sites open to recreational hikers while ensuring that the projected number of successful nesting sites during the next breeding season exceeds an established threshold. Park managers must determine how many nesting sites to close off to hikers the following season based on information about golden eagle occupancy and reproductive success during the current breeding season (Williams & Brown, 2012).

Give Priority to Processes and Outcomes over Stand-Alone Products (Principle 3)
Researchers used several frameworks and models to understand the effect of recreational activity on golden eagle occupancy and reproduction. Multistate site occupancy models provided estimates of transition probabilities among nesting areas, taking into account recreational activities (hikers) and environmental covariates. An adaptive-management framework informed optimal management of hiking activities within Denali National Park. Threshold concepts were applied to recommend management decisions based on a minimum desired occupancy level for Golden Eagles (Eaton et al., 2014; Martin et al., 2011; Martin et al., 2009).

Monitoring surveys of potential nesting sites and prey (hare) abundance provided information for the models. Park managers can specify the current conditions of the Park (eagle occupancy, reproductive success, hare abundance) using results from the surveys. Based on current conditions, the models can identify optimal management plans and actions (Williams 2012).

Build Connections across Disciplines and Organizations (Principle 4)
Even though the golden eagle monitoring program at Denali has been ongoing for many years, the current management program between the NPS and USGS has introduced an explicit process for using monitoring and survey data to inform management decisions. This process can continue to be used for addressing various factors in Golden Eagle management and conservation (Williams 2012).

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Martin, J., Fackler, P.L., Nichols, J.D., Runge, M.C., McIntyre, C.L., Lubow, B.L., McCluskie, M.C., and Schmutz, J.A. (2011). An adaptive-management framework for optimal control of hiking near Golden Eagle nests in Denali National Park. *Conservation Biology*, 25(2):316-23. doi: 10.1111/j.1523-1739.2010.01644.x.

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Williams, B.K., and Brown, E.D. (2012). Adaptive management: The U.S. Department of the Interior applications guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC. Pages 92-94. http://www.usgs.gov/sdc/doc/DOI-Adaptive-Management-Applications-Guide-27.pdf

Maximizing the Social and Ecological Value of Coastal National Wildlife Refuges along the Atlantic Coast in the Face of Global Change Processes

Co-Produce Actionable Science (Principle 1)
The Northeast and Southeast Climate Science Centers (CSCs) are pursuing a management-research collaboration that would help coastal National Wildlife Refuge (NWR) managers make informed management decisions about how to plan for and adapt to sea level rise and related global change processes.

In March 2014, Northeast and Southeast CSC staff met with staff from the Blackwater, Alligator River, and Cape Romain NWRs to identify pressing climate-related problems for the refuges. During the meeting, CSC scientists listened and learned about the refuge managers' greatest challenges regarding adaptation to global change (e.g., sea level rise, habitat loss, saltwater intrusion) and thought about the type of science that could assist them with the management decisions they must make. Conversations with NWR staff have formed the basis for the proposed collaboration between the CSCs and NWR managers.

A follow-up workshop was scheduled for June 2014 at the National Conservation Training Center to develop a prototype decision structure and analytical approach for the Cape Romain NWR. Researchers from the Northeast and Southeast CSCs will provide coordination and decision science support for staff at the Cape Romain NWR, as well as the North Carolina Coastal Plain Refuges Complex and the Chesapeake Marshlands NWR Complex.

Start with a Decision that Needs to be Made (Principle 2)
Discussions at the March 2014 meeting resulted in the framing of the critical management issue faced by coastal refuges: How can we optimally allocate management resources over time to maximize the conservation value of refuges (i.e., achieve the refuge mission) as landscape conditions evolve?

Build Connections across Disciplines and Organizations (Principle 4)
In working directly with NWR staff at meetings and subsequent projects in 2015 and 2016, the Northeast and Southeast CSCs will assist in the development of an adaptation strategy to allow coastal NWRs to continue to provide social and ecological benefits in the face of climate and land-use changes. This process may involve tasks such as developing models to describe the relationship between stakeholders' values with respect to social and ecological benefits of the refuges and the existing ecological systems (e.g., habitat, wildlife, ecological services); and designing or redesigning monitoring programs to support learning and decision making.

References
This case study was based on the four-page project description, Maximizing the social and ecological value of coastal National Wildlife Refuges along the Atlantic coast in the face of global change processes, by Mitch Eaton, Fred Johnson, Jerry McMahon, and Mary Ratnaswamy.

Brook Trout Vulnerability to Projected Climate Changes in Driftless Area Streams in Wisconsin

Start with a Decision that Needs to Be Made (Principle 2)
This project began with Wisconsin Department of Natural Resources (DNR) scientists reaching out to DNR managers to assess climate change impacts on different fish species. The problem was the potential loss of an important recreational fish, the brook trout.

Co-Produce Actionable Science (Principle 1)
A collaborative effort was undertaken by the U.S. Geological Survey, Wisconsin DNR, Michigan Institute of Fisheries Research, and Michigan State University. Funding was provided by the Great Lakes Restoration Initiative through the Upper Midwest and Great Lakes Landscape Conservation Cooperative. The FishVis website was developed, where data analysis and planning opportunities coincide to target vulnerable habitat, build flexibility into management practices, increase resilience for impacted species, and recognize future opportunities and limitations.

Give Priority to Process and Outcomes (Principle 3)
This case study focused on sound processes, which helped identify barriers early on, encouraged a sense of ownership among all parties, and built effective networks for the future. Two interactive workshops were held to get input from stakeholders. DNR researchers invited NGOs, federal and state agency managers, and others to gain feedback and increase accessibility to the data they had synthesized. The participants were tasked with beta testing the FishVis Mapper, an online tool that uses a number of models to present possible changes in fish species occurrence in response to climate change. These workshops developed connections with decision makers, which later led to the application of FishVis data in land use planning.

In addition to the workshops, nine public meetings were held and surveys were emailed to interested parties. Participants gave input on habitat management issues, land acquisition recommendations, recreational preferences, and perceived future challenges.

A background document was drafted to describe the features and attributes of the DNR properties included in the master plan and their surrounding landscape. The analysis presented science-based findings, which have the potential to become matters of department policy.

Build Connections across Disciplines and Organizations (Principle 4)
Now in its third generation of modelling, FishVis continues to help managers identify stream segments capable of supporting brook trout populations. Decisions about how to manage riparian zones and new acquisitions are based on projected effects of where brook trout will be able to survive in the future. The models and data can influence where to buy land, land rights, and how to manage DNR-owned lands. A Riparian Reforestation Working Group was formed to prioritize the most effective adaptation strategies, one of which is to build thermal resilience by reforesting riparian zones. Dialogue between scientists (fisheries researchers) and clients (managers and planners) has helped identify “no-regret” strategies that meet environmental, economic, and managerial goals.

References
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NorWeST: Developing High-Resolution Stream Temperature Forecasts in the Northwest United States from a Crowd-Sourced Database

Start with a Decision that Needs to be Made (Principle 2)
The goal of the NorWeST project is to organize stream temperature data collected in the Northwest United States by several resource agencies and use these data to create high-resolution models and maps of historical, current, and future stream temperatures. Over the last 20 years, stream temperature data has been collected to monitor state, federal, tribal, and private interests, yet was inaccessible, unorganized, and hard to access. The NorWeST project aims to coordinate access to historical and current stream temperature data in one comprehensive database.

The database and model outputs cover Oregon, Washington, Idaho, western Montana, most of Wyoming, and parts of northern Colorado, Utah, and Nevada. All data pass through rigorous quality assurance tests. All data and models found on the NorWeST website are being used to develop high-resolution climate scenario maps, which are available to managers seeking to make better-informed local climate adaptation decisions.

Build Connections across Disciplines and Organizations (Principle 4)
The willingness to share data through interagency collaborations with many state, federal, tribal, and local agencies has made this project successful. Results are being shared with regional partners, managers, and other stakeholders through periodic workshops, project updates regarding use of the data, and the Climate-Aquatics blog. The workshops help practitioners understand management needs and demonstrate ways to use the information with complimentary decision support tools.

References

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SOUTH BAY SALT POND RESTORATION PROJECT

Start with a Decision that Needs to be Made (Principle 2)
The South Bay Salt Pond Restoration Project, developed by the Center for Collaborative Policy, the U.S. Fish and Wildlife Service (USFWS), the California Department of Fish and Wildlife, and the California Coastal Conservancy, is the largest tidal restoration project on the west coast. The project intends to transform over 15,000 acres to a mosaic of tidal wetlands and managed pond habitats capable of providing complex habitat, recreational opportunities, and a critical natural buffer against sea level rise, coastal flooding, and erosion.

Evaluate Co-Production Products, Processes, and the Actionability of the Science (Principle 5)
The project evaluated three potential long-term alternatives to the restoration efforts, and ultimately settled on an adaptive management approach to determine how best to achieve project goals while avoiding adverse impacts to natural resources and ecosystem services. An Adaptive Management Plan was developed to implement the restoration efforts in multiple phases, allowing for monitoring and evaluation at each step to inform future phases and determine the final habitat configuration.

The South Bay Salt Pond Restoration Project faces many challenges, such as the effects of sea level rise on sediment supply, possible establishment of invasive species, and the potential mobilization of mercury in the salt ponds' sediments. The adaptive management plan uses a scientific approach to generate information useful for decision-making, including monitoring, applied studies, and modeling. This adaptive management approach is based on restoration targets, and ensures science is always informing management decisions throughout each project phase. This allows project leads to assess progress and refocus activities if the system is not responding to the intended restoration goal.

References

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New Eden Landing Report. (n.d.). Retrieved January 12, 2015, from http://southbayrestoration.org/

INFORMING IMPLEMENTING THE GREATER YELLOWSTONE COORDINATING COMMITTEE'S WHITEBARK PINE STRATEGY BASED ON CLIMATE SCIENCES, ECOLOGICAL FORECASTING, AND VALUATION OF WHITEBARK PINE-RELATED ECOSYSTEM SERVICES

Start with a Decision that Needs to be Made (Principle 2)
The Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee has developed and is implementing a management strategy to protect and restore the whitebark pine, which is threatened by mountain pine beetles and blister rust. The whitebark pine strategy states that, as they become available, climate models and predictive mapping will be incorporated into management work plans. Yet, throughout the development of this strategy, little information was available to the subcommittee about how future climate change might influence the effectiveness of whitebark pine-related management decisions.

Give priority to Processes and Outcomes over Stand-Alone Products (Principle 4)
In this project, researchers from Montana State University, with support from the North Central Climate Science Center, are working with the Greater Yellowstone Coordinating Committee's Whitebark Pine Subcommittee to inform future management decisions and implementation of the whitebark pine management strategy based on climate science. A subgroup of the full subcommittee will engage with the research team and coordinate with the full subcommittee. The research team plans to hold a "pre-implementation workshop" with members of the full subcommittee to review and refine the project methodology, climate scenarios, and timeline.

In addition to providing ecological forecasting models and analyses of paleoclimate data, the research team also plans to develop four management alternatives and evaluate them under different climate scenarios. These management options will be developed in workshops with coordinating committee managers. Management alternatives will be analyzed using cost-benefit analyses and other criteria for suitability (e.g., adequate survival and growth rates).

After the research and analysis components of the project are complete, the research team will hold a workshop with the full Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee to make recommendations for the whitebark pine management strategy, accounting for future climate change. The research team plans to develop recommendations within the context of the subcommittee's operating structure and history to allow immediate implementation.

References
This project was funded by the North Central Climate Science Center in 2013. Information for this case study was taken from the project proposal (available upon request).

The whitebark pine strategy can be found at http://fedgycc.org/documents/WBPStrategyFINAL5.31.11.pdf.

Appendix V: Review of the Climate Science and Services Landscape

The Advisory Committee on Climate Change and Natural Resource Science (the ACCCNRS or Committee) conducted an inventory of the major providers of climate science and climate science services among federal, state, and tribal governments and academic, nonprofit, private, and other entities. The purpose of this inventory was to enhance the ACCCNRS members' understanding of the "landscape" of providers of climate-related information for decision makers, and to support the Committee recommendations in the ACCCNRS Report.

Finally, the Committee reviewed the President's Climate Action Plan and the 2013 Executive Order on Climate Preparedness to identify opportunities for linkages between the NCCWSC-CSC enterprise and the actions called for in the plan and the executive order. The Committee received assurances from USGS staff that going forward, the CSCs and NCCWSC will link their strategic planning and communication efforts to support the interagency climate adaptation strategies referenced in the executive order, including the *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate*, released October 28, 2011; the *National Fish, Wildlife and Plants Climate Adaptation Strategy*, released March 26, 2013; and the *National Ocean Policy Implementation Plan*, released April 16, 2013.

The NCCWSC will help lead science/research planning and delivery on multi-agency implementation teams or work groups for the three strategies. Additionally, the NCCWSC will work with USGS to provide assistance to advisory and intergovernmental committees intended to support the executive order, as appropriate, and under the department's guidance. Finally, many of the Committee's coordination recommendations will help DOI support other aspects of the executive order.

Appendix VI: Climate Change and Indigenous Peoples: A Primer – Executive Summary

Below is the executive summary excerpted from, "Climate Change and Indigenous Peoples: A Primer." The full Primer is available at http://climatetkw.wordpress.com/.

Climate Change and Indigenous Peoples: A Primer

The information presented in this report is believed to current as of the time of production. The information, law, and policies involving Indian tribes and indigenous peoples are in a continual state of flux, both domestically and internationally.

Prepared for the Advisory Committee on Climate Change and Natural Resource Science
May 2014

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Purpose

Provide tribal perspectives on foundational information on Climate Change, Indigenous Peoples, and Tribes to the Advisory Committee on Climate Change and Natural Resource Science on three major topics: 1) the impact of climate change on tribal and Indigenous Peoples; 2) relationships between Indigenous Peoples and the Federal-Government; and 3) the availability of funding to support the participation of Indigenous Peoples in federal climate initiatives.

Forward

A Primer and TK Guidelines have been produced to provide foundational information to the Advisory Committee on Climate Change and Natural Resources Science (ACCCNRS) on intergovernmental relationships and science when engaging Tribal and Indigenous Peoples in federal climate change initiatives.

Executive Summary

To indigenous peoples, climate change is not about theories, obtuse mathematics, fancy graphs, model abstractions, statistics, voluminous reports, media hype, slogans, or dire projections for a distant future. It is reality. They experience it every day in countless ways because of their economic and cultural dependence on place and natural resources. As noted by workgroups II and III in the April 2014 Fifth Assessment prepared by the International Panel on Climate Change and Chapter 12 of the May 2014, National Climate Assessment, indigenous peoples among the most vulnerable human populations to climate change. Sea level rise, dead zones, ocean acidification, melting glaciers, invasive species, drought, severe storm events, wildfire, invasive species, and infestations from insects and disease among the many manifestations of local, regional, national, and global causal factors that are disrupting the ecological process that lie at the very core of their lifeways.

For indigenous peoples, the impacts of climate change extend beyond the physical environment to their responsibilities as governments and cultural continuity. Indigenous peoples have their own inherent governmental structures, powers and special rights and interests in land, natural, and cultural resources. Yet their role in climate governance is being ignored. They are rarely recognized or even acknowledged as having a legitimate need to be at the table as full partners when climate policies and programs are being developed and implemented.

The governments of indigenous peoples take many forms, from federally-recognized tribes to self-recognized communities. Each form of governance has different implications with attendant responsibilities and processes for federal entities when engagement in climate change initiatives is sought. For example, federal entities are required to undertake consultation on a government-to-government basis with federally-recognized tribes and to fulfill fiduciary responsibilities for lands and resources held in trust by the United States for the benefit of Indians.

There is great diversity in the organizational structures of tribal government and the roles of written and customary law and cultural traditions and practices. Legal rights and responsibilities of tribal governments vary widely as well. Some have reserved treaty-protected rights and co-management authorities for shared resources like fish, wildlife, and water. Some have rights established by Executive Order or Statute. Others have neither. Because the governments and cultures of indigenous peoples are distinctively different, federal entities must be especially careful to avoid stereotyping and "one size fits all" approaches and work with indigenous communities with awareness, respect and sensitivity, whether undertaking research, implementing programs, or responding to emergencies. The Primer provides suggestions for interacting with indigenous peoples generally and in emergency situations.

Indigenous peoples have gained intimate, intergenerational understandings of interconnections between people and the environment gained through thousands of years of living with the land, learning how to prepare and adapt to change in order to survive. These understandings and rules of governance for their sharing are commonly referred to as Traditional Knowledge(s)

or TKs. Because TKs are uniquely kept and shared within indigenous communities, access and use must be arranged separately with each indigenous community. A companion piece to this Primer provides some general guidelines to help inform keepers and would be users of TKs of helpful principles and protocols.

The experience, science, and wisdom of indigenous peoples can add a critical local dimension as the world seeks to develop effective policies and programs to contend with climate challenges. The need for and value of including TKs and local observation to inform understanding and devise climate strategies are becoming increasingly acknowledged.

TKs and western science are founded in fundamentally different, culturally-determined world views and values. TKs reflect long-term, holistic perspectives in which everything in interconnected, i.e., man is a part of nature. In contrast, western science reflects a short-term, segmented perspective that tends to result in segmentation and isolation, i.e., that man is a part from nature. These different cultural underpinnings lead to vastly different views on the value and importance of science and information to decision-making. To indigenous peoples, science informs decision processes that include consideration of economic, cultural, and environmental implications for today and future generations in a holistic, integrated fashion. In contrast, western societies often put science in a subservient role narrowly focused on isolated cause-effect relationships and short-term cost-benefit consequences of individual decisions. This difference in world views affects attitudes towards science.

Indigenous peoples have long understood the folly of trying to dissect the world into component parts and attempting to view science in isolation from economics, law, policy, and culture. The controversy that has festered for nearly two decades over the remains of *The Ancient One* (aka Kennewick Man) serves as a prime example of the conflict that can result from the melange of tribal rights, science, law and culture. The Native American Graves Protection and Repatriation Act requires ancestral human remains and cultural artifacts to be returned to Tribes for reburial. Scientists oppose repatriation and reburial of *The Ancient One*, asserting that further study can provide valuable information on ancestral origin, diet, and the source of a stone point found in the hip. Tribes argue that the remains should not be treated as an object of scientific curiosity, but rather should be reburied as a sacred ancestor.

Indigenous communities value information and data in the context of implications for their economies, lifeways, and cultures. The rights and interests of indigenous governments also create needs for special types of information from climate science. For example, decisions of indigenous communities are usually made at relatively small, local scales so there is a need to: (a) access downscaled information from regional data and models along with information on uncertainty; and (b) provide a means to upscale, i.e., understand how local decisions will interact at the landscape, regional, and even global scales to evaluate their effects on the resources and values of interest. Another example illustrates how science may be called upon to inform decisions regarding interactions between the special rights of indigenous communities and impacts of climate change. Climate change is expected to result in sea level rise, more violent water surges and changes in meander of river beds with increased frequency and

intensity of storm events; since tribes often own shorelines to mean high water lines and river meander areas, information may be needed to evaluate implications of potential conflicts between tribal and individual property rights arising from climate change impacts. Another example is the information needed by tribal governments to evaluate implications of federal actions or policies affected by conflicts of interest between duties relating to the trust responsibility and general administration of agency programs and missions or the implications of shifting the conservation responsibility for ESA listed species onto tribal lands due to habitat deterioration in other areas.

TKs and western science each have their own strengths and weaknesses; neither is superior to the other. Braided together, both can retain their own identity while strengthening the whole body of knowledge regarding climate science.

Because of the heightened awareness that traditional knowledge has potential commercial value, the need for international protection of the rights and interests of indigenous peoples is receiving increasing attention. For example, the United Nations Convention on Biodiversity and Declaration on the Rights of Indigenous Peoples (UNDRIP) contains tenets intended to discourage unprincipled exploitation of the traditional territories and knowledge of indigenous peoples, such as the need for Free, Prior, and Informed Consent (FPIC).

Tribal communities typically suffer from disparities in infrastructure, capacity, economic development, health, and social services. Their ability to substantively engage in climate initiatives is greatly affected by confusing bureaucratic and administrative structures and the lack of federal funding to support capacity development and active participation. Moreover their ability to collaborate is often impeded by agency administrative restrictions, such as information technology policies and procedures that affect access to data, analysis, and file sharing.

Funding available to the Bureau of Indian Affairs (BIA) and federally recognized tribes continues to fall far short of that provided to other entities within the Department of the Interior. In FY12, less than $200,000 was provided to support BIA and tribal involvement in Interior's $200 million Cooperative Landscape Conservation and Adaptive Science (LCAS) program, and that meagre funding was repurposed from a realty account. In FY13, the less than $1 million made available to support participation by the BIA and 566 federally recognized tribes was also not new funding, but was rather repurposed from other BIA accounts. This modest amount of funding supported a single staff position and a competitive grant program. The FY14 operating budget for the BIA provides nearly $10 million for participation in LCAS and other climate related activities, along with youth initiatives and landscape management improvements. The President's FY15 budget proposes just under $10 million for BIA and tribal participation in climate-related initiatives. In addition to inequitable funding for participation in the LCAS, federally recognized tribes are not eligible to receive funding from several sources available to states and other entities.

There are huge and growing demands for tribal participation on at least ten federal climate planning strategies and a plethora of ever increasing federal, state, regional, international, academic and non-governmental fora and processes, such as landscape conservation cooperatives, climate science centers, conferences, workshops, and climate hubs. Yet the availability of adequate, dedicated funding to support tribal involvement is rare. The proliferation of climate-related processes is overwhelming. Few, if any, tribes have the capacity, the resources, staff, and expertise, to engage in climate change activities on their own behalf.

Tribes must have both technical and political capacity to engage in climate change initiatives. They must have access to western science and the ability to incorporate the wisdom, insight, and TKs from their own communities into decision processes. Their governments must be able to bring special legal and political rights and interests to local, regional, national, and international fora to help overcome impediments to the development of a collaborative framework to address climate change.

The long, proven history of balanced stewardship of indigenous peoples can help build partnerships across political jurisdictional that reconcile views among a multitude of divergent interests. Federal climate initiatives and indigenous peoples stand to benefit greatly by working together to establish and support the development and implementation of viable approaches for addressing the diverse and difficult economic, social, and ecological challenges confronting climate change.

Land and resources are integral to the cultures and economies of tribes and indigenous peoples. As climate change affects local ecological processes, generations of place-based knowledge within their communities can provide information and guidance for preparation, adaptation, and mitigation. Moreover, tribes and indigenous peoples have unique political status as governmental sovereigns, own substantial quantities of land and resources, possess reserved rights on large areas of federal land, and have co-management authorities and responsibilities for shared resources. Federal, state, and regional entities in landscape scale climate initiatives will need to encourage and support the substantive engagement of tribes and indigenous people. This primer is intended to provide information to help participants in landscape level processes fulfill needs for knowledge exchange and build partnerships with tribal communities.

Appendix VII: Traditional Knowledges Guidelines – Executive Summary

Below is the executive summary excerpted from, "Guidelines for Considering Traditional Knowledges in Climate Change Initiatives." The full document is available at https://climatetkw.wordpress.com/.

Guidelines for Considering Traditional Knowledges in Climate Change Initiatives

The information presented in this report is believed to be current as of the time of production. The document is a work in progress. The workgroup anticipates revising it over time.

Prepared for the Advisory Committee on Climate Change and Natural Resource Science
September 2014

These Guidelines have been developed by a group of indigenous persons, staff of indigenous governments and organizations, and experts with experience working with issues concerning traditional knowledges.

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Executive Summary[1]

There is increasing recognition of the significance of how traditional knowledges (TKs) can inform our understanding of the impacts of climate change and strategies for adaptation and mitigation. And yet there are potential risks to indigenous peoples in sharing TKs in federal and other non-indigenous climate change initiatives. We intend the term indigenous peoples to designate the diverse populations in the U.S. who could interact with federal and non-indigenous climate change initiatives in ways that involve TKs, whether in the U.S. they are federally-recognized, state-recognized, or unrecognized. We refer to "indigenous peoples" and "tribes" interchangeably in this document, unless we are talking about a specific group or a specific status related to recognition.

These guidelines are intended to examine the significance of TKs in relation to climate change and the potential risks to indigenous peoples in the U.S. for sharing TKs in federal and other non-indigenous climate change initiatives. Although it is common to refer to "traditional knowledge(s)" as individual pieces of information, this term also refers to traditional "knowledge systems" that are deeply embedded in indigenous ways of life. These guidelines use the phrase "traditional knowledges" deliberately in plural form because knowledges are emergent from the symbiotic relationship of indigenous peoples and places - a nature-culture nexus. Tribes and indigenous peoples use "knowledges" to emphasize that there are diverse forms of traditional knowledge and knowledge systems that must be recognized as unique to each tribe and knowledge holder. These guidelines should be used to inform the development of specific protocols in direct and close consultation with indigenous peoples.

Federal agencies and national climate change initiatives are recognizing the significance of TKs, and are proposing and funding collaborative efforts between indigenous communities and federal and non-indigenous climate change entities in ways that involve TKs. This interaction requires an understanding of how individual tribes and knowledge holders choose to share or not to share TKs.

[1]This Executive Summary synthesizes the key information from the full report on *Guidelines for Considering Traditional Knowledges in Climate Change Initiatives*. The full report includes detailed information for each of the guidelines, as well as complete citations and an annotated bibliography of relevant sources.

Principles for Engagement

The guidelines focus on a two principles: "Cause No Harm" and "Free, Prior and Informed Consent." These principles are described in detail below and are intended to guide the motivation, character and intent of collaborative climate initiatives undertaken by government agencies, research scientists with tribal communities, and TKs holders. Broadly, these principles recognize that each tribal community has its own laws which guide and structure how different facets of TKs are treated by tribal and non-tribal entities, and more broadly regulates interactions between parties. Sharing of TKs is governed by principles and values of an indigenous community, which defines an equitable and productive relationship. Key issues discussed in these two principles include the collective custodianship of TKs, custodianship by knowledge holders, and the secret, sacred, cultural and individual privacy associated with TKs.

"Cause No Harm"[2]

- The "Cause No Harm" philosophy involves identifying and avoiding risks that could lead to loss of or misappropriation of TKs. Specifically, identify risks to natural and cultural resources in regards to intellectual property interests that may come from sharing TKs.
- Define the roles and responsibilities of all partners clearly and carefully
- Define what information will be shared
- Establish use, ownership and means to interpret or share information at the outset of the project
- Respect, Trust, Equity and Empowerment

Principles for collaboration between tribes, TK holders, federal agencies and others that are intended to guide collaboration and the creation of mutually beneficial relationships between tribes and TK holders and outside researchers and/or government agencies include integrity, validity, fairness and equity, respect and recognition. Finally, the principles include a discussion of traditional rights, sovereign status of American Indian Tribes, the Nation of Hawai'i and Alaska Native Tribes, the trust obligation of the federal government, the inadequacy of current intellectual property law, and international agreements to protect indigenous peoples and TKs from exploitation.

The principle of "first, do no harm" (principle of primum non nocere, principle of non-maleficence) is a core ethical principle in medicine and law, and appears in the ethical guidelines of many professional societies in many other disciplines. A prime directive of the Hippocratic Oath, it is the duty not to cause harm to others through any intervention (a negative duty). This is interpreted as having the duty to ensure that actions benefit everyone involved (a positive duty). Medical procedures, policy interventions, knowledge exchanges and other actions are regarded as being acts of deliberate choice, and choices can have both

[2] This principle references the Canadian International Development Agency (CIDA) Handbook on Project Planning and Indigenous Traditional Knowledge best practices in working with indigenous peoples.

beneficial and detrimental consequences for which one can be held ethically, morally or legally responsible. The principle is an admonishment to look carefully at potential consequences of decisions to act to ensure that all are made better off, while no one is made worse off. It is closely linked to the principle of beneficence, or the duty to do good, and the principle of due care, all foundations to good stewardship and right relationships.

Free, Prior and Informed Consent

The United Nations Declaration of Rights of Indigenous Peoples (UNDRIP), as well as other intergovernmental organizations and international forums recognize the concept of Free, Prior and Informed Consent (FPIC) as a fundamental right of indigenous peoples when negotiating or entering into agreements with governments, businesses and others. Following is a summary of each of these terms, which are more fully defined in the full Guidelines.

- **Free:** This term ensures procedural fairness in negotiations.
- **Prior:** This term ensures that, procedurally, indigenous peoples should be involved from the beginning. For undisclosed TKs, prior refers to a process to obtain consent before it is accessed.
- **Informed:** This term ensures substantive fairness in negotiations. Existing treatments of the meaning of "informed" have emphasized the need to address costs and benefits, risks and opportunities.
- **Consent:** This term ensures that processes for obtaining consent should first affirm the right of indigenous peoples to decline to engage in mobilizing TKs for cooperative projects, and saying "no" should have no legal implications for respecting indigenous rights and interests or fulfilling trust obligations.

Guidelines Considering Traditional Knowledges in Climate Initiatives

These guidelines are intended to provide specific measures that federal agencies, researchers, tribes and TK holders can follow in conceptualizing, developing, and implementing climate change initiatives involving TKs. The actions in these guidelines are not comprehensive, and are not in any way intended to supersede the obligation of federal agencies to consult tribes and TK holders with whom they are collaborating or amend or modify any agreements that may exist between tribal governments and federal entities. These guidelines are intended to promote the use of TKs in climate change initiatives in such a way as to benefit indigenous peoples, promote greater collaboration between federal agencies and tribes, and increase tribal representation in federal climate initiatives. These guidelines are a work in progress.

Summary of Guidelines and Actions

Guideline 1. Understand key concepts and definitions related to TKs.

Terms such as traditional knowledge are coined in non-indigenous academic and policy circles, and often do not fully reflect the ways in which indigenous communities refer to, or think of, their knowledge and lifeways. However, these terms may be helpful in providing agencies and

researchers with greater understanding of issues that tribal people are facing regarding their own knowledge systems, climate impacts, and impacts to TKs resulting from climate initiatives.

Actions for agencies and researchers:

- Respect and seek to understand the unique conception each individual tribe has of their own knowledge system(s). Recognize that tribal experts and TK holders are the authorities of their own knowledge systems, and deserve to be treated as such.
- Find out how to follow communication protocols and respectfully identify authorities in order to develop an appropriate approach for working with TK systems in a partner community (e.g. what are common terms used in the community? What types of questions are appropriate for outsiders to ask? Who is a contact person/go-between in the community who will help educate researchers?)
- Be humble and open to getting advice from those who know the communication protocols and how to identify authorities.

Actions for tribes and TK holders:

- If you choose to share information about TKs, clearly articulate conceptions of your knowledge system with the expectation that your people's TKs will be respected and held as valid. Make personnel and/or resources available to aid researchers and agency staff in educating themselves about your community's approach toward working with non-tribal people on projects involving TK.

Guideline 2. Recognize that indigenous peoples and holders of TKs have a right NOT to participate in federal interactions around TKs.

Indigenous individuals are holders of TKs. It is the right of the individual to withhold sharing information. However, indigenous governments and individual holders of TKs within these communities must work together to decide when it is appropriate to share TKs or bring TKs to non-indigenous initiatives.

Actions for agencies and researchers:

- Respect the right of indigenous governments and/or TK holders to withdraw participation and access to TKs at any time during the collaborative process. Some reasons for withdrawing participation may not be evident to those not operating within a given TK system.
- Explain in a non-biased manner the risks and benefits of sharing or not sharing information in a given climate initiative BEFORE attempting to enter into any partnership with a tribal community. Inform the indigenous government and/or TK holder of risks "on your end," e.g., agency's lack of ability to protect information from FOIA requests.
- Support tribal judgment about when/if to share TKs. Support and back tribal partners as they make decisions about whether/how to share information.

Actions for tribes and TK holders:

- Be explicit about the choice not share TKs with agency or other partners, and your right to not disclose information about your tribe's knowledge systems.
- Find out if the tribe or community has a protocol for accessing and asking about knowledge. If you choose to share information about TKs, make sure that agencies or other partners have conformed to the protocols of your tribe for ethical research, such as review by a tribal council, tribal institutional review board, or cultural committee, among other possible relevant institutions that vary from community to community.

Guideline 3. **Understand and communicate risks for indigenous peoples and holders of TKs.**

TKs in a climate change context occur in a spectrum from the highly secret and sacred to daily observations of phenomena useful for identifying climate impacts and adaptation actions. The open exchange and co-production of knowledge may be beneficial to all stakeholders and rights holders, and may be desired by indigenous peoples. But exchanges carry risks as well, particularly for indigenous peoples and the nature of their knowledge systems and cultural resources. Currently, there are few protections for indigenous peoples who share TKs with federal partners to ensure that TKs will remain the right and property of indigenous peoples or knowledge holders. There may also be inadequate protections for the resources (e.g., culturally-important species) associated with TKs. Therefore, it is critical that federal agencies, and most importantly TK holders, have a balanced understanding of the risks as well as the benefits of bringing TKs into climate change initiatives.

Actions for agencies and researchers:

- Determine the extent to which TKs involving confidential or sensitive information can be protected from unauthorized public disclosure because of federal mandate (e.g., without express legislative authority, TKs recorded in written or electronic form provided to federal entities are subject to FOIA requests).
- Research your agency/organization's codes and policies regarding the publication or dissemination of TKs gathered for projects.
- Inform tribes/TK holders about potential risks of disclosure. It is the obligation of agency staff and researchers to share information about what risks the project poses "on their end."
- Research existing intellectual property and copyright laws in your country, as they pertain to your research/project results. Will data from the project be subject to appropriation? How will this information be protected?

Actions for tribes and TK holders:

- Identify risks to natural and cultural resources and intellectual property interests.
- Identify potential violations or conflicts related to TKs, risks of overexploitation of resources associated with TKs.

- Clearly state what risks you find acceptable, and what risks are not acceptable/must be avoided. If there are risks to natural and cultural resources because of intellectual property concerns, determine whether the tribe would like to share your TKs.
- Consider recording TKs orally in the indigenous language and storing this information within a tribal entity, such as a Tribal Historic or Cultural Preservation Office in order to preserve confidential or sensitive information.
- Consult your tribal attorney regarding the understanding of potential risks.

Guideline 4. **Establish an institutional interface between indigenous peoples, TK holders, and government for clear, transparent and culturally appropriate terms-of-reference, particularly through the development of formal research agreements.**

Federal agencies have a trust responsibility to federally-recognized tribes, and must ensure that TKs are brought to climate change initiatives in an ethical, respectful, and protective manner that responds to the needs of each individual tribe. Terms-of-reference are commonly formalized through explicit research agreements that spell out conditions prior to the start of the research, and methods for fairly resolving conflicts are identified once the research has started. Tribes can specify conditions during the FPIC process. Although these processes may differ among tribes, common issues are identified below.

<u>Action for agencies, researchers, tribes and TK holders:</u>

- The Department of Interior should undertake concerted efforts to support the engagement of tribes and indigenous peoples in federal climate-related science investments, including the capacity to access and benefit from the services provided by CSCs, LCCs, and NCCWSC.
- When appropriate and only with the Free, Prior and Informed Consent of indigenous peoples and knowledge holders, decision-makers should consider and utilize western science and TKs.
- Collaborate with project partners to develop pre-determined methods for each step of bringing TK into climate change initiatives. Questions to address might include:
    - What are the appropriate goals and objectives for the project?
    - How will TKs holders be involved as equal partners?
    - How will TKs be identified for the project? Will federal staff request information? Will TK holders offer up information that they feel is relevant?
    - How will TKs be shared within the project team? Who will have access to information?
    - How will TKs be stored for safekeeping? What confidentiality measures will be employed and enforced? Who will oversee these? Who will be responsible in the event that these measures fail?
    - What obligations within the tribal community will accompany the TKs that are involved in the project, if any?
    - Who will enforce these standards? What means will TKs holders redress potential grievances? What are the penalties for the measures failing?

Guideline 5. **Provide training for federal agency staff working with indigenous peoples on initiatives involving TKs.**

Federal agencies and other non-indigenous entities seeking to work with indigenous peoples and knowledge holders that have access to TKs must adequately train staff that will be interacting with indigenous peoples. This training should include what TKs are, how TKs differ from western science, the risks to indigenous peoples and knowledge users/holders when TKs are shared with non-indigenous entities, and how staff can ensure that they do not place indigenous peoples, TKs, or TK-associated resources at risk. This training should also clarify what legal or other protections may be afforded to TKs under FOIA, related statutes, and applicable federal policy. Federal or other climate efforts should provide funding for training for tribal partners.

Actions for agencies and researchers:

- Provide training on community standards, protocols, and legal rules for all project team members participating in projects related to TKs.
- Allocate resources to train staff about TKs, and ongoing issues regarding the sharing and protection of TKs, and existing models guiding collaborative projects between non-indigenous researchers and holders of TKs.
- Provide funding for tribal partners to train and advise agency staff on how to work with tribes on issues related to TKs.

Actions for TK holders/tribes:

- Train tribal staff and TKs Holders on protocols needed to govern the sharing and protection of TKs.
- Inform and train the Tribal Legal Office of potential project and potential risk.

Guideline 6. **Provide specific directions to all agency staff, researchers and non-indigenous entities to ensure that protections for TKs requested by tribes and knowledge holders are upheld.**

Agencies and research organizations should prepare their staff for interactions with tribes and TK holders to ensure that their staff members are able to carry out their jobs in an ethical and respectful manner, and to promote partnerships between tribes, TK holders and non-indigenous entities. This preparation will promote an iterative process between researchers and tribes, as well as the potential for co-production of knowledge about climate change issues.

Actions for agencies and researchers:

- If the indigenous government or knowledge holder requests protection for TKs that may be shared, agency staff should not write down or electronically record confidential or sensitive information.

- Consult with indigenous governments to develop an appropriate research agreement detailing the nature of the research/ knowledge exchange. Agreements should[3]:
    - Be developed collaboratively through equal standing.
    - Be based on FPIC and mutually agreed terms, goals and understandings.
    - Acknowledge contributions by TK holders.
- Outline expected risks and benefits.
- Clearly disclose any constraints or limitations regarding the ability to protect sensitive or confidential information before seeking access to TKs. Specify what measures will be taken to protect sensitive or proprietary information (understanding that there are often legal limits, to what protections can be provided by Federal agencies to any information that is submitted to them or that is shared with others, such as under FOIA).
- Use appropriate language when referencing the role and content of TKs in climate change initiatives.
- Consider sharing data and information with indigenous peoples to support indigenous efforts and indigenous use of TKs *without the expectation* that indigenous peoples will share TKs in return.
    - Focus on the value of the beneficial outcomes that come from use of TKs as opposed to a focus on knowledge exchange.
    - Implement the principle of co-protection to the fullest extent possible. Co-protection refers to measures that protect both TKs and their associated tribal trust resources. Any actual exchanges of any particular traditional knowledge should take place in the context of safeguards that take into account legal, economic, cultural and cultural resource issues.
    - Work to establish a long-term relationship with indigenous peoples built on respect, mutual benefit, and extends beyond current understandings of professional obligations.
    - Provide recognition, policy guidance and education for the public and agencies to promote understanding and respect for TKs and associated resources to build a relationship based on trust and respect.
    - Consider the use of proxies in knowledge sharing. For example, indigenous peoples may share the results or outcomes without sharing sacred knowledge.

<u>Actions for Tribes, TKs holders, federal agencies and researchers:</u>

- Detail how data will be collected and stored and specify rules for access, ownership and control, if any will exist.

[3] See Appendix I of the full guidelines for more detail (http://climatetkw.wordpress.com/).

- Take special caution in the creation of databases of TKs, which should be only compiled or made available through Free, Prior and Informed Consent. Databases may provide benefits, for example, in bringing together traditional knowledge of past weather patterns to fill in gaps in the scientific record and lead to culturally appropriate solutions. But there are cultural issues and risks as well, for example through loss of control or ownership over the knowledge.

Guideline 7. **Recognize the role of multiple knowledge systems.**

Agencies and research organizations should recognize the role and interaction of TKs and multiple knowledge systems in climate change research and adaptation and vulnerability assessments. These entities should also recognize multiple knowledge systems may exist within one tribe and among different TKs holders. These knowledge systems may conflict with one another. The agencies and research organizations need to work closely with all parties to ensure that all TKs is protected and credited appropriately.

Actions for federal agencies, researchers, tribes and TKs holders:

- Develop measures of success for projects from multiple perspectives/knowledge systems—define parameters of success from both western science and TKs.
- Ensure that each the contributions of tribal partners are recognized in final products, publications, and efforts to publicize projects.
- Create opportunities for partnerships involving TKs in climate change initiatives only when it is requested by and includes leadership of tribes in the development of these programs.
- Ensure that all collaboration with TK holders occurs according to principles of FPIC.

Actions for Tribes and TKs holders:

- Develop an internal protocol/processes that ensures that all participants in these projects are informed of risks, benefits, and anticipated outcomes.

Guideline 8. **Develop guidelines for review of grant proposals that recognize the value of TKs, while ensuring protections for TKs, indigenous peoples, and holders of TKs.**

Many federal, state and other grant programs are including criteria in proposal review that recognizes and awards points to applicants that incorporate TKs within their proposals. While this demonstrates awareness of the importance of TKs in climate change initiatives, it may pose a risk to indigenous peoples and knowledge holders who are unaware of potential abuse or misappropriation of TKs.

Actions for federal agencies and grant reviewers:

- The grant and materials produced (e.g., reports, videos) should recognize the sovereign rights of indigenous peoples to control access to, and the use of, their

traditional knowledge and the right to give or deny access to it based on their right to FPIC according to their own traditions and processes.

- The grant should, where appropriate, include reference to a human subjects protocol and approval from the appropriate Institutional Review Board.[4]
- The grant should follow the appropriate indigenous research protocols established by individual tribes to guide research involving tribes or knowledge holders.
- Federal grants should not require that all data collected during the grant period be presumed to be under the ownership of the federal government. TKs should not be disclosed without the Free, Prior and Informed Consent of the indigenous government and knowledge holder, even when generated under a grant period funded by the federal government. The grant should clearly articulate that if indigenous peoples and their knowledge holders disclose TKs in written form then TKs would currently be subject to disclosure through FOIA. If funding entails a requirement to disclose based on Federal rules associated with publicly funded research, then alternative sources of funding should be sought for activities related to the collection of TKs if indigenous governments or knowledge holders do not wish TKs to become publicly available.
- The grant should demonstrate that there is substantial tribal leadership and tribal legal representation in the conception and project management of the grant.
- The grant should demonstrate substantial benefits and minimal risks to tribes for the proposed projects.
- Agencies could consider a tiered approach to grants, with an initial disbursement for attempting to obtain FPIC, including tribal consultations and risk and opportunity assessment, with another tier only for projects that have obtained FPIC and meet IRB requirements, where appropriate.

[4] An institutional review board (IRB) is a committee that has been formally designated by institutions to approve, monitor, and review research that involves humans. The Association for the Accreditation of Human Research Protection Programs, Inc. (AAHRPP) accredits high-quality human research protection programs in order to promote excellent, ethically sound research. Through partnerships with research organizations, researchers, sponsors, and the public, AAHRPP encourages effective, efficient, and innovative systems of protection for human research participants. Agencies should promote the revision of human subjects protocols to accommodate specific tribal issues, for example regarding collective tribal consent.

Appendix VIII: Program Evaluation Measures for CSCs

Draft Program Evaluation Measures For Climate Science Centers

The following represents a framework for the United States (U.S.) Geological Survey's (USGS) Climate Science Center (CSC) program evaluation, together with a set of possible evaluation measures and illustrative metrics. The Advisory Committee on Climate Change and Natural Resource Science (the ACCCNRS or Committee) recommends use of these four general categories in program evaluation of the CSCs: (1) institutional development; (2) science; (3) capacity building; and (4) partnerships.

The Committee recognizes, however, that translation of these categories into a workable set of indicators and metrics requires additional work. This list should be viewed as a starting point in that process; it describes a broader set of possible measures than ultimately should be put into place. Specifically, USGS National Climate Change and Wildlife Science Center (NCCWSC) program managers will need to identify a subset of measures that can productively and efficiently be deployed, ensuring that any particular metric is feasible and cost-effective to measure, and is informative for program management.

Evaluation Category Descriptions

Institutional Development: These measures are intended to capture the overall health of the center as an institution, with an emphasis on planning processes, management and operations, finances, and institutional coordination.

Actionable Science: These measures are intended to capture the performance of the center in providing relevant and useful scientific products and services, with an emphasis on the relevance, quality, processes, accessibility, and impact of research and science products and services carried out directly by the center and through its external grant funding.

Capacity Building: These measures are intended to capture how well the center is building capacity for conducting and applying actionable science, with an emphasis on formal training (e.g., of graduate students and post-doctoral fellows) and providing training and capacity building to the broader community in how to use and apply climate science and services.

Partnerships: These measures are intended to capture how well the center is working with partner organizations beyond the CSC consortium itself, which is included under institutional development, with an emphasis on breadth and scope of engagements and leverage.

Program Evaluation Framework

Institutional Development

Measure	Question	Illustrative Metrics (Note: Examples provided for some, but not all measures)
1.1. Planning (Strategic and Annual)		
Stakeholder engagement	How are stakeholders being identified for inclusion? Are stakeholders providing timely input into Climate Science Center (CSC) planning processes?	Number and variety of methods engagement Number and diversity of stakeholders in planning process
Decision maker needs	Do plans address high-priority decision-maker needs?	% Percent of plan priorities that directly reflect expressed decision maker needs or priorities
Consistency with USGS plans	Are plans consistent with the National Climate Change and Wildlife Science Center (NCCWSC) strategic plan and broader U.S. Geological Survey (USGS) goals for the CSC network?	
Plan quality	Are the strategic and annual plans well-crafted in terms of scope, clarity, and achievability	
Plan implementation	How well are the plan objectives being achieved?	Percent of benchmarks rated as fully successful, partially successful, delayed, not successful
1.2. Management and Operations		
1.2.1. Staffing		
Core staffing	Are expectations for number of core staff for the center being met?	Percent of core staff positions filled
Total staffing	What is the total size of the center's staff?	Number of full-time equivalents directly associated with center

Measure	Question	Illustrative Metrics (Note: Examples provided for some, but not all measures)
1.2.2. Physical Assets		
Adequacy of facilities	Are adequate facilities (space, technology) available to the center?	
Center cohesiveness	How cohesive is the physical space occupied by center staff?	Proximity of USGS/CSC employee offices and labs with university/CSC employee offices and labs Number of regularly scheduled events/meetings that bring together entire center staff
1.2.3. Grants Management		
Timeliness of grant awards	Are external grant proposals awarded in a timely fashion?	Average time elapsed from issuance of request for proposals to announcement of awards
Timeliness of award execution	Are project agreements executed in a timely fashion, enabling timely project starts?	Average time from award announcement to execution of formal grant or contract agreement
Timeliness of fund transfers	Are funds being transferred in a timely fashion?	
Financial compliance	Are funds managed according to applicable financial management and accounting standards?	
1.2.4. Budget		
Total budget	What is the total amount of money flowing through center?	Total dollar amount of center budget, including USGS and university host components
Budget sources	What proportion of the budget comes from different major sources?	Proportion of total budget from (1) USGS base funding; (2) university host base funding (i.e., hard funding); (3) soft funding
External funding	How much external research funding is generated by the center?	Number of external research grants generated by center staff Dollar amount of external research grants generated by center staff

Measure	**Question**	**Illustrative Metrics** (Note: Examples provided for some, but not all measures)
In-kind support	What in-kind support is provided to the center from the University host?	List of in-kind host contributions by year (e.g., personnel, facilities, computers, software)
Effective indirect cost rate	What is the effective indirect cost rate applied by the University host?	Percent of effective indirect cost rate calculated as allowable indirect rate revenue minus amount of allowable indirect rate invested back into operation of the center
1.3. Institutional Coordination		
1.3.1. USGS and University Host		
Collaborative planning	How well are USGS and the university host engaging in joint center planning?	Frequency of joint planning meetings
Collaborative governance	How well are USGS and the university host engaging in collaborative governance?	Existence and functioning of oversight or executive committee
Collaborative activities	To what degree are USGS and the university staff collaborating on specific projects or activities?	
1.3.2. Among CSC Consortium		
Collaborative planning	How well are consortia partners engaging in collaborative center planning?	Frequency of joint planning meetings
Collaborative governance	How well are consortia partners engaging in collaborative governance?	Existence and functioning of oversight or executive committee
Collaborative activities	To what degree are consortia principle investigators collaborating on specific projects or activities?	

Measure	Question	Illustrative Metrics (Note: Examples provided for some, but not all measures)
1.3.3. With other Federal Agencies		
Coordination	How well is the CSC coordinating with other federal agencies to achieve complementarity and avoid duplication in activities?	
Collaborative activities	To what degree are CSC staff collaborating with other Department of Interior bureaus and federal agencies on specific projects or activities?	

Actionable Science

Measure	Question	Illustrative Metrics (Note: Examples provided for some, but not all measures)
2.1. Relevance		
Support for stakeholder priorities	To what degree does CSC science programming address the needs of local and regional stakeholders and decision makers?	Percent of projects or research carried out or funded that closely align with stakeholder needs expressed in annual and strategic planning efforts OR Percent of funding that aligns with stakeholder priorities as expressed in planning processes
Support for regional national priorities	To what degree does CSC science programming address issues and priorities in regional or national adaptation strategies and climate action plans?	Percent of projects or research carried out that is most relevant at supporting local, regional, or national needs
Geographic scale of science priorities	At what geographic scale (local, regional, or national) is the science programming designed to have most relevance?	Number (or percent) of projects in which stakeholders were involved and agreed with (1) the problem definition; (2) proposed research approach, and (3) intended outputs and products.

Measure	Question	Illustrative Metrics (Note: Examples provided for some, but not all measures)
2.2. Quality		
Peer-reviewed publications	How productive is the center in producing high-quality, peer-reviewed scientific publications?	Number of peer-reviewed papers and corresponding journal Impact Factors[1] from center; Number of peer-reviewed papers and journal impact factor resulting from funded projects
Adherence to standards	Do products and services meet standards of practice for the relevant discipline and application?	Depending on intended application there are differences in how to evaluate "fitness for use" (e.g., quantitative vs. qualitative analysis; appropriate level of spatial or temporal resolution; levels of acceptable uncertainty)
Suitability for intended applications	Are products and services appropriately scaled to intended applications and users (e.g., level of rigor, complexity, resolution, and/or uncertainties)?	
Innovation	Do science products, services, or approaches represent novel or noteworthy advances?	List of papers, projects, tools, or other products formally recognized by peers as representing significant advances or breakthroughs in technique or approaches
2.3. Processes		
Co-production of science	Are stakeholders and decision makers substantively involved in project definition, design, and execution?	Number (or percent) of projects in which stakeholders were involved and agreed with (1) problem definition; (2) proposed research approach, and (3) intended outputs and products

[1] This is a standardized ranking of scientific journals updated annually that reflects the average number of citations for papers published in a given journal.

Measure	Question	Illustrative Metrics (Note: Examples provided for some, but not all measures)
Data management	Are appropriate standards used for data collection, management, and archiving?	
External grant review	Do review and selection processes for external grants adequately evaluate scientific rigor, stakeholder relevance, and potential impact?	Scientific expertise of grant review committees with respect to the focus of the particular RFP or grants program
2.4. Accessibility		
Online accessibility of products and resources	To what degree are the data, information, and science products easily accessible online?	Percent of tools and resources made available to potential users through website Number of external links to online resources made available by center; Number of web users and other standard web analytic metrics for online offerings
Tailored communication	To what degree are science products developed in ways that meet the specific communication needs of target audiences?	List of science products tailored for audience-specific communications (e.g., print materials, presentations, tailored apps, exportable GIS layers)
2.5. Impact and Efficacy		
Actions based on science	To what degree are stakeholders and decision makers applying CSC scientific products and services?	Percent of stakeholders reporting that center products were useful Percent of stakeholders reporting that center products were applied
Decisions influenced	To what degree have CSC products and services been incorporated into specific decisions or decision-processes?	List of decisions directly influenced by specific science products and services Number and description of high consequence decision/processes influenced by specific products and services

Measure	Question	Illustrative Metrics (Note: Examples provided for some, but not all measures)
		Number or list of references to science products in formal and informal decision-making processes or protocols

Capacity Building

Measure	Question	Illustrative Metrics (Note: Examples metrics provided for some, but not all measures)
3.1. Formal Training		
Graduate student training	How many graduate students are receiving training through the CSC?	Number of supported graduate students
Post-doctoral training	How many post-doctoral fellows are receiving training through the CSC?	Number of supported post-doctoral fellows
Engagement with stakeholders	How engaged are graduate students and post-doctoral fellows in working with decision makers and other stakeholders?	Degree of engagement with end users (high, medium, low)
3.2. Partner/Stakeholder Capacity Building		
Decision maker capacity	To what degree is the CSC building capacity among decision makers and other stakeholders in the co-production and appropriate use of climate science products and services?	
Professional development and training	To what degree is the CSC developing professional capacity in the scientific and resource management communities?	Number of formal trainings courses Number of participants attending training courses

Measure	Question	Illustrative Metrics (Note: Examples metrics provided for some, but not all measures)
Innovation in capacity building	Has the center developed any innovative approaches to capacity building among partners and stakeholders?	List of innovative outreach and capacity-building approaches or products
3.3. Impact and Efficacy		
Effectiveness of capacity building	Is capacity building resulting in people and organizations using the knowledge to change practices or otherwise make a difference in planning or management outcomes?	Documented changes in practices among trained people or organizations.

Partnerships

Measure	Question	Illustrative Metrics (Note: Examples provided for some, but not all measures.)
4.1. Breadth and Scope of Engagements		
Geographic and institutional reach	To what extent does the CSC engage partners across its geographic region and across different institution types (e.g., local, state, federal, tribal, nongovernmental organization, industry)?	Number of "activities" by state Number of "activities" by institution type (federal agency, state agency, tribal, local agency, nongovernmental organization, industry, other private)
Multi-institutional collaboration	To what extent does the CSC demonstrate leadership in organizing multi-institutional collaborations?	List of multi-institutional activities (e.g., meetings, proposals, outreach, professional development) with brief description, number and types (federal, state, tribal, private) of participants, and date(s) of activity

Measure	Question	Illustrative Metrics (Note: Examples provided for some, but not all measures.)
4.2. Leverage		
Financial leverage	To what extent are partners and other expected beneficiaries of center activities co-funding those activities?	Dollar amount provided by project and activity partners of CSC efforts
In-kind leverage	To what extent are partners and other expected beneficiaries of center activities providing in-kind support for those activities?	List of in-kind partner contributions by year (e.g., personnel, access to land, facilities, computers, software)
4.3. Outcomes		
Partnerships outcomes	Are partnerships yielding desired outcomes?	Assessment of expected/desired outcomes from specific partnerships with actual results