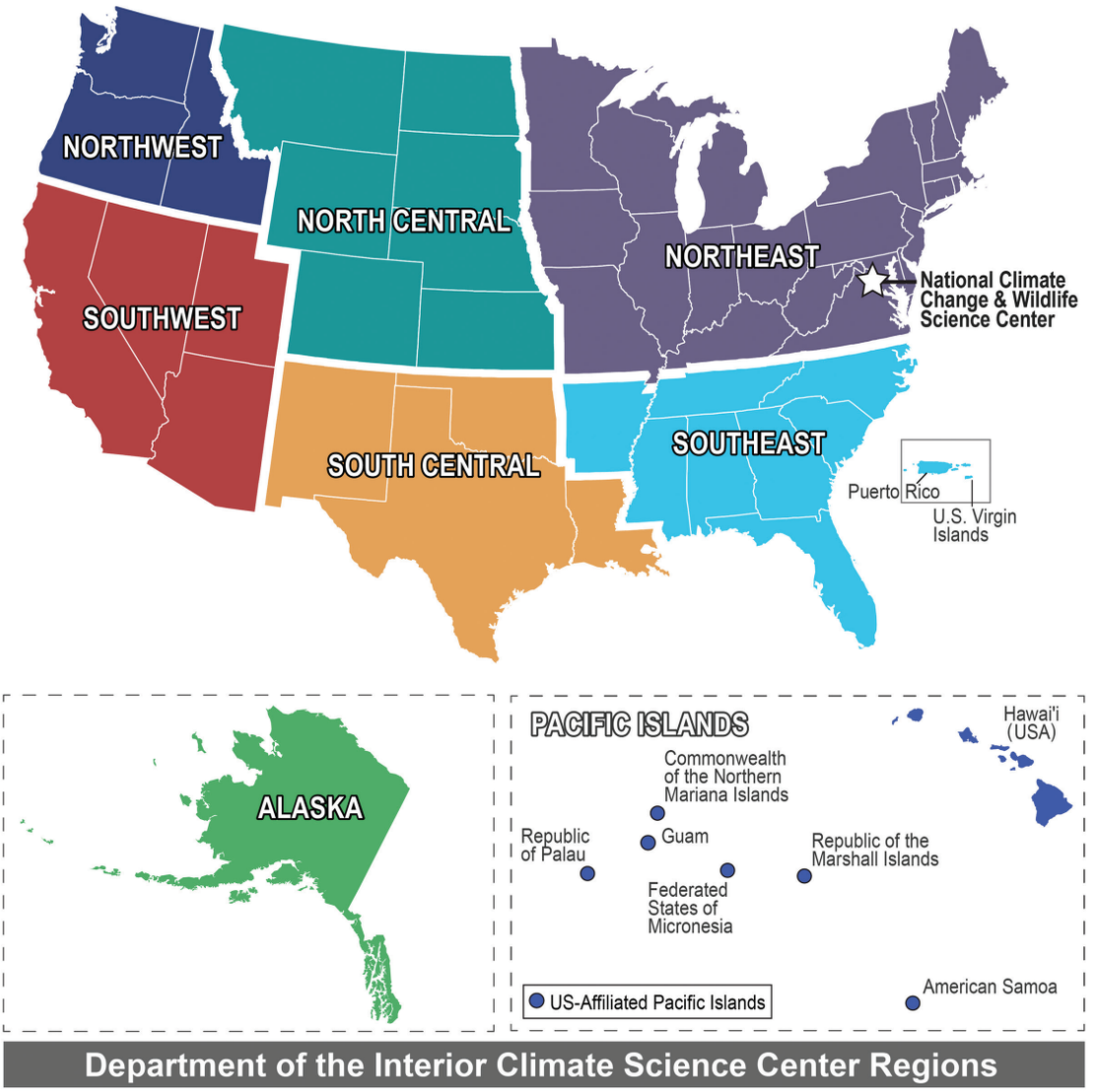
Five-Year External Reviews of the Eight Department of Interior Climate Science Centers

Northeast Climate Science Center



Department of the Interior Climate Science Center Regions

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Five-Year External Reviews of the Eight Department of Interior Climate Science Centers

Northeast Climate Science Center*

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Contents

Acknowledgments

This review involved substantial effort and time commitments from numerous individuals, particularly members of the Science Review Team who took time away from their jobs and professional commitments to prepare for the review, conduct a 3-day site visit, and assemble their findings into this report. Northeast Climate Science Center (NE CSC) staff devoted significant time to compile and provide necessary background material, hosted the week-long on-site review, answered follow-up questions, and provided substantive feedback to help improve the final report. In particular, we appreciate the contributions from the staff of the U.S. Department of the Interior NE CSC: Mary Ratnaswamy, director, and Olivia LeDee, deputy director; the staff of the University of Massachusetts NE CSC: Richard Palmer, university director/College of Engineering University of Massachusetts, Addie Rose Holland, program manager, and Jeanne Brown, communications and outreach manager; and all of the NE CSC staff and consortium university partners who participated. We greatly appreciate the assistance of the numerous science user stakeholders and science producers who participated in the survey and focus panels to share their experiences and opinions. This review was conducted under the guidance of Janet Cushing, acting chief, National Climate Change and Wildlife Science Center (now National Climate Adaptation Science Center).

Executive Summary

In 2008, the U.S. Congress authorized the establishment of the National Climate Change and Wildlife Science Center (NCCWSC; now the Climate Adaptation Science Center) within the U.S. Geological Survey (USGS), with further direction set forth in Secretarial Order 3289 (Salazar 2009). The mission of 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. Eight regional Climate Science Centers (CSCs), each a collaborative arrangement between the USGS and a regional host university, carry out this mission.

The National Climate Change and Wildlife Science Center, with the engagement of the American Fisheries Society and Cornell University, began working with independent science review teams (SRTs) to conduct reviews of individual CSCs in 2016. These reviews evaluate operational and programmatic aspects of each CSC, including the host-university relationship, to ensure that established goals and obligations are being met, as well as to identify obstacles and areas of improvement for future agreements.

The Northeast CSC (NE CSC; as of April 2018, renamed the Northeast Climate Adaptation Science Center), established in 2012, is based in Amherst, Massachusetts, with the University of Massachusetts serving as host university, coordinating a consortium of six other academic/research entities (including one tribal college and one private research institution) spread throughout the region. The NE CSC has completed its initial 5-year project cycle and is in its sixth year through a 1-year funding extension. The geographic footprint of the NE CSC is the largest of any of the eight CSCs while the proportion of federal land in this area is the smallest among the CSCs, presenting many challenges associated with climate-related issues across a vast, ecologically diverse landscape. More than 41% of the U.S. population lives within the boundaries of this region, heightening the potential impact that funded adaptation research might have on a large portion of the nation's population. Overall, the NE CSC demonstrates a strong and deep partnership between the federal and university sides of the enterprise. Consortium partners provide an extensive bench depth of research capabilities that allow the NE CSC to address the wide diversity of climate adaptation research in the region. Much of the success of the first 5 years is directly attributable to the substantial commitment of federal leadership to integrate the federal and university operations of the CSC, as well as the host-university leadership's extraordinary investment of personal and professional resources into developing the partnership.

The NE CSC has built an impressive portfolio of actionable, mostly stakeholder-driven research. The portfolio appears to be heavy on vulnerability assessment, leaving growth opportunities for adaptation science. Cumulatively, the science themes are broad and the NE CSC will benefit by revisiting these themes to sharpen the focus and better prioritize the research focus. In a region as diverse as this one, and containing a wide breadth of federal, state, and private research institutions, the NE CSC would benefit from continuing to evaluate climate change issues within subregions of the NE CSC and identifying where they can contribute most effectively, considering other ongoing research and identified needs in the region. While the research portfolio reflects a solid endpoint of the funding decisions, the process for making those funding allocation decisions to accomplish priorities was not explicit and should be clarified, including articulating clear criteria or factors for this allocation.

The NE CSC-funded research reflects a strong commitment to including stakeholders into the design of projects from the outset of projects. However, opportunities exist to ensure that end products are truly actionable to stakeholders within the mission boundaries of the NE CSC.

While the Stakeholder Advisory Committee (SAC) was instrumental in identifying initial priorities for the NE CSC, its current role is unclear and does not appear to maximize the potential advisory capabilities as originally envisioned at the formation of the CSCs. Beyond clarifying the role (and re-energizing the involvement of the committee), the NE CSC may consider expanding the SAC to include other federal

agencies with large land resource holdings in the region, such as the Department of Defense and Department of Energy among others. While the capabilities and credentials of the research community currently represented in the consortium are excellent, expanding efforts to increase gender and ethnic diversity among principal investigators would enhance the consortium partnership and likely lead to new and innovative approaches to climate adaptation research.

Like other CSCs, the NE CSC has struggled with developing metrics of success for the implementation of the actionable science that they produce. A need exists for furthering the discussion on appropriate metrics within the NE CSC as well as with the NCCWSC. The NE CSC has already made headway in this area and therefore has a great opportunity to influence that nationwide discussion.

The NE CSC has developed a robust and targeted communications capability, particularly considering the modest level of fiscal and personnel resources available for this aspect of the program. Numerous examples were presented demonstrating extremely effective communication of science to the identified stakeholder groups. The SRT recognizes the need to prioritize audiences for communication products, as the NE CSC has done, but encourages exploration of more effective ways to convey the value of the NE CSC products to agencies. Additionally, opportunities likely exist to expand the integration of the communication capabilities of consortium institutions (e.g., cooperative extension and other programs) to leverage the relatively small communications capacity of the NE CSC staff to produce a greater impact.

In summary, the SRT was extremely impressed with the accomplishments made by the NE CSC in its first 5 years. The NE CSC has served as a mechanism to unify disparate capabilities in this region to develop a focus on stakeholder-driven research into climate adaptation science. The full review report provides details and many more observations about the first 5-year cycle of the NE CSC's program along with recommendations to strengthen future planning and execution.

Abbreviations and Acronyms

ACCCNRS	Advisory Committee on Climate Change and Natural Resource Science
AFS	American Fisheries Society
CSC	Climate Science Center
CSC-Federal	Federal USGS-staffed component of the CSC
CSC-University	Host-university component of the CSC
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
FACA	Federal Advisory Committee Act
FG	focus group
GLISA	Great Lakes Integrated Sciences and Assessments
HDRU	Cornell University Human Dimensions Research Unit
LCC	Landscape Conservation Cooperative
MAFWA	Midwest Fish and Wildlife Association
NCCWSC	National Climate Change and Wildlife Science Center*
NE CSC	Northeast Climate Science Center†
NEAFWA	Northeast Association of Fish and Wildlife Agencies
NGO	nongovernmental organization
NIACS	Northern Institute of Applied Climate Science
NOAA	National Oceanic and Atmospheric Administration
PI	principal investigator
RFP	request for proposal
RISA	Regional Integrated Sciences and Assessments
SAC	Stakeholder Advisory Committee
SERDP	Strategic Environmental Research and Development Program
SIP	Science Implementation Panel
SRT	science review team
SSA	Strategic Science Agenda
TOR	Terms of Reference
UMass	University of Massachusetts–Amhearst
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service

* NCCWSC was renamed National Climate Adaptation Science Center in April 2018. However, for purposes of this report, the former name will be used since it was in place at the time of the review and provides consistency with other reports in this series.

† The Northeast Climate Science Center was renamed Northeast Climate Adaptation Science Center in April 2018, but for purposes of this review the former name is used since it was in place at the time of the review.

List of Figures

List of Tables

Introduction

Review Purpose

In 2008, the U.S. Congress authorized the establishment of the National Climate Change and Wildlife Science Center (NCCWSC) within the U.S Department of the Interior (DOI).[1] Housed administratively within the U.S. Geological Survey (USGS), NCCWSC is part of the DOI's ongoing mission to meet the challenges of climate change and its effects on wildlife and aquatic resources (TWS and ESA 2009). Further direction for NCCWSC was set forth in Secretarial Order 3289, "Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources," on September 14, 2009 (amended February 22, 2010; Salazar 2009). Through this order, the original concept of eight "climate hubs" was redefined into the DOI Climate Science Centers (CSCs) and their mission was slightly expanded to "synthesize and integrate climate change impact data and develop tools that the Department's managers and partners can use when managing the Department's land, water, fish and wildlife, and cultural heritage resources" (Salazar 2009). As a result, NCCWSC established eight regional DOI CSCs from 2010 through 2012 (Figure 1) and has responsibility for their management. For the structure of the CSCs, NCCWSC developed a dual-approach model that employs a federal USGS-staffed component (CSC-Federal) and a parallel host-university component (CSC-University) established competitively through a 5-year cooperative agreement with NCCWSC.

The Northeast Climate Science Center (NE CSC) was established in 2012, has completed its initial 5-year project cycle, and is into its sixth year through a 1-year funding extension. As such, the university hosting agreement for this CSC region is subject to a recompetition process by USGS for the host university. As part of the recompetition process, NCCWSC, with the engagement of the American Fisheries Society (AFS) and the Cornell University Human Dimensions Research Unit (HDRU), coordinated an operational and programmatic review and evaluation of the CSCs to ensure that established goals and obligations under the hosting agreements were being met, as well as to identify obstacles and areas of improvement for the CSC as a whole.

This report covers only the findings from the programmatic evaluation of the NE CSC conducted by AFS and the HDRU and does not include any findings or discussions from the operational review conducted by NCCWSC. This report also does not discuss the goal of developing recompetition recommendations, which were submitted to NCCWSC in a separate report.

NCCWSC and CSC Missions and Guiding Principles

In developing a review for the CSCs, it is important to understand their fundamental roles and audiences, as well as the services that they are expected to provide. The most basic documents for understanding this are the mission statements that NCCWSC and the CSCs have developed, based, in large part, on the directive provided in Secretarial Order 3289 (Salazar 2009). The mission statements of the NCCWSC and each CSC vary only slightly, with the CSCs including cultural resources in addition to the fish and wildlife emphasis of NCCWSC.

> The mission of 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. [USGS 2013.]

> The mission of the individual DOI CSCs 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. [USGS 2013.]

[1] Consolidated Appropriations Act of 2008, Public Law 110–161, 110th Congress (26 December 2007). In this bill, NCCWSC was referred to as the National Global Warming and Wildlife Science Center.

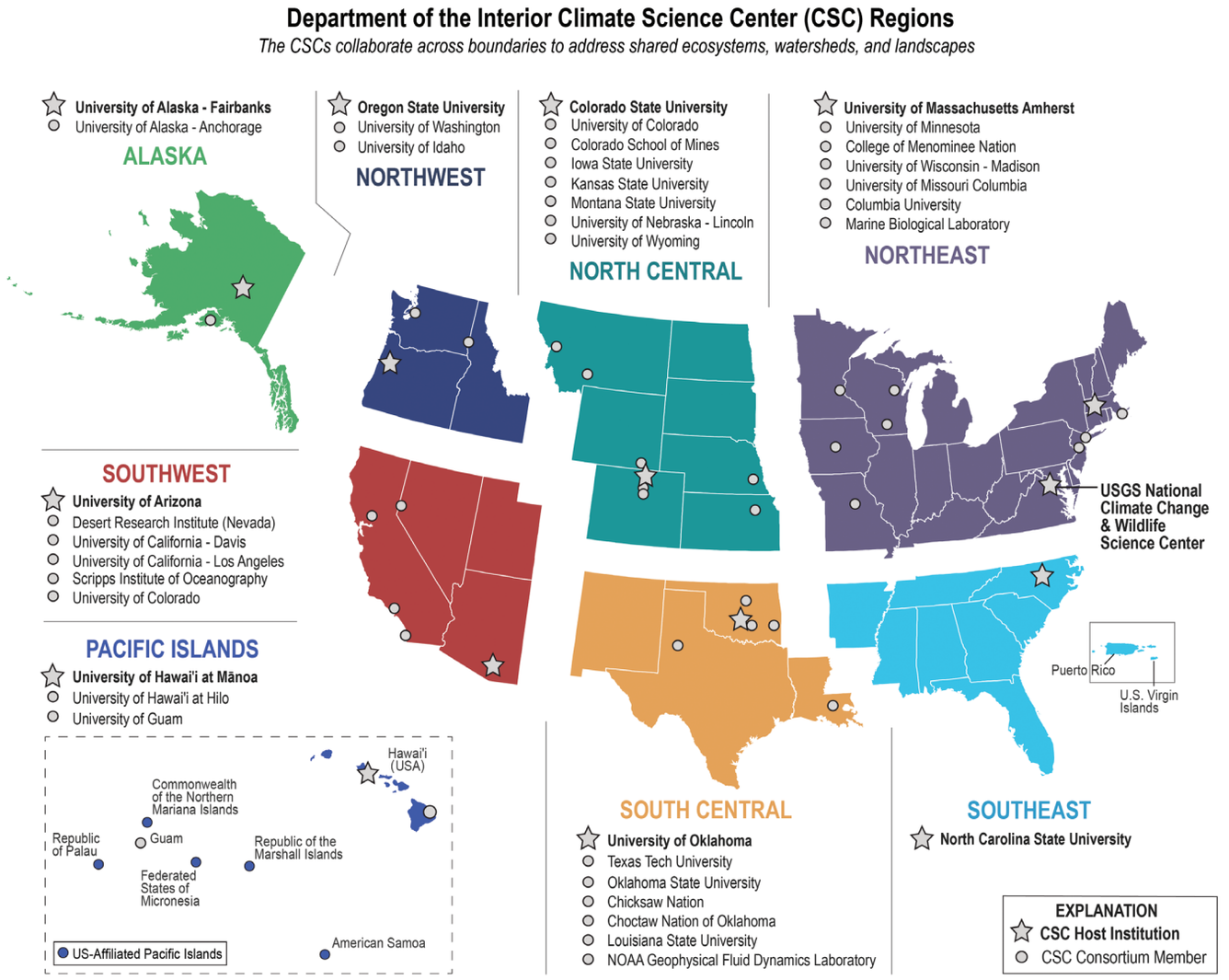

Figure 1. Map of the eight Climate Science Centers and consortiaas constituted during the period under review (2012–2017).

The NCCWSC 5-year strategy (2009–2014) was developed to guide the efforts of the NCCWSC–CSC network (NCCWSC 2009). The plan states three basic goals:

- Work in close partnership with the natural resource management communities to understand their highest priority science needs regarding climate change impacts, and determine what is needed to fill those knowledge gaps.
- Work with the scientific community to develop the science information and tools in such a way that they can be readily used to generate management strategies for responding to climate change.
- Deliver these relevant tools and information in a timely and useful way directly to resource managers.

The NCCWSC strategic plan (2009–2014) also identifies priority scientific activities to help meet its mission and goals:

- Use and create high-resolution climate modeling information and derivative products in order to produce key information that is needed to forecast ecological and population response at national, regional, and local levels.
- Integrate physical climate models with ecological, habitat, and population response models.
- Forecast fish and wildlife population and habitat changes in response to climate change.

- Assess the vulnerability and risk of species and habitats to climate change.
- Develop standardized approaches to modeling and monitoring techniques in order to facilitate the linkage of existing monitoring efforts to climate models and ecological/biological response models.

The NCCWSC proposed 5-year strategy states that a key component of the NCCWSC–CSC network is to work with partners. Two major groupings of partners include (1) science partners (e.g., federal agencies, universities, scientific societies, and other nongovernmental organizations [NGOs]); and (2) conservation partners, which cover a broad category of those working to apply conservation (e.g., state and federal natural resources agencies, conservation NGOs). It is important to note that these two primary partner groups are not discrete and sometimes have overlapping membership. For example, many conservation partners are also science producers (e.g., Ph.D.-level U.S. Fish and Wildlife Service [USFWS] biologists). A major indicator of success of the NCCWSC–CSC network is, therefore, the degree to which partners are effectively engaged and benefit from the work of the NCCWSC–CSC network.

Recognizing that no single agency or organization has the capacity to effectively address the challenges of climate change, the DOI, through Secretarial Order 3289 (Salazar 2009), launched a network of Landscape Conservation Cooperatives (LCCs) around the same time period as the establishment of NCCWSC and then the CSCs. The LCCs were developed to organize and coordinate large-scale conservation efforts through a partnership approach. The LCCs are primary CSC partners and consist of natural and cultural resource managers from federal, state, tribal, and other entities whose mandate is to work collectively to identify key resource issues and provide information and other support for integrated, landscape-scale conservation planning. The LCC network currently includes 22 geographic units across North America, the Caribbean, and U.S.-affiliated Pacific Islands, delivering unprecedented collaboration across jurisdictional boundaries (Figure 2).

The process of identifying the CSCs began in fiscal year 2010 with the identification of the University of Alaska as the location of the first CSC, after which the USGS initiated a competitive selection of host institutions for the additional centers (NCCWSC 2011). The Alaska, Northwest, and Southeast CSCs were formally established in September 2010, with fiscal year 2010 funds (NCCWSC 2011). Implementation of the Southwest and North Central CSCs was delayed by the late passage of appropriations legislation for fiscal year 2011, and these centers were established in June 2011 (NCCWSC 2011). The final three CSCs were established formally in March 2012 (Northeast, South Central, and Pacific Islands), completing the planned suite of eight regional CSCs (Varela-Acevedo and O'Malley 2013).

The NCCWSC–CSC network is committed to a partnership-driven model (NCCWSC 2011). As such, the CSC scientific agenda is not driven by an a priori national science agenda, but rather through the identified needs of the LCCs, as well as other land, water, wildlife, and other natural and cultural resource managers (NCCWSC 2011). All of the CSCs employ some form of a Stakeholder Advisory Committee (SAC) as a means of formally engaging partners in the strategic direction of the CSC. The SAC is intended to provide a vehicle for building collaborative partnerships, identifying key regional science priorities, and communicating and coordinating results and objectives across regional stakeholder agencies and organizations. NCCWSC established a set of guidelines in the CSC SAC Terms of Reference (TOR), which defines membership, primary purpose, and other operating guidance (NCCWSC 2014). The SACs are compliant with the operating principles of the Federal Advisory Committee Act (FACA) but are not officially chartered under the provisions of that act. As outlined, the CSC federal director, with input and guidance from its SAC, is to develop a 5-year strategic plan, as well as annual work plans that drive science priorities and requests for proposals (RFPs; Jones and Dalton 2012). Regional priorities should be reconciled with input from NCCWSC, advisory committees, and other CSCs to build a higher-level national-scale agenda. This supports the identification of multi-CSC needs and ideas in addition to the opportunity to more effectively leverage resources. Together, the NCCWSC–CSC network forms the cornerstones of DOI's integrated approach to climate change sci-

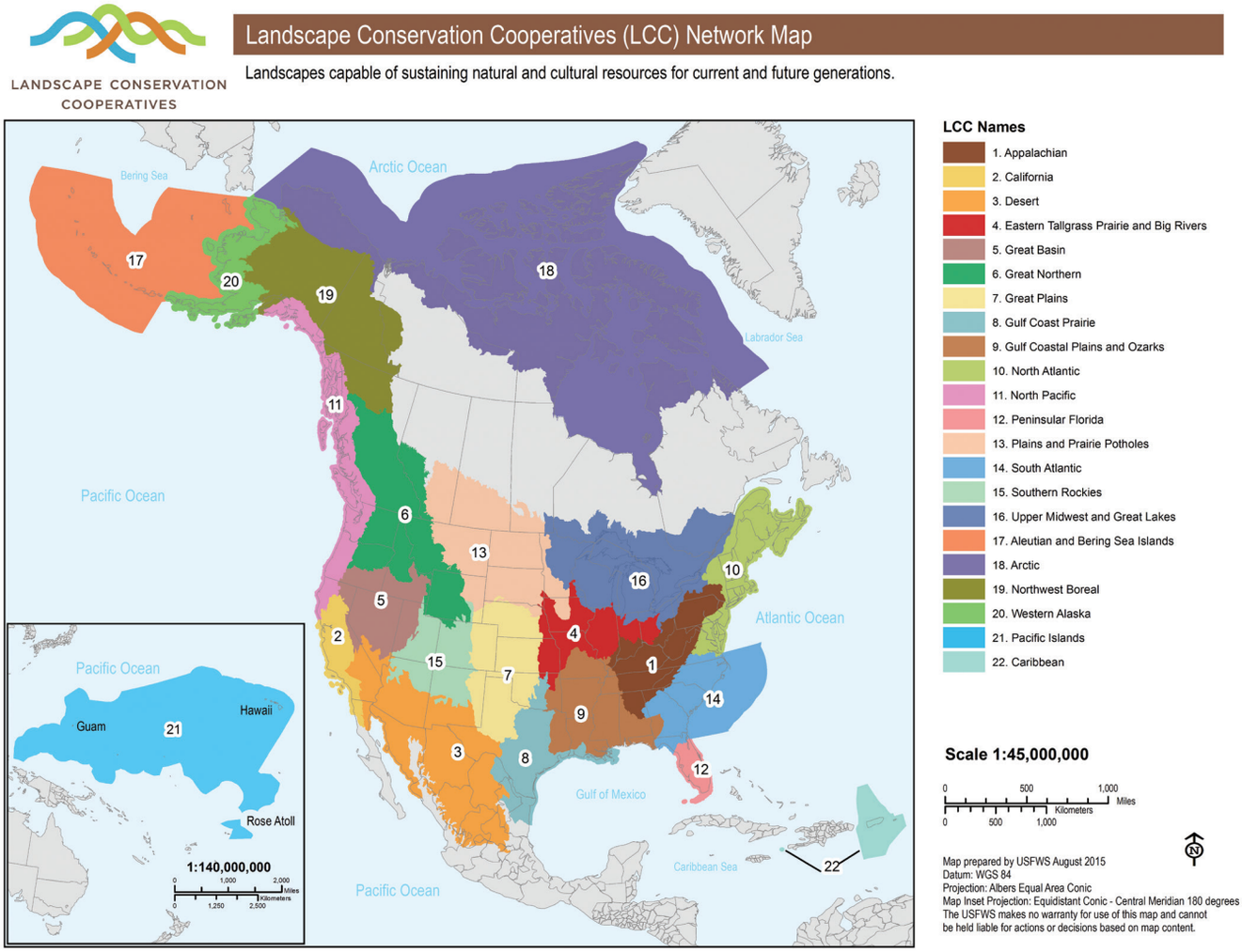

Figure 2. Map of the 22 Landscape Conservation Cooperatives.

ence and adaptation and assesses climate impacts that typically extend beyond the borders of any single land-management agency unit.

Review Process

Roles of AFS, the HDRU, and NCCWSC

The CSC evaluation consisted of two parts: an external programmatic review led by AFS and the HDRU and an internal operational review led by NCCWSC, which is not addressed in this report. To evaluate the performance of the host university, AFS and the HDRU established a Science Review Team (SRT) for each CSC. An SRT consisted of a team of up to five non-CSC affiliated experts selected through a national solicitation and review of credentials, as well as a nonvoting USGS science center director who served as chair and a CSC federal director from outside the reviewed CSC (both selected by the NCCWSC deputy chief; Appendix A). The American Fisheries Society was tasked with assembling the SRTs, developing review metrics, managing the on-site review process (data collection, interviews, and discussions), and developing review reports from evaluation findings, as well as logistical planning (travel, lodging, and food).

Human Dimensions Research Unit investigators focused on the evaluation of CSC partnerships. During on-site reviews, the HDRU interviewed stakeholders and partners to assess the quality and extent of partnership involvement with the respective CSC. Using the interview data, the HDRU constructed a

standardized survey that was sent out to all current and past CSC partners in each region to identify patterns of engagement with the CSCs, as well as barriers to engagement.

The NE CSC on-site review was conducted over a period of 3 days (October 31–November 2, 2017) in Amherst, Massachusetts, on the campus of the University of Massachusetts–Amherst (UMass; Appendix B). The review process was designed to develop a full understanding of the NE CSC. The review included the administrative structure, foundational documents and processes (e.g., strategic and science planning), research projects, communications of results, and engagement of stakeholders and others in an actionable science pathway approach that includes assessment of the utility of the science products.

Program Evaluation Measures for CSCs

Currently, no standard systemwide CSC performance measures (e.g., specific deliverables or activities completed by given dates) exist. Each CSC was established within the general frameworks of both the NCCWSC and CSC missions and in response to the needs of their region. As described in the review findings, the NE CSC developed a region-specific strategic science and operational plan and annual work plans. These plans establish objectives within the seven strategic science plan themes. While these science themes could provide a basis for assessment, they are not consistent across the CSCs and are more reflective of activities than measures of impact. As a result, the construction of the CSC reviews sought other models upon which to construct the review process.

The Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS) was a multi-stakeholder federal advisory committee established by the DOI in 2012, chartered under FACA, to provide guidance and input on the overall NCCWSC–CSC network (USGS 2012). The committee had 25 members from the DOI, other federal agencies, state and local governments, tribal nations and partners, NGOs, academia, and the private sector (USGS 2012).

In the "Report to the Secretary of the Interior, March 30, 2015" (ACCCNRS 2015), ACCCNRS provided recommendations to the Secretary of the Interior to enhance the CSC program, including program evaluation. The committee recommended that the following four-part framework be used when developing new CSC agreements and conducting CSC program evaluations:

- 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.
- 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 CSC and through its external grant funding.
- Capacity building: These measures are intended to capture how well the CSC is building capacity for conducting and applying actionable science, with an emphasis on formal training (e.g., of graduate students and postdoctoral 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 CSC 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.

While the ACCCNRS report was released several years after the formation of the CSCs and therefore cannot be applied as a definitive measure of effectiveness to the CSC's in retrospect, these general categories provide a useful framework under which to organize review findings and are applied in this report. Although the NE CSC initiation predates the ACCCNRS report, the original NE CSC project proposal highlights themes of partnerships and stakeholder-driven climate science, which are further developed but consistent with the ACCCNRS framework.

Survey and Focus Group Methodologies[2]

The partnership evaluation component of the CSC review, conducted under the lead of the HDRU, was designed to measure the quality and extent of partnership involvement at each CSC. The activity focused on the following questions:

- To what extent are science users and producers involved with the CSC?
- What are the predictors of this involvement? What limits involvement?
- To what extent do partners believe the CSC is producing actionable science?
- To what extent are CSC-affiliated science users and producers involved in coproduction? What are the predictors of this involvement?
- To what extent does the CSC play a role as a boundary organization, facilitating the co-production of actionable science? What characterizes that role?

This component of the CSC review consisted of two activities: a series of group interviews and a standardized Web-based survey.

Group interviews.—Two group interviews were conducted with partners of the NE CSC during the site visit. The purpose of the group interviews was to understand the range of perspectives and experiences of CSC partners in relation to their work with the NE CSC. Two groups were included: science producers (or science partners) and science users (or conservation partners).

Participants were recruited by the NE CSC with guidance from the HDRU with the intent to include participants representing a diversity of organizations and regions. Participants in the science producers group included faculty members, graduate students, and/or postdoctoral associates that had received research funding from the NE CSC. Participants in the science users group included representatives of agencies intended to benefit from the science produced by the NE CSC, including LCCs, federal natural resource agencies, state fish and wildlife agencies, tribal organizations, and NGOs. Twelve science producers and nine science users participated in the two group interviews during the on-site visit.

Each interview consisted of a semi-structured conversation guided by a series of open-ended questions (Appendix C) and lasted approximately 2 hours. The questions were designed to explore how partners contributed to the work of the NE CSC and the factors that influenced the ability of the NE CSC to work with their partners. The specific topics of questions focused on how participants have worked with the NE CSC, reasons for becoming involved with the NE CSC, benefits of involvement with the NE CSC, challenges to involvement, and what the NE CSC could do to promote even more benefits from involvement.

Particular focus was placed on exploring how the NE CSC contributed to the coproduction of science and the generation of actionable science, with questions about interactions between science producers and science users and the role of the NE CSC in connecting them.

Web-based survey—A standardized, Web-based survey of partners and potential partners of the CSCs was conducted, referred to herein as the HDRU survey (Lauber and Stedman 2018). An initial sample for the survey was compiled from science producers and science users identified by each CSC, LCC staff and steering committee members within each CSC region, and members of the Association of Fish and Wildlife Agencies Climate Science Committee. The Northeast survey was sent to a total of 501 individuals, with 254 responding. The survey documented the ways in which partners were engaged with the NE CSC and the factors affecting their engagement. The survey questions (Appendix D) were developed based on insights from group interviews conducted in previous CSC reviews and a review of the scholarly literature. The question topics included

- Nature of respondents' work
- Perspectives on the importance of addressing climate change

[2] The material in this section is a modified version of material presented in Dayer et al. (2016).

- Extent of involvement with the CSC
- Benefits of involvement with the CSC
- Limitations on involvement with the CSC
- Perceptions of climate adaptation science

For science users,

- Use of climate adaptation science
- Limitations on use of climate adaptation science
- Importance of and engagement in coproduction of science
- Limitations on coproduction of science

For science producers,

- Use of climate adaptation science produced by others
- Limitations on others' use of climate adaptation science
- Importance of and engagement in coproduction of science
- Perceptions of the role of the CSC

The same survey instrument was used for all the CSCs, with minor changes to reflect the region referenced.

Individuals were e-mailed at the initiation of the survey and provided with a link to a Web-based questionnaire. Individuals who did not respond to the first request received up to five additional requests to complete the questionnaire by e-mail. The Web-based survey instrument was programmed and administered using Qualtrics, which provides a means of soliciting participation in a survey via e-mail and recording responses. Qualtrics assigns each individual a unique Web link to prevent individuals outside our study population from participating in the survey and prevent access to survey data by anyone other than the research team. Implementation of survey began on September 6, 2017 and concluded on October 4, 2017. A short (5 minute) telephone survey of nonrespondents to the Web-based survey was conducted by the Cornell University Survey Research Institute from October 11 to November 9, 2017. The survey questions included a sample of questions from the Web-based survey to determine whether and how nonrespondents differ from respondents on key criteria. Twenty-five nonrespondents completed the questionnaire.

Institutional Development

Summary Observations of the NE CSC Science Review Team

The rapid development of the NE CSC has been impressive, particularly since the geographic coverage is very large, encompassing a vast variety of habitats, ecosystems, and relevant human organizations. This scope presents special challenges, and meeting those challenges is a theme that underlies the content of this report. As independent, outside reviewers, the SRT seeks to help the NE CSC members view their program more comprehensively and thereby assist the NE CSC to build a stronger program for the future.

In general, the NE CSC recognizes the substantial scope of their charge and has worked to meet it with considerable success. However, fully meeting the goals over such a large geographic expanse is likely an impossible charge given the resources available. The NE CSC and partners may benefit from a greater introspection and expressed awareness of the enormous scope of the charge through a thorough inventory of the research coverage of all entities and identifying areas where others are already addressing needs as well as unserved or underserved areas. This would lead to more explicit and strategic choices of the areas where the NE CSC will, and will not, seek to contribute to future climate science research in this region. The SRT suggests several different ways that such strategic choices may be structured, recognizing that more than one such construct may be helpful. We note that *strategically* leaving out areas of work will not be detrimental to climate science in the Northeast region because (1) solid climate science research work

in well-defined areas will be appreciated, and (2) a thorough review of all climate science research will identify areas where other groups are better positioned to address climate science issues in the region. The SRT was very impressed with the thoughtful, professional, and vibrant staff assembled into the NE CSC and the considerable and commendable efforts to keep the NE CSC well integrated. We have no doubt that such a group can meet the need for more big-picture strategic planning.

The NE CSC staff exhibits an incredible amount of energy and dedication and an impressive work ethic on both the university and federal sides with a vibrant community and wide breadth of expertise and talents.

NCCWSC has established a very strong and deliberate approach to scientific work for the constituent CSCs: products must be actionable science and should be coproduced with the users of that science (although these were attributes introduced after the initial establishment of the CSCs). These concepts are fundamental to the operations of the NE CSC as well, although they can be more fully developed conceptually and in an operational sense. While the responsibility to define these concepts is not solely that of the NE CSC, opportunities exist for the NE CSC to fully operationalize these concepts for local purposes as well as to contribute to the national discussion with NCCWSC.

A consistent theme appearing throughout this report is that a more focused mission, better-defined practice of actionable science, and periodic evaluation of the impact of NE CSC work should guide future allocation of resources. Further, there are many types of users or consumers of information; carefully defining the end-consumers of each communication product would strengthen the implementation of the NE CSC communication aspects.

NE CSC Development

The NE CSC has been charged with conducting actionable climate-adaptation science for an extensive and diverse section of the United States. The region encompasses 22 states and the U.S. portions of the Great Lakes in an area bounded by Minnesota, Missouri, Virginia, and Maine. This large area spans a daunting diversity of climatic, geological, ecological, and social systems. The region contains 41% of the U.S. population (131 million people) and a very large number of regional, state, and local institutions involved with, or impacting the implementation of, climate-related research. Many of these institutions share overlapping interests with those of the NE CSC, either as potential partners or as users of NE CSC science. While the land area identified by DOI as the NE CSC footprint is the largest of any of the eight CSCs, the proportion of federal land in this area is the smallest among the CSCs. This geographic diversity and widespread operational relevance present the NE CSC with its greatest challenge while also providing unique opportunities for making impacts.

The NE CSC was established in 2012 following the model established by the NCCWSC: a university consortium (led by a host university) was established to form a partnership with the USGS office (colocated with the host university). The NE CSC is hosted by UMass in partnership with three land grant universities (University of Minnesota, University of Missouri–Columbia, and University of Wisconsin–Madison), a tribal college (College of Menominee Nation), a private university (Columbia University), and a private, nonprofit research institution (Marine Biological Laboratory, an affiliate of the University of Chicago located in Woods Hole, Massachusetts), collectively comprising the university consortium. In addition to consortium institution faculty and scientists, partnerships have been developed with numerous state and federal agency scientists and managers and NGOs during the initial 5-year performance period. As noted earlier, the NE CSC encompasses a large geographic area containing numerous state, private, and federal administrative entities as well as diverse environments. Sensitive natural resources in the region may be threatened by complex natural processes and human actions, a variety of land ownership and administrative types that complicate resource management

coordination, and emerging climate challenges that can be best examined with transdisciplinary, collaborative science.

The consortium institutions provide extensive expertise and collective knowledge relevant to the region's diverse climate system processes and components and develop science-based information and tools to inform strategies for climate adaptation. The NE CSC annually receives and distributes funds to the host university for operations (facilities, travel, supplies, outreach, science, education, and programmatic support to consortium universities), science (distributed through RFPs or direct noncompetitive awards to consortium partners or USGS centers), federal administrative and science services costs, and federal travel and operating expenses. Since 2012, the NE CSC received and expended $14.8 million (averaging $3.1 million annually) for research, training, communication, and administration. Approximately half of the funds were used by the host and consortium universities (averaging $107,776 annually to each) to support graduate and postdoctoral students, administrative costs, travel, and research supplies (Table 1). The host agreement provides an indirect rate of 51.5% (which is a 12.7% overhead reduction from the normal 59%), but for pass-through funds to other consortium partners, indirect is only assessed on the first $25,000 of the award, even if it is a multi-year award.[3] Additionally, UMass leverages resources such as office space and equipment, maintenance and operations support, and facilitated interactions with conservation partners. Additionally, since 2012, the NE CSC has awarded $5.3 million to projects through RFP competition and direct-funded projects. The total funding is nearly evenly split between USGS ($2,289,510) and university ($2,529,542) principal investigators (PIs), with additional awards through interagency agreements ($488,860) to the U.S. Forest Service and the U.S. Fish and Wildlife Service (Table 1).

Both the federal office and the UMass-led university consortium are now well developed with excellent staff and one of the larger staffs among the CSCs nationwide. The university consortium has intentionally recruited members from institutions across the region, including the College of the Menominee Nation. The federal NE CSC office employs four permanent staff: a federal director providing leadership and oversight of the CSC, a deputy director providing leadership in the development and implementation of CSC strategic operations, a science coordinator assisting with the implementation of the Strategic Science Agenda (SSA), and a research ecologist leading research initiatives related to natural resource management and habitat and species conservation (Holland et al. 2017)). The research conducted by all CSCs is inherently collaborative, with the main collaboration between the university and federal administrators and producers of information related to climate science. This collaboration requires substantial effort, and the NE CSC has clearly invested significant effort in fostering appropriate collaborations. The efforts to maintain the USGS–UMass partnership and the coordination among far-flung university members of the consortium are impressive and commendable. This appears to flow from the commitment to coordination by the co-directors of the NE CSC.

Clearly, the host-university CSC director has invested an extraordinary amount of personal and professional resources into developing the NE CSC, beyond what is generally expected, while the USGS CSC director has gone out of her way to fully integrate the federal side into this enterprise.

The challenge for the NE CSC is to find a way to meet the mission for the entire, incredibly diverse, northeast region. In general terms, that mission is

> to increase understanding of climate change and to coordinate an effective response in its impacts on tribes, and the land, water, oceans, fish and wildlife, and cultural heritage resources. [NE CSC 2014:4.]

[3] From Budget Justification-University of Massachusetts Amherst, original DOI Budget Summary of Cooperative Agreement.

Table 1. Full budget and breakdowns by consortium member and funding mechanism of the Northeast Climate Science Center (NE CSC). (Source: Holland et al. 2017.)

A. Full budget of NE CSC

	Fiscal year					
Category	2012	2013	2014	2015	2016	Total
Science (directed and request for proposal [RFP])	$632,550	$1,441,872	$1,284,835	$1,023,000	$925,655	$5,307,913
Host agreement	$1,499,065	$1,494,883	$1,494,551	$1,492,881	$1,495,710	$7,477,090
Personnel (federal)	$325,523	$207,676	$224,428	$469,328	$554,589	$1,781,544
Travel and operating expenses (federal)	$46,577	$39,452	$20,737	$37,672	$49,659	$194,096
Total	$2,503,715	$3,183,883	$3,024,551	$3,022,881	$3,025,613	$14,760,643

B. University consortium budgets for the NE CSC

	Year					
Consortium institution	1	2	3	4	5	Total
University of Massachusetts	$880,256	$866,896	$848,202	$830,868	$817,588	$4,243,810
Columbia	$98,836	$101,199	$104,111	$107,361	$107,955	$519,462
College of Menominee Nation	$90,391	$91,610	$95,904	$96,946	$100,780	$475,631
Marine Biology Lab	$100,454	$102,369	$104,319	$106,309	$108,338	$521,789
University of Minnesota	$118,999	$120,427	$124,041	$127,763	$131,594	$622,824
University of Wisconsin	$100,170	$101,211	$103,361	$105,575	$107,855	$518,172
University of Missouri	$109,959	$111,172	$114,613	$118,059	$121,600	$575,403
Total	$1,499,065	$1,494,884	$1,494,551	$1,492,881	$1,495,710	$7,477,091

C. Directed and RFP project allocations by category

	Fiscal year					
Category	2012	2013	2014	2015	2016	Total
University	$259,367	$635,590	$497,804	$607,379	$529,401	$2,529,542
U.S. Geological Survey	$373,183	$596,281	$767,031	$275,621	$277,394	$2,289,510
Other federal agencies	–	$210,000	$20,000	$140,000	$118,860	$488,860
Total	$632,550	$1,441,872	$1,284,835	$1,023,000	$925,655	$5,307,913

This is an impossibly large task for an organization the size of the NE CSC to fully accomplish and should thus be viewed as an aspirational goal. The good news is that there are a large number of other institutions that focus on related issues in the region. Nonetheless, the task of carving out an appropriate subset of tasks that fall within the CSC mission is crucial to the NE CSC. At the establishment, the intention was that LCCs would be the primary external users of information produced by the CSCs and that the LCCs within the Northeast region would hence provide most of the direction for the work of the NE CSC. However, the work of the NE CSC has a broader potential reach than only federal lands covered by LCCs in the region given that there are many other institutions in the region that can benefit from CSC support and collaboration.

The NE CSC has a daunting charge to cover myriad issues across a large geographic area, and the resources are limited; clearly, much effort has gone into developing/guiding the program to meet the challenges.

The amount and quality of research undertaken by the NE CSC are impressive and have been directed towards meeting the broad mission of the NE CSC. The challenge is clarifying the mission and selecting goals so that the greatest impact can be made. The SRT recommends that the NE CSC conduct an analysis of gaps in climate change/climate adaptation information as well as ongoing initiatives across the Northeast region to help inform future activities of the NE CSC and identify future priorities. The task will not be trivial in that there are so many others working in this field. The niche of the NE CSC might be defined in many ways as described below, but one feature that separates the work of the CSCs from others is the methodology of actionable science. This concept would benefit from being operationalized more explicitly.

The SAC and the Science Implementation Panel

The NE CSC utilizes two formal bodies to provide input and feedback into their programs: the SAC and the Science Implementation Panel (SIP). The SAC for the NE CSC is an advisory body of federal, state, and tribal representatives with regional interests whose purpose is to advise the NE CSC on (1) the development and updating of the strategic science agenda, (2) the development of NE CSC planning and implementation documents, and (3) the effectiveness of NE CSC products in meeting the needs of stakeholders. The SAC also includes representatives from the LCCs in the NE CSC operational area (Eastern Tallgrass Prairie and Big Rivers, North Atlantic, Upper Midwest and Great Lakes, Gulf Coastal Plains and Ozarks, Plains and Prairie Potholes, and Appalachian). The SAC operates under guidance provided by NCCWSC in the TOR. The NE CSC SSA was developed with SAC input and concurrence. In addition, the NE CSC benefits from higher administrative levels in other federal spheres knowing how the NE CSC may be contributing to their own missions. However, the NE CSC has struggled to put the SAC to its best use, due to structural and other issues. First, the group meets annually or less frequently, and often the representatives at the meetings are acting for actual committee members. These substitutes, while presumably well qualified to serve as representatives, may not have the organizational reach to disseminate the benefits of the NE CSC work throughout their respective organizations. Second, the scope of work for the NE CSC is broader than represented by the initial membership of the SAC. The SAC is compliant with the provisions of the Federal Advisory Committee Act but is not officially chartered under FACA and therefore is composed of federal and state government and tribal representatives only who are chosen to represent a broad geographic diversity. Compliance with FACA provisions has limited the scope of advice and guidance that the SAC could provide, although the NE CSC may engage NGOs in other innovative ways. Third, and perhaps unavoidably, some of the members of the SAC have their own climate science work ongoing and some territorial bias may be inherent in the guidance received. Nevertheless, given the limited budget available to CSCs, more could be done to leverage efforts of other federal agencies, such as

the U.S. Department of Energy (DOE), Department of Defense (DOD; e.g., Strategic Environmental Research and Development Program [SERDP]), and the National Oceanic and Atmospheric Administration (NOAA; whose involvement, although represented on the SAC, was not clear to the SRT). These agencies may be better funded and should be seen as an additional resource to leverage the capabilities of the NE CSC. In addition, integration across agencies can help to inoculate climate science efforts from political vagaries as they shift between preferences for funding (e.g., for military versus environmental spending). Toward this goal, the SAC will be useful in developing a more directed NE CSC focus on the goals to meet scientific gaps and in promoting collaborations with other agencies to take advantage of, and enhance the actionability of, existing products.

The SIP has proven to be more useful on an ongoing basis (more frequent meetings, more technical knowledge), but the membership of this panel seems to overlap in ways that may make its work redundant with other coordination activities. Evidently, SIP members are often the same individuals who act as substitutes for the SAC and often are members of the LCCs. Overall, we recommend that a more organized set of advisors may be useful; the challenge in making this work is that knowledgeable persons are busy with their own work as well.

The role of the SAC as used in the NE CSC is unclear, but it does not appear to fulfill the role as originally envisioned at the formation of the CSCs. We encourage the NE CSC to explore more effective ways to convey the value of the CSC to agencies

Strategic Science Agenda

The NE CSC SSA establishes the NE CSC's science priorities. The SSA identifies the NE CSC's overall goals and guides the research portfolio addressing seven themes through a competitive RFP process or direct funding of projects. The SSA was developed through review of partner and stakeholder operational plans and priorities, with feedback gathered via interviews, surveys, meetings, and workshops during 2013. The information gathered during these exchanges was incorporated into the final SSA in 2014 in collaboration with the host and university consortium partners.

The SSA identifies four goals:

- climate science and global change research
- education and training
- information management and data sharing
- monitoring and observation

These goals are to be achieved through research and other activities that address the seven science themes (Figure 3). These science themes are addressed in individual projects that contribute to one or more of the themes, which are not mutually exclusive. The themes are tiered, with climate projections (theme 1) evaluated for effects on land cover/land use (theme 2), freshwater resources (theme 3), and Atlantic and Great Lakes coastal and nearshore habitats (theme 4), to reveal factors contributing to species (theme 5) and cultural-resource (theme 6) vulnerabilities to climate variability and change, and culminating in development of decision support frameworks to evaluate risk and guide conservation and management with respect to climate change (theme 7).

Implementing the SSA.—The SSA is implemented by the NE CSC's federal director and science coordinator through development of an annual work plan that addresses partner and stakeholder information needs, fills information gaps, and balances the research portfolio across the seven science themes. This plan annually identifies science priorities (determined through discussions with the SAC, the SIP, and selected stakeholders) to be addressed with either directed research or through an RFP process. The RFP

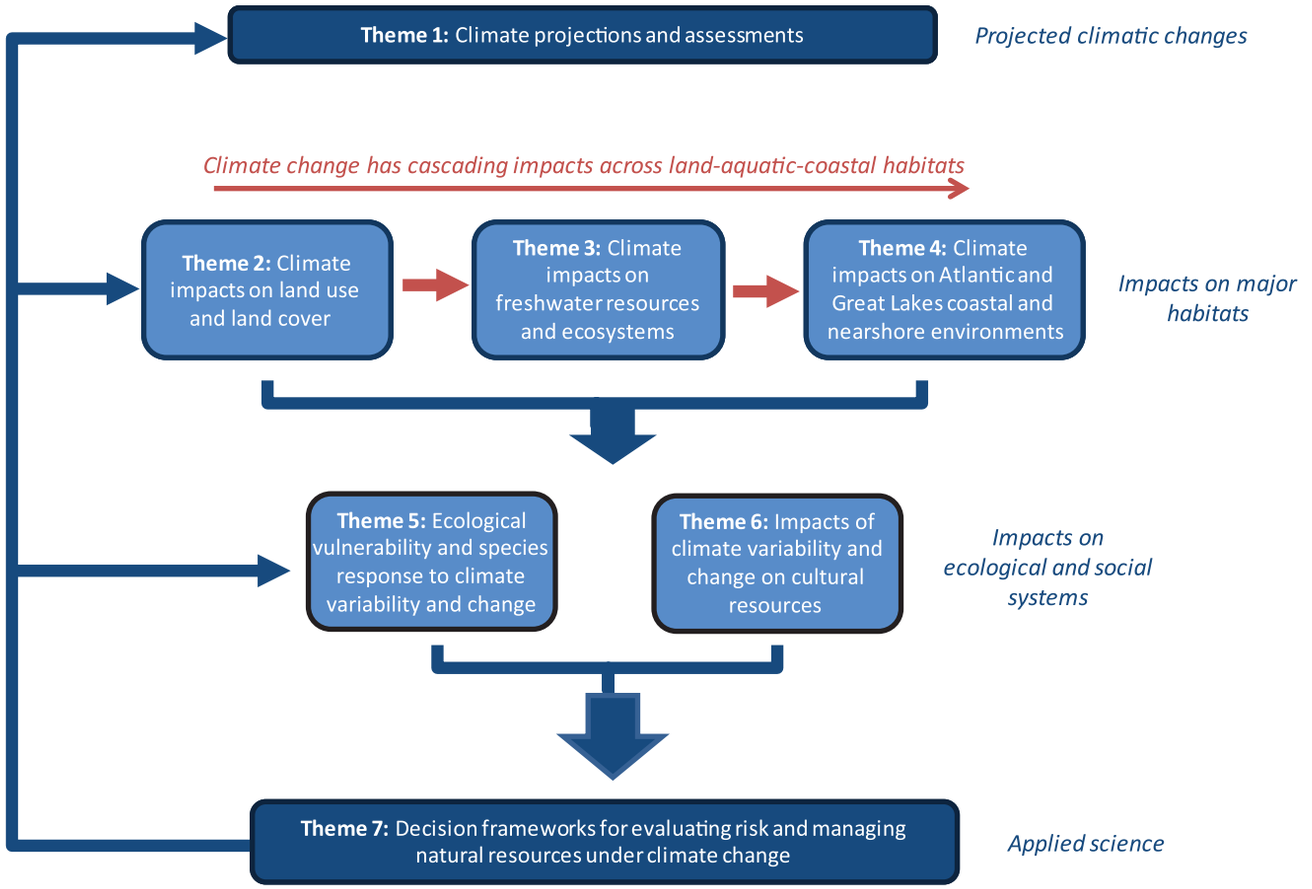

Figure 3. Seven science themes identified by the Northeast Climate Science Center. (Source: Holland et al. 2017.)

topics are determined by the NE CSC federal director, deputy director, and science coordinator and serves as the NE CSC's annual work plan. The projects selected for direct funding, as well as those receiving funding via the RFP, are reviewed technically by the SAC, the SIP, and selected stakeholders to identify those with greatest merit and those that address regional science priorities.[4] Annually, the NE CSC host university and consortium PIs develop an implementation plan to address the science goals for the fiscal year.

The SRT is impressed with the breadth of research projects conducted during the NE CSC's first 5 years. The NE CSC initiated 95 projects resulting in 238 peer-reviewed publications and numerous Web-platform tools, brochures, data sets, fact sheets, and other outreach materials. The NE CSC summarizes each year's activities in annual reports highlighting outreach, selected scientists and graduate students, noteworthy research accomplishments, expertise of the NE CSC's PIs, and research to be initiated in the next year. The NE CSC Web site (https://NE CSC.umass.edu) archives these annual reports as well as the extensive array of products developed through the NE CSC's research and outreach. The SRT commends the NE CSC for the design of the Web page and high-quality presentation of their work. The team encourages the NE CSC to continue to broaden the distribution of the Web page to diverse audiences to expand public awareness of their work.

The host university and consortium scientists clearly strive to ensure product relevance to decision makers. Each project is evaluated with respect to the question "What are the stakeholder needs that are being met through this project?" By organizational design, primary stakeholders for the CSCs are LCCs within the same region. In addition, other entities that can benefit from climate adaptation science have been identified. However, the NE CSC research portfolio has not supported the LCCs in the western part

[4] Refer to http://necsc.umass.edu/ for a current list of projects.

of the region (e.g., Eastern Tallgrass Prairie and Big Rivers LCC) to the same extent as the North Atlantic LCC. This may be an area to explore in the NE CSC's next strategic plan, or to *explicitly* leave to others to support, depending on the outcome of overall planning within the NE CSC.

The NE CSC's strategy for ensuring relevance is to coproduce science with their stakeholders. Stakeholder testimonials and example projects presented during the review attest to the utility of the science and the importance of NE CSC's products. However, it is not clear how the NE CSC identifies the most appropriate product format for different audiences, and whether utility of science products should differ between stakeholders versus other end users. Additionally, some stakeholders expressed difficulties assimilating the vast amount of scientific information produced and identifying relevance to their management issue. The NE CSC survey of stakeholders and focus group (FG) interviews conducted by the HDRU (Figure 4; Lauber and Stedman 2018) found

> The only factor that a majority of science users thought was limiting the use of CSC science was management issues not being well defined (51%). Neither group considered a lack of quality of the science to be a problem (science users—2%; science producers—7%).

The discussion of limitations on the use of CSC science in the focus groups surfaced a greater number of concerns. Both science producers and science users thought that making science accessible to users was a challenge:

> I think the challenge then comes back to us ... how do we take the science ... is there some way, some framework we can put it in, some tool we can use, that makes it easier for them? [Northeast Producer FG.]

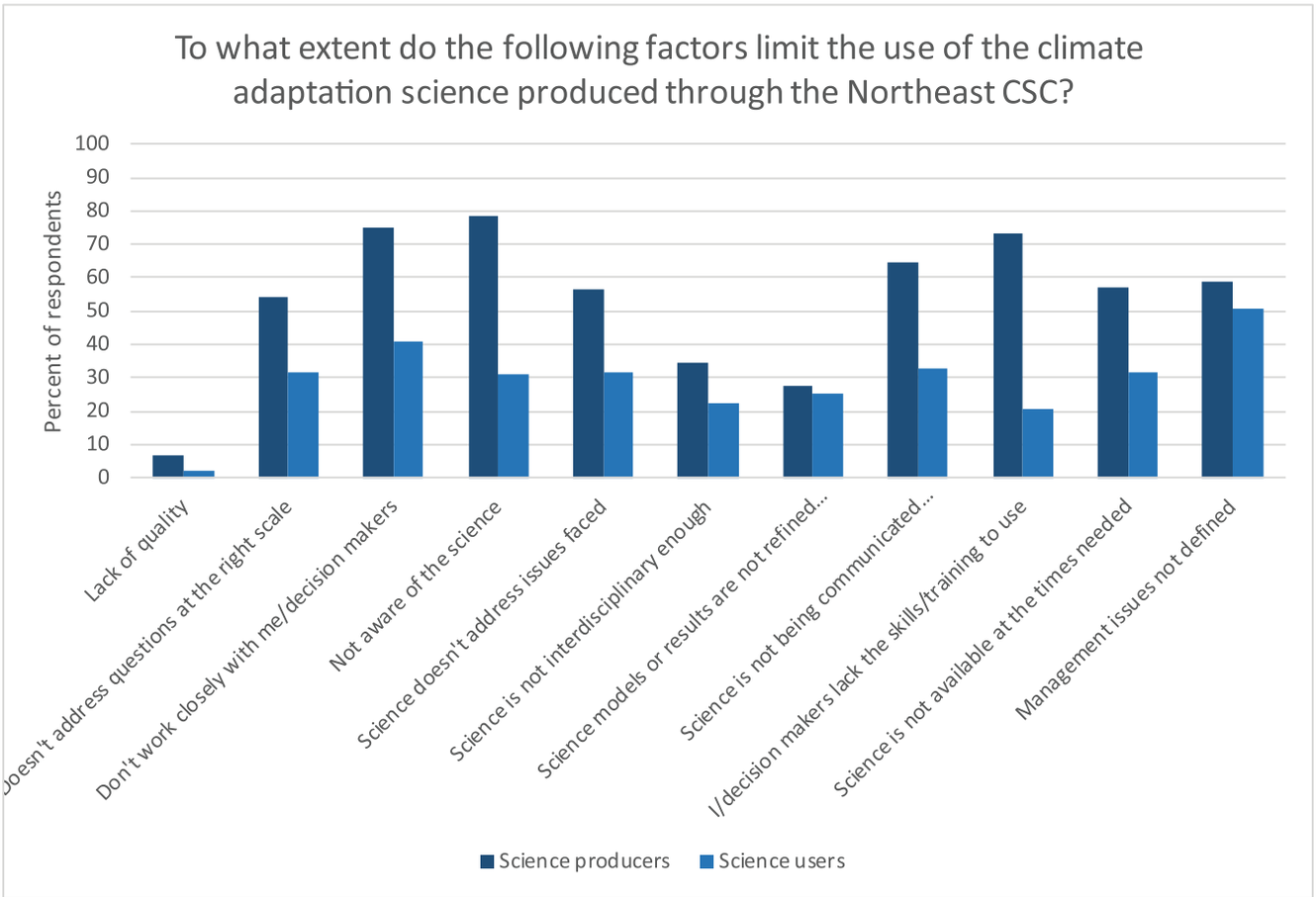

Figure 4. Factors limiting the use of science produced by the Northeast Climate Science Center (Source: Figure NE-7, Lauber and Stedman 2018).

> I just think that there's this inherent challenge to disseminating and translating that science and then perhaps to a lesser extent to make sure that the science is as user-friendly as possible. [Northeast User FG.]

> I'm really an end user.... The challenge has always been to take those products and ... step it down a level that is applicable to us, and also having that background and time to understand it and interpret it. [Northeast User FG.]

An area of growth for the NE CSC may be enhancing their science communication with stakeholders; the SRT suggests that the NE CSC expand collaborations with university faculty who specialize in developing tools for science communication and conduct project evaluation with respect to stakeholder needs, including identifying the most appropriate formats for delivering the science to those stakeholders. Improvements can also be made to communication regarding downscaling the science to address stakeholders' questions about applying the science to address site-specific information needs. For example, enhanced visualization to aid interpretation of the science is identified as a critical need:

> I would highly recommend some focus on data visualization at some level.... You could require that every project has a data vision component.... I was actually in this room a year ago talking about the visualization kind of approaches to the Climate Science Center and it hadn't really been thought about at all. And I was frankly shocked that ... they hadn't been taking it to that ... almost final step of how to communicate these very complicated things. So that's I'd say from my point of view the biggest deficiency in the Climate Science Center right now. [Northeast Producer FG.]

These disconnects suggest that an increased effort to engage stakeholders beginning with study planning may increase understanding of how the science may be more broadly appreciated and applied beyond the focal study area. In this sense, the concept of actionable science would seem to be as much of a process as a product.

Strategic planning recommendations.—Cumulatively, the science themes addressed by the NE CSC are extremely broad, reflecting the variety of partners and stakeholders that provided direction for the SSA. In charting the NE CSC's plan for the next 5 years, the SRT suggests that the NE CSC engage in a critical, holistic evaluation of the annual theme-based research activities to reflect on how these activities collectively accomplish long-term goals established in these seven themes while continuing to address stakeholder priorities and information needs. This strategic priority setting is especially important in a restrictive funding climate that requires reassessment of management priorities to accommodate variable and uncertain resources. The SRT observes that revisiting these themes may be needed to prioritize research efforts. Specifically, the SRT suggests that the NE CSC evaluate the science priorities with the following questions in mind (possibly resulting in revised themes):

1. Importance: Does the science address major climate vulnerabilities (i.e., those likely to have a significant regional ecological or cultural impact)? The SRT advises that the NE CSC evaluate how each research project helps to achieve the long-term goals. How is uncertainty addressed? How do stakeholders respond to these vulnerabilities and uncertainties?
2. Actionable: Is science in the theme area likely to become actionable (i.e., do adaptation measures exist and does implementation of these mitigation actions fall under the DOI mission or that of other agencies)? What measures are required for implementation of the actions? How is success measured?
3. Strategic: Are other agencies, CSCs, or conservation interests engaged in this thematic area? Can collaborations with other agencies and scientists contribute to the NE CSC's long-term research vision and strategic plan? How does the NE CSC's science complement and build on the strengths of other agencies and groups? Is the focus uniquely suited to the capacities and resources available within the NECSC? Consider an adaptation-focused approach that enhances knowledge about climate adaptation (i.e., identify primary climate vulnerabilities and DOI mission-related actionable priorities).

4. Organized: Based on the guidance provided above, the SRT suggests that the NE CSC explore alternative ways of organizing the research portfolio and assigning priorities with respect to criteria above.

Cumulatively, the science themes are extremely broad and there may be a need to revisit these to narrow down the focus and prioritization. The NE CSC-specific goals and objectives should be included in the overall science themes as a way to focus and prioritize.

Upon narrowing the science themes, they may be used in two ways: (1) to modify the university consortium research consistent with the themes, and (2) to select USGS-funded projects. We note that selection of research themes through the university consortium-funded projects is determined through the 5-year SSA. Appropriately, the PI then has wide latitude in carrying out the proposed and funded research agenda. Such an approach will enhance transparency and ensure that individual projects contribute to long-term goals. For example, the NE CSC could develop a matrix that includes a geographic and ecosystem dimension to evaluate regional differences in priorities, and then assess the degree to which the research portfolio addresses those priorities. Another dimension could be prioritizing ecosystems at risk within the region. These matrices may reveal important research omissions that can be science priorities in the next annual plan. Such a process may serve, for example, to addressing any deficiencies that may exist in research applicable to the Eastern Tallgrass Prairie and Big Rivers LCC, as mentioned earlier.

The SRT noted that northern forests are a terrestrial ecosystem research focus, and the aquatic or interface ecosystems addressed are coastal, lake, and river systems. These were identified during the NE CSC's 2013 stakeholder meetings and surveys and reflect the expertise that the consortium members could provide. However, a subset of funded projects does not appear to reflect the regionally focused climate theme as a primary driver. Rather, these projects (e.g., the drought research and Great Lakes research) may be intended to create synergies with larger programs or take advantage of cofunding opportunities. Regardless, these links should be clarified in the larger context of a strategic plan to increase transparency in the project selection process.

The SRT recommends a gap analysis that lists research areas and the strengths and assets provided by other agencies and universities to identify underrepresented topics and geographic areas that offer opportunities for NE CSC research in the next 5 years. The SRT believes that a vulnerability assessment would help to prioritize climate risks, and this, by itself, could be a research product, perhaps even one conducted at the national scale across CSCs. Selecting a geographic focus (e.g., Chesapeake Bay, Great Lakes, Appalachian forests, etc.) and working with stakeholders to identify priority information needs within those regions may be another refinement of the NE CSC's research prioritization approach.

The decision process for allocation of NE CSC resources to accomplish priorities was not explicit. Criteria for allocating resources need to be articulated and may include a gap analysis to help identify where NE CSC resources can best be applied. Similarly, a vulnerability assessment would help to prioritize climate risks, perhaps even conducted at the national scale across CSCs.

Institutional Coordination

The proposal by the university consortium to host the NE CSC recognized the challenges created by the diversity of climate, geography, biota, and anthropogenic effects in the expansive NE CSC region. The proposal identified the NE CSC as an opportunity to develop collaborations among the host, the consortium institutions, and federal partners including engineers, geoscientists, environmental scientists, ecol-

ogists, and other disciplines engaged in active climate science programs. Specific consortium members invited to participate in the NE CSC included colleagues with communications capabilities, long-standing relationships with state and federal agencies, and a portfolio of expertise to address the anticipated climate science needs for the region. The host and consortium institutions already were engaged in stakeholder-driven research in regional, national, and international collaborations with many state, federal, and NGOs. Additionally, collaborations with many DOI programs and offices at the host and consortium institutions existed that would be integral to the success of the NE CSC. There was unanimous agreement of the review participants from the university consortium and stakeholders that the presence of the NE CSC has energized the climate science community in the region. The ongoing complementary programs of the host and consortium universities and their established, productive relationships with many diverse partners both within the consortium institutions and more broadly in the conservation science community provide a strong foundation for the NE CSC.

Between USGS and the host university.—The University of Massachusetts provides the office space for the NE CSC's university and USGS staff in the Department of Geosciences' Climate System Research Center. This space is shared by the USGS staff, university faculty and staff, postdoctoral students/researchers, and graduate students, providing a central location that fosters collegial relationships among the partners. Federal and host university staff meet biweekly to monthly to review NE CSC activity, administrative aspects, and research accomplishments with respect to the strategic science agenda and to identify potential new research and stakeholder collaborations. The strong project management, communication, and leadership provided by the UMass and USGS staff have contributed to the NE CSC success. The SRT notes that the collaborative spirit and colocation of the federal and university partners greatly contributes to the NE CSC's integration of science and education in climate science to address the breadth of information needs for sustainable natural resources management in the region.

The NE CSC and scientist relationship.—Scientists both at UMass and the broader university consortium have benefitted from the NE CSC through enhanced research funds as well as opportunities to network with each other and with state and federal management agencies, support for graduate student research, and connection to stakeholders. Northeast Climate Science Center support also enables multidisciplinary focus at large geographic scales for some research, as well as opportunities to develop application-specific products that may be difficult to produce with support from non-CSC grants.

The NE CSC provides opportunities for host and consortium scientists to interact closely with LCCs, resource management agencies, climate scientists, and researchers in other disciplines that otherwise would not have been possible. The NE CSC also provides graduate students and postdoctoral associates with professional development opportunities, student engagement with resource management agencies, and early-career support for new faculty. The relationships and proximity to resource management agency partners has facilitated regular engagement with agencies. The NE CSC has increased opportunities for transdisciplinary collaborations that may not be available within the consortium institutions. Many consortium and host scientists remarked that relationships with the USGS staff have been exceptional, noting the leadership, integration of faculty in training students, and administrative support for research and data management. The host-university staff is instrumental to facilitating communications with the consortium members and the host university, and the NE CSC communications and outreach manager (host university) distributes results of the science to the public through Web-based outlets.

Consortium (and host) scientists identified a number of challenges that hinder the efficiency of conducting research in collaboration with the NE CSC.

- The large geographic extent offers an opportunity to avoid narrow jurisdictional boundaries, but the large number of ecosystem types and variety of management concerns is very difficult to address comprehensively.

- Some researchers perceived that the limited resources for high-performance computing and modeling that they felt was available to them limit research progress (although these talents may be available on the UMass campus).
- Administrative roadblocks such as long delays in funding availability, frequent reporting requirement and inefficient report process, and difficulty navigating bureaucracies of different universities and federal agencies are areas suggested for improvement by consortium members (although the SRT has no comparison to determine whether these issues are greater with the NE CSC or are on par with other large-scale bureaucracies involving multiple institutions).
- Though the Web page provides a platform for archiving and disseminating science products, greater public engagement to broaden the distribution and increase the impact of the research is of interest.
- The distribution of consortium scientists across seven institutions provides an opportunity to develop a large network of collaborators; however, the "buzz" that happens at UMass owing to the proximity to the USGS staff is understandably attenuated with distance across the broader university consortium network.

Stability in funding is an essential component to maintaining and strengthening the NE CSC's relationship with the scientific research community. The combined direct and RFP funding sources have enabled research continuity for host and broader consortium member PIs to conduct long-term research, enabling the NE CSC to leverage $14 million in research contracts over the first 5 years. Additional host university resources such as staff support that are not accounted for in the NE CSC budget have been critical contributions to the operations.

Diversity: Development of the Consortium

The NE CSC university consortium has a diversity of institutions, with several large research universities, two research centers, and one tribal college, as noted earlier. During the on-site review, the SRT heard that PIs and affiliates were chosen because of existing professional relationships focused on climate science topics. Although this may facilitate rapid development of productive collaborations, this approach to recruitment may not necessarily result in a high diversity of qualified members.

The SRT notes the relatively low gender diversity among consortium partners and seemingly low ethnic diversity. Among the consortium members, 9 of 10 PIs are male. Of the affiliated investigators, 20% are women and two are from tribal colleges, historically black colleges and universities, or other institutions with large numbers of underrepresented groups. Meanwhile women are concentrated in staff positions: among the nine staff members, seven are women and two (one male and one female) are affiliated with tribal institutions. In comparison, the Fellows Program membership is currently much more diverse, with 42% women and one tribal-college member (as part of the Fellows Program, the NE CSC has hosted a variety of training sessions and discussions on topics related to diversity in science careers to improve the future diversity of mid-career natural resources scientists and professionals). There is high participation of female researchers in the USGS program, which is led by a woman, and the involvement of tribal participants in the university consortium are examples of inclusivity within the NE CSC.[5] The NE CSC has made several efforts to increase diversity within the PI and affiliated investigators, but recruiting and retaining professionals of any gender or ethnicity who possess the interest or experience in stakeholder engagement or actionable science as is required from the CSC construct has proven challenging.

We note that while this situation is not unusual among institutions in the United States, there is a consequence to diversity that is revealed in the range of scientific ideas brought forth and evaluated with the tools of scientific investigation (Nielsen et al. 2017). For example, increasing the involvement of tribal researchers may open opportunities to develop research to understand historical human adaptations to shifts

[5] All figures derived from https://necsc.umass.edu/people, December 2017.

in fish, animal, and plant distributions that typify shifts in climate. Similarly, it has been shown in many fields that in the aggregate, female practitioners bring points of view not typical among male practitioners. Similarly, there are issues of social justice associated with climate adaptation that might be associated with urban centers within the geographic scope of the NE CSC.

The SRT would not prescribe a particular research agenda or stipulate who should carry it out. However, we recommend that the NE CSC leadership assess the process of recruitment with the goal of attracting the range of expertise needed from a broader pool of highly qualified candidates. Often, institutions have achieved this by advertising and recruiting for positions in creative and nontraditional ways.

Diversity recommendations.—The SRT recommends the following actions to assist the NE CSC expand diversity among PIs:

- Strive for diverse representation among staff in all units, especially at the research levels (PIs, affiliates).
- Increase participation of women and underrepresented groups at the PI and affiliated investigator units.
- Increase participation of early career scientists into the PI and affiliated investigator units.
- Increase participation of tribal-member graduate students in the Fellows Program.
- Consider new methods for advertising and recruitment of new members that will reach a highly diverse pool of candidates (e.g., Diversify ecologists and evolutionary biologists, https://diversifyeeb.wordpress.com/)

Stakeholder Engagement

All contributors to the NE CSC (federal employees, university hosts, and university partners) have an exceptionally strong commitment to engaging stakeholders in their science. In addition, examples of effective communication of science to stakeholders were evident. Overall, the NE CSC works hard to meet its goal of producing actionable science and information that can be applied, although, as noted earlier, some stakeholders would benefit from enhanced communication on applying this research on the ground.

The requirement in RFPs that the investigators work with stakeholders is commendable. Building even more on this strong foundation would increase the NE CSC's overall impact and ability to produce actionable science. Specifically, determining what stakeholders consider to be actionable science is important. Once that definition of actionable science is mutually established, the requirement for actionable science in RFPs can be enhanced and included in the prioritization that should become part of the NE CSC's overall planning. The time needed for this level of planning and advanced understanding may be substantial.

The NE CSC exhibits a strong commitment to including stakeholders in the design of projects from the outset with many examples of extremely effective communication of science to these stakeholders.

The commitment and effectiveness in communication can be seen in many instances; we highlight here a couple of examples. The USGS side of the NE CSC has strived to produce synthetic scientific information, such as the project "Integrating Climate Change into the State Wildlife Action Plans" (M. Staudinger, project leader), tailored to the specific needs of local managers. By all accounts, this particular report was extremely useful to state agencies in identifying local impacts of climate change as well as potential mitigation and adaptation strategies as they built their required State Wildlife Action Plans. Second, the Massachusetts Climate Action Tool is a noteworthy example of aggregating and interpreting information in ways that are immediately useful to a wide range of natural resource managers and decision makers for the exact issues that they face on a day-to-day basis (we might encourage such a tool for all the states!).

The SRT appreciates that the climate challenges associated with the extremely diverse and large geography that the NE CSC encompasses means that there are many potential partners whose needs cannot be addressed. This is likely unavoidable with the resources available to the NE CSC, but the larger organizations (e.g., DOI) should consider this lack of full geographic coverage in their own prioritization efforts.

Actionable and collaborative science (discussed in the Actionable Science section) is an important ingredient for stakeholder engagement. Opportunities exist for the science developed, particularly on the university side of the collaboration, to more explicitly assist natural resource management and decision makers. The SRT noted that many (not all) of the products that were identified as most useful by the stakeholder community were often those developed by the USGS staff; the act of making connections with specific expertise (inside and outside of the NE CSC community) that helped with very specific problems and issues was repeatedly cited as an important service. Stakeholders noted that while all the projects were informative, a relatively small subset would actually inform or result in actions or decisions on the ground. According to the HDRU survey:

> The only factor that a majority of science users thought was limiting the use of CSC science was management issues not being well defined (51%). Neither group considered a lack of quality of the science to be a problem (science users—2%; science producers—7%).

The SRT recognizes the real challenges to producing actionable science, including that the actions to be taken (or not) are outside of the control of scientists and that the whole concept may require a bit of a culture change from typical scientific pursuits. Scientists may be able to enhance the relevance of their work with even more coordination with the end-users by exploring avenues of disseminating their results that augment the more familiar publications in peer-reviewed journals (discussed further under Communications). These challenges in the stakeholder partnerships indicate opportunities for growth, primarily with respect to communication of the climate science with appropriate levels of detail, as products that can be used by managers and in ways that address their most pressing management needs.

The NE CSC relationship with stakeholders and other science partners.—The NE CSC has a strong record of partnerships with federal, state, local, and tribal programs in the region, and its presence has strengthened and expanded these partnerships, in number and type. The number and diversity of these collaborations is noteworthy (Table 2).

The users of scientific information value participating in the research from the initial development of ideas to the final steps of translating the science into formats that they can understand and apply locally. However, there are opportunities to ensure that such start-to-end integration happens across the portfolio of projects (see earlier discussion related to enhancing this beginning-to-end integration of partners). In fact, a focus group participant commented,

Table 2. Major categories of partners engaged in Northeast Climate Science Center (NE CSC) projects (Source: Holland et al. 2017).

Major partners	Number of NE CSC projects
U.S. Fish and Wildlife Service	46
U.S. Geological Survey partners	43
State agencies	42
Landscape Conservation Cooperatives	28
Nongovernmental organizations	25
U.S. Forest Service	25
National Park Service	17
Tribal organizations	14
Local and county organizations	13

> As projects get started ... they really need to be specific about the users/stakeholders.... Like who is actually going to use this. 'Cause I think there may be a disconnect there.... I think some projects have done a great job and some really probably haven't, but I think you know the way to address that is to really have the researchers, the project leaders, to be thinking about who's going to use it. I don't think they are going to be trying to reach the general public, but they may be interfacing with organizations like the Park Service.... Who are actual people in organizations that could be using this information? And work with them throughout the process and not have it kind of be, well sometimes I've seen proposals, they list a whole bunch of stakeholders that could use it but there's not really you know a sharp connection there and it doesn't actually happen. [Lauber and Stedman 2018.]

Technical assistance to synthesize vast amounts of published climate science and increase management relevance of research products is a service that stakeholders value highly. Stakeholders specifically noted that guidance about downscaling climate projections, interpreting model results, focusing on appropriate scales, understanding model uncertainty, and evaluating alternatives through scenario analysis as important. Furthermore, stakeholders value assistance with condensing the vast amount of available climate science into products they can understand and use. In one notable example, state agencies collaborated with the NE CSC during development of the State Wildlife Action Plans to obtain information about climate science relevance and to develop climate scenarios applied to deer, moose, and elk. The NE CSC also has worked with LCCs (particularly North Atlantic, South Atlantic, Gulf Coast Prairie, Gulf Coastal Plain and Ozarks, Peninsular Florida, and Caribbean) to identify science needs and develop projects that assist the LCCs in addressing the effects of climate change. The SRT commends the NE CSC on these highly effective partnerships.

Many consortium and host institution PIs cited the monthly conference calls as essential to maintaining connections with the NE CSC. Additionally, the Fellows Program brings together scientists and students across the consortium through various means, including annual workshops. The SRT encourages the NE CSC to continue this Fellows Program and workshops, which provide an important networking opportunity. The participants find this to be productive because it facilitates and fosters integration of research across the institutions.

Metrics and Accountability

Currently, there is no national set of metrics developed by NCCWSC by which to gauge the effectiveness and success of the CSCs, although the ACCCNRS report provides an evaluation framework and a substantial set of undeveloped metrics suggested for employment by the CSCs. The NE CSC has invested thought into the general issue of measuring success and has an opportunity to develop metrics relevant to its own situation and to influence substantively any national discussion about standard metrics that might be applied to all CSCs. Metrics should include at least some that are outcome-based and should include the range of outputs that CSCs are expected to produce, including both standard academic metrics (e.g., peer-reviewed papers and presentations) and metrics that reflect more clearly the charge of the CSCs to produce science that enables natural resource managers—particularly those in the DOI—to make decisions allowing their trust resources to persist and flourish under climate change. Enlisting social scientists to help develop these metrics may be useful; for example, a survey of the stakeholder community might provide one mechanism to quantify some of the less countable goals, such as clear, broadly used communications or input to decision making.

A real opportunity exists for the NE CSC to influence the development of metrics of success that span all CSCs, and we encourage the NE CSC to engage in dialogue within the region and across the network to develop these metrics, including outcome-based indicators.

Although the NE CSC's performance on actionable science is discussed in the next section, an aspect related to accountability is presented here. The SRT suggests that the NE CSC, in cooperation with the LCCs and the other CSCs, develop a document describing best practices for actionable science. The reviews that the CSCs have undertaken, as well as the surveys of stakeholders and other collaborators, will be useful sources for such a document, which could be a living document to be updated regularly as novel insights are gained. Such a report would help guide new fellows and other collaborators, as well as provide some measures against which to gauge both proposals received and the outcomes of the NE CSC's overall efforts.

The NE CSC should consider developing with LCCS and other CSCs a best practices document (synthesis of what has been learned) on actionable science.

Actionable Science

The SRT commends the NE CSC for an explicit focus on actionable science. Resulting projects varied in the degree to which actions or adaptation was developed or identified. One collaborator identified 25% of the portfolio as being actionable, which is impressive. One of the best examples highlighted was the overview report that helped inform state climate adaptation plans. These plans met a need identified by a stakeholder (state agencies) that clearly demonstrated a direct and actionable translation from NE CSC science to resource agencies responsible for making local decisions to increase resilience and reduce vulnerability to future climate change. Similarly, contributions to the National Fish, Wildlife and Plants Climate Adaptation Strategy (www.wildlifeadaptationstrategy.gov) are an excellent example of communication toward actionable science. However, the "action" part would appear to be dependent on whether the state and federal plans are operationalized, funded, and carried out. Northeast Climate Science Center projects need to explicitly address the concept of actionable science during initial stages of research.

The SRT is encouraged by a NE CSC scientist's involvement in a workshop and contributions to a paper on translational ecology highlighted in a special issue of *Frontiers in Ecology and the Environment*, which is based on a 2015 translational ecology workshop (National Center for Ecological Analysis and Synthesis, Santa Barbara, California, November 17–19, 2015). Translational ecology shares many attributes in common with actionable science (http://NECSC.umass.edu/news/four-new-papers-moving-concept-translational-ecology-forward). Translational ecology is an approach in which ecologists, stakeholders, and decision makers work together to develop research that addresses the sociological, ecological, and political contexts of an environmental problem. The application of this approach to climate science is obvious, with the end result being actionable science (Enquist et al. 2017; Hallett et al. 2017; Littell et al. 2017; Schwartz et al. 2017). Examples of actionable science highlighted by this publication include finding and protecting climate refugia, defined as "areas relatively buffered from contemporary climate change over time that enable persistence of valued physical, ecological, and socio-cultural resources" (Morelli et al. 2016).

A Northeast Refugium Coalition has also been organized, and thus far, research has been focused on refugia for temperature-sensitive species and ecosystems (e.g., coldwater streams containing Brook Trout; glacial lakes containing Walleye and Cisco; vernal pools containing salamanders; spruce-fir forest providing habitat for moose, Bicknell's thrush, Canada lynx, marten, snowshoe hare, etc.) The two aquatic projects targeting the climate-refuge theme are summarized below:

- Research in the Northeast and Midwest has identified particularly cold streams and lakes where prized fish like Brook Trout and Walleye may persist despite warming temperatures. Working closely with state and federal managers, NE CSC researchers have mapped these coldwater refugia so that they can be protected from pollution and other stressors.

- Research on streams of the Northeast has used historical temperature data to identify thermal refuge areas.

The research funded by the NE CSC to address sea-level rise and its effects on salt marsh is another example of actionable climate science. Restoring aquatic vegetation in shallow nearshore coastal areas can have important wildlife benefits and, in fact, can interrupt the positive feedback cycles leading to coastal hypoxia.

A project by The Nature Conservancy, in collaboration with UMass and USGS, to optimize reservoirs in the Connecticut River under projected climate scenarios is an outstanding example of actionable science. Although this climate information is not currently being directly considered by the Federal Energy Regulatory Commission in the relicensing process, stakeholders at the beginning of the relicensing process had articulated the desire to incorporate this research. This kind of research is extremely actionable and has consequences over the lifetime of the license, which may be 30 to 50 years.

Although much of the NE CSC-sponsored research adheres to priorities of the region, some of the research appears to be opportunistic, either with weaker ties to pressing climate issues or less-clearly associated with actionable interventions. Some of the research (including some presented during the on-site review) and papers listed on the NE CSC Web site was clearly a pre-existing research priority of the scientists and not necessarily driven by NE CSC priorities.

The SRT offers three ways to evaluate projects in the research portfolio that may better help the NE CSC focus on true climate science priorities that incorporate actionability:

- Map projects funded to SSA objectives: how well do they overlap?[6]
- Map project locations to geographic operational area of the NE CSC. Is the entirety of the NE CSC region adequately covered? Why or why not?
- Does the project have an adaptation-relevant outcome?

The SRT suggests that the NE CSC consider an adaptation-focused approach as they develop the next 5-year strategic plan (i.e., first identifying primary vulnerabilities and DOI mission-related actionable priorities), consider whether there are opportunities for science to identify where adaptations are needed, and to consider what they might be. It is commendable that the CSC directors from different regions coordinate through a network with regular meetings. This dialog potentially provides a venue to initiate a cross-CSC overview activity that ranks the potential vulnerability of ecosystems, importance (potential effect on humans), degree of uncertainty, and whether the threat can be mitigated (or is there a need for research to identify actions that might mitigate against climate threats).

There may also be an opportunity for more deliberate gap filling of the NE CSC research portfolio to ensure that the most DOI-relevant vulnerabilities and adaptations are addressed for the Midwest and Appalachian regions of the NE CSC. This should be achieved through consultation with the Eastern Tallgrass Prairie and Big Rivers LCC, the North Atlantic LCC, Appalachian LCC, and the Upper Midwest and Great Lakes LCC. Are certain LCCs receiving considerably more climate-related support than others, and is this justified? As noted earlier, a concern was raised about whether (for example) agricultural interests in the Midwest would turn to the NE CSC for climate guidance or are even aware of it as a potential resource. Strengthened partnerships with entities who may have established partnerships with these types of user groups (e.g., U.S. Department of Agriculture [USDA] Climate Hubs, etc.) might be a way to engage non-traditional consumers of USGS science products and extend the stakeholder base for NE CSC products.

The NE CSC may also benefit from assessing whether mitigatable, climate-associated threats exist that may be understudied because less is known about them. There is always a concern of a bandwagon effect where researchers are attracted to research in a currently "hot" area (e.g., stream connectivity) rath-

[6] Note: We recognize that Appendix B of the *Five-Year Summary Report* (Holland et al. 2017) maps projects to the science themes but include it as a suggestion that it be done in concert with the other recommendations.

er than exploring the frontier of unstudied but potentially new vulnerabilities about which little is known and that may have a stronger link to climate (e.g., emerging diseases). Likewise, it is not clear that newly proposed adaptations emerged from the NE CSC research portfolio.

The NE CSC project portfolio appears to be heavy on vulnerability assessments, leaving growth opportunities for adaptation science.

Ensuring Persistent Impact of NE CSC Research Products

Ensuring that the investment made into actionable climate science continues to be used in the future is an issue with which all researchers, including the NE CSC, should be concerned. This is particularly true in an uncertain funding environment. For example, does the NE CSC have plans for continued access to decision-making tools if support for Web sites is not maintained? Can strategic decisions be made today to ensure the long-term viability of these research products? It is commendable that the NE CSC has produced publications and thereby ensured access to research results regardless of future funding threats, but strategic thinking of additional mechanisms to ensure continued access to products and tools would extend the long-term value of the funding that has been invested to date.

In anticipation of the recompetition to host the CSC, the NE CSC should continue to evaluate climate change issues within subregions and identify where NE CSC can best contribute.

Communications

The NE CSC Communication and Outreach Plan (April 7, 2014 revision) describes five objectives targeted to five audiences (combining resource managers and conservation partners into one audience):

- Conservation partners
- Resource managers
- Scientists
- Policymakers
- The general public

Among these audiences, the NE CSC communications team specified that their top priorities were scientists and stakeholders. The overarching goals of their communications program are to

1. Facilitate development and dissemination of Northeast climate-related science, information, assessments, and tools to support management of natural and cultural resources under changing climate conditions; and
2. Increase access to and understanding of Northeast climate-related science and data to the scientific and management community, as well as other stakeholders and the public.

The NE CSC achieves these goals primarily by distributing a newsletter and producing webinars on topics related to implementing climate science. Stakeholders who provided input during the review process provided many positive comments about the webinars and the newsletter. However, it is not clear how these platforms would reach a larger circle of influence beyond individuals already involved in the NE CSC. The NE CSC communications team indicated that strong positive demand from the public existed, yet no NE CSC staff was identified as being responsible for public outreach (but as noted above, the general public is not a priority audience and public outreach does occur via various partners and consortium members independently). The NE CSC does not maintain a Facebook page

and its Twitter account does not seem to be integrated well with its Web page, where it could be easily found; much of its social media communication apparently flows through the USGS national office (Reston, Virginia) to disseminate information through its accounts on platforms. However, NE CSC staff indicated that social media is not an important platform to engage with stakeholders, according to stakeholders themselves.

Communications Recommendations

The SRT recognizes the limitations on communications due to low funding and staff resources and applauds the NE CSC for prioritizing target audiences, given these limitations. With that in mind, the SRT provides the following recommendations to assist the NE CSC improve and strengthen its communication capabilities:

- Use existing expertise in the university consortium (e.g., University of Minnesota, University of Wisconsin) to provide professional, sustained training to the Fellows in science communication, data visualization, and synthesis, as well as in verbal, written, and digital formats.
- Consider working with university consortium experts in evaluating and assessing effectiveness and reach of science communication efforts.
- Consider reassessing the desired outcomes to increase content covering the scientific products, materials, tools, and actions developed by the consortium.
- Ensure that effective communication training is available to all participants within the NE CSC, including at all research levels.
- Recognizing the limitations on staff and the prioritization of audiences (as discussed above), consider expanding the communication to the public and to policymakers if cost–benefit warrants.
- Expand the collaboration with extension agents at consortium universities to disseminate information to the public.

Capacity Building

Measures of capacity building are intended to capture how well the NE CSC is building capacity for conducting and applying actionable science, with an emphasis on formal training for graduate and postdoctoral fellows as well as providing training to the broader community in how to use and apply climate science and services.

A key activity to further this mission on the university side is the Fellows Program, which is designed to develop a cadre of graduate students and postdoctoral researchers who are trained in the issue of climate and conservation science, impacts of climate change on natural and cultural resources, and potential climate adaptation and mitigation strategies for resource managers. This program requires a major commitment to fund Fellows and to engage them in the coproduction of climate sciences and coordinated and sustained efforts across institutions to foster collaborative linkages to create actionable science.

The Fellows Program has demonstrated success through high participation, having produced more than 60 postdoctoral, Master's, and doctoral students. Most of these students are from the biological sciences, with fewer from social sciences or engineering. Students of all PIs are eligible, as well as any other student advised by a USGS staff member.

The Fellows Program seems to be a prime opportunity for communications training, although this training seems to be composed mostly of opportunities to give presentations. This might be improved upon by adding professional training or guided feedback. Although no mention was given during the review of science communication training, NE CSC staff later conveyed that annual retreats include training on science communication and professional development, Fellows meetings offer guided feedback during presentations as well as discussions on effective science communication, and workshops on communications are periodically made available to Fellows.

Metrics for professional development of graduate students (and faculty) are not likely to be the metrics of greatest value to USGS staff or to the NE CSC. However, metrics of success for individuals in the Fellows Program should be clearly articulated to set expectations for both the Fellows and the advisors. These metrics could include aspects to strengthen proficiencies in adaptation science (as compared to traditional science), communications, partnerships, and other attributes that might not be measured in the traditional scientific academic track but that are essential for developing strong professionals in the field of actionable climate science. This will enable students and their faculty advisors to plan projects and activities to maximize professional development opportunities so that students will be competitive for jobs related to climate science.

The NE CSC organized and cohosted a CSC-network-wide retreat for Fellows and students that was widely attended. The retreat was highlighted by those who attended (from multiple CSC programs) as having been extremely valuable for sharing information and experiences. These types of venues may be extremely beneficial for growing the capacity of future scientists who are capable of implementing actionable climate science.

Capacity Building Recommendations

The SRT provides the following recommendations to assist the NE CSC in strengthening elements of capacity building within the program:

- Clearly articulate the goals of the Fellows Program in a way that will allow participants and sponsors to establish expectations of benefits.
- Assess outcomes of the Fellows Program by identifying metrics that would identify whether Fellows are achieving the objectives of the program.
- Consider how to recruit more students from engineering, social sciences, and other relevant fields.
- To train the next generation of practitioners, undertake seminars on actionable science and include the following topics: What is actionable science? How is it different from traditional science? What skills are needed to do actionable science? Is graduate school the best place to learn actionable science? What metrics are indicators of successful actionable science?
- Clearly identify and articulate expectations for the graduate students as well as metrics of success for both individuals and the program so that students and their faculty advisors can plan projects and activities to maximize professional development opportunities that prepare students for competitive for jobs.

Capacity Building (Communications)

A broader Communications section is contained elsewhere in this report; this section focuses on communications as a form of building capacity for conducting and implementing this research. The NE CSC is conducting innovative research that brings together researchers and practitioners to co-develop projects. This is a relatively new approach to doing actionable science that lacks an established methodology for designing, implementing, or assessing impacts, necessitating that the NE CSC develop the process as they go.

The SRT heard from some of the practitioners that science translation is a major problem in general, not just with the NE CSC, and the ability of the audience to absorb and understand the science is the major limiting step to implementation. In addition, stakeholders mentioned additional problems in communication associated with climate science in a political environment that does not always favor climate change research.

Capacity Building: Communications Recommendations

To expand the successes that the NE CSC has had implementing an actionable science approach to climate research, the SRT offers these recommendations:

- The NE CSC should quantify how NE CSC-generated science, information, and products are being used by other stakeholders so that the extent of usage can be understood more fully and conveyed to others.
- The NE CSC should consider quantifying the research impact by tracking how many conclusions/findings/tools have been used by other stakeholders.
- The metrics used to assess communications should be expanded to include impact as described by the UK Research Excellence Framework (e.g., https://epsrc.ukri.org/innovation/fundingforimpact/pathwaystoimpact; www.esrc.ac.uk/rEsearch/impact-toolkit/what-is-impact).
- The NE CSC is encouraged to develop a "best practices" paper or case study on the process of how they create and implement projects, how they develop products and share that information with practitioners and the larger public, and how they assess the success of the project.

Partnerships

Effective partnerships are critical for the success of the NE CSC, which operates in a complex ecosystem of local, state, regional, and national organizations working in the boundary zone between climate science and its applications in natural-resource decision making. In order to apply its limited resources most effectively and strategically, the NE CSC must collaborate with many of these other organizations to leverage resources, share information, avoid duplication, and ensure that important gaps are identified and covered. The sheer number of potential partners makes it particularly important that the NE CSC be strategic about its partnerships.

The NE CSC has developed strong and productive partnerships with an impressive number of relevant organizations, particularly in view of the size and diversity of the region, including the following:

- Collaboration with adjoining CSCs in boundary-spanning projects; the sea-level rise and coastal storms project with the Southeast CSC is particularly noteworthy.
- Partnerships with the seven LCCs in their region (although some LCCs, particularly on the southern and western periphery, perceive that their relationships with the NE CSC are not as strong as they would like).
- Collaborating with the two NOAA Regional Integrated Sciences and Assessments (RISA) in the NE CSC region, cofunding meetings with them, and avoiding duplication with efforts as much as possible. The Great Lakes Integrated Sciences and Assessments (GLISA) has a strong social science component and NE CSC might benefit from some degree of partnership aimed at leveraging that element, partic-ularly given the limited social science expertise in the NE CSC.
- Collaborating with USDA Climate Hubs, Northeast and Midwest, are entirely within the NE CSC territory, and a third Hub (Southeast) overlaps with the NE CSC.
- The U.S. Forest Service has a Northern Forests Climate Hub that is closely associated with the Northern Institute of Applied Climate Science (NIACS). The NE CSC has multiple links with the Northeast, Midwest, and Northern Forest Hubs, via its U.S. Forest Service PIs (Nislow and Thompson), its partnerships with NIACS, and the participation of university PIs and USGS staff in Climate Hub activities and committees.

The NE CSC faces the daunting task of partnering with each of the 22 states in its region and has done an excellent job of partnering with agencies in selected individual states, notably Massachusetts. In most cases, the NE CSC has targeted obvious low-hanging fruit, leveraging opportunities provided by existing relationships between PIs and state agencies and by the geographic location of the consortium institutions. However, with limited direct involvement of a number of state agencies in the region, the NE CSC may benefit from a more strategic effort to identify agencies and personnel in states that are willing to engage with the NE CSC, and to seek creative ways to partner with them individually, in subregional groups, or in partnership with LCCs.

The NE CSC has already developed and implemented one such creative partnership via its collaboration with the Northeast Association of Fish and Wildlife Agencies (NEAFWA) and the Midwest Fish and Wildlife Association (MAFWA) to develop a guide for incorporating climate science into State Wildlife Action Plans (Staudinger et al. 2015). This effort stands out because it leveraged limited NE CSC resources in a highly effective way to serve a critical state agency need across the entire region. It has been well received by state and other stakeholders and serves as a model for other CSCs in the network. The SRT encourages the NE CSC to continue partnering with NEAFWA, MAFWA, and other organizations in seeking effective ways to address the needs of the many states in the region.

The NE CSC region has a large number of USGS research facilities, including Water Science Centers and Cooperative Fish and Wildlife Research Units, in accord with its geography (which includes USGS headquarters and several research centers in the Washington, D.C. region) and has partnered with several of them. Many of these partnerships were necessarily opportunistic, building on existing collaborations and relationships as well as geographic locations. As with other partner categories, the NE CSC is at a juncture where it can be, and needs to be, more strategic in identifying partners to ensure effective coverage of critical needs and to fill important gaps in the research capacity of the consortium universities.

The NE CSC has been involved in collaborations with a number of federal agencies, particularly the U.S. Fish and Wildlife Service, the National Park Service, the U.S. Forest Service, NOAA, and selected USFWS Migratory Bird joint ventures. It is now hosting or cohosting two tribal climate liaisons in collaboration with the Bureau of Indian Affairs and its contractors. Its strong and fruitful partnership with the U.S. Forest Service's NIACS has rendered stakeholder engagement and translation efforts particularly effective in the forest management community. The SRT notes that the region includes a number of military bases and ports. In addition, some of the modeling tools developed under the DOD SERDP program to assess sea-level rise (a major concern for coastal military installations) may be useful for CSCs. We therefore encourage the NE CSC to reach out to the DOD programs charged with natural resource management of these properties. Similarly, other federal agencies (e.g., DOE, NOAA) devote considerable resources to high-performance computing and projection and downscaling of global climate models and Intergovernmental Panel on Climate Change economic scenarios, and these can be made available to CSC researchers. Addition of DOD and DOE representatives to the SAC might help identify further potential cofunding partnerships, research products, identification of needs and potential mitigations, and other collaborative activities.

The NE CSC has also developed partnerships with NGOs (The Nature Conservancy, etc.), municipal and county governments, and tribes. The Regional Effort on Invasive Species and Climate Change (RISCC) network stands out as an effective, multi-level, multi-partner initiative for which the NE CSC has provided leadership. As with other partnerships, the NGO and local/county partnerships have been largely effective but appear to be largely opportunistic. We expect that addition of the Bureau of Indian Affairs liaisons will lead to partnerships with tribes and tribal organizations beyond the College of Menominee Nation activities.

In summary, the NE CSC deserves recognition for developing a number of effective partnerships. It seized opportunities to leverage relationships that already existed between universities and various stakeholder groups to spin up very strong collaborations within a short time. These provide a solid foundation for future partnering, as well as a number of lessons from the experience. The NE CSC has also worked hard to engage diverse partners, including LCCs and state agencies, across a large, state-rich region. It is no surprise that these partnerships are uneven, given the limited staff and resources as well as the time and travel commitment required to develop strong relationships. As it approaches its next phase, the NE CSC needs to work more strategically to guide its future approaches and decisions in developing partnerships and avoid the appearance of opportunism in partnering with other entities. Developing a more transparent and effective strategic plan, with clear priorities for resource allocation, will help the NE CSC use its resources most effectively to engage with other organizations in pursuing its mission.

The NE CSC deserves recognition for developing a large number of effective partnerships.

Concluding Comments

The NE CSC should be commended for galvanizing and focusing capabilities in the region to address pressing needs for climate adaptation research. The SRT was generally impressed by the progress that the NE CSC has made in five short years and with less-than-anticipated funding. The recommendations in this report should be viewed more as advisements for strengthening an already robust program rather than as criticisms. The strong program reflected in the overall NE CSC enterprise is undoubtedly due to the strong capabilities and unwavering commitment of the NE CSC federal and host-university leadership. Through their involvement, an impressive consortium of academic and research institutions has been developed and a strong and very capable professional staff has been assembled.

Every program and agency should continually strive to improve and strengthen its programs to remain relevant and vibrant, and the NE CSC is no exception. Their already-strong research portfolio can benefit from an introspective review to maximize the contributions that can be made in the area of climate adaptation research through activities such as a gap analysis to uncover opportunities for filling research needs in this vast region. Increasing the gender and ethnic diversity of principal investigators and affiliated researchers will lead to a stronger and more vibrant institution overall. Beyond the research, the NE CSC should not lose sight of the fact that they must address stakeholder needs for actionable science and increase efforts to communicate to agency stakeholders how the NE CSC research and programs can benefit their specific needs as they face increasing challenges to managing resources in changing climatic conditions. The SAC should be re-energized and enhanced to regain the former meaningful engagement of a broad diversity of agencies and institutions, and the process for prioritizing funding decisions should be clarified and articulated to stakeholders and partners alike. These and other suggested enhancements outlined on this report will position the NE CSC to become an even stronger, and more relevant leader in actionable, stakeholder-driven climate-adaptation research in the Northeast and in the nation.

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Appendix A
Northeast Climate Science Center Review Team Members

Science Review Team Members:

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Appendix B
Northeast Climate Science Center On-Site Schedule of Activities

October 30 to November 2, 2017
134 Morrill Science Center
University of Massachusetts–Amherst
611 North Pleasant Street
Amherst, Massachusetts 01003, USA

Monday, October 30 2017

Time	Activity	Desired output	Lead entity/ person(s)
5:00–6:00 pm	Pre-meeting of **Review Members only**. • Review schedule of meetings/ discussions • Overview of goals and expected products • Writing expectations • Identification of additional information needs		
6:00 pm	Dinner gathering of review team members. (**only Review Team members and USGS-Reston staff**) Follow-up discussion questions: • From the material that you've seen so far, what is missing? What do you want to see more of? • What new questions do you have for the CSC?	Comprehensive view of the CSC and the goals of the review; develop list of questions for tomorrow	French

Tuesday, October 31, 2017

Time	Activity	Desired output	Lead entity/ person(s)
8:00–8:30 am	Gather in Building II, Room 134 (conference room)		
8:30–9:00 am	Welcome, introductions, and short background statements by Review Team members. Review charge to the committee. Campus welcome and orientation.		Austen, Cushing, Ratnaswamy, Palmer
9:00–10:00 am	Brief review of points from preparatory conference calls • Q&A and discussion of issues raised from the calls.	Ensure that SRT has full understanding of the structure of the CSC and key processes.	Austen, French

Tuesday, October 31, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
	• Identification of additional information needs. *Questions to be gathered by Austen/SRT chair resulting from the calls and conveyed to SW CSC staff prior to site visit to allow for preparation of responses.*		
10:00–10:15 am	Break		
10:15–10:45 am	**Institutional Development** Science agenda, science themes, funding pathways, SAC, working together (USGS and universities) • Mary Ratnaswamy, Federal Director • Richard Palmer, University Director • Q&A	Presentations and discussion will enable the SRT to recognize the linkage between these issues and the strategic plan and science agenda of the NE CSC. Status of consortium coordination, involvement, management, adequacy of coverage, etc.	
10:45–11:30 am	**Partnerships** Review of partners and mechanisms for engagement, leveraging; creating effective research partnerships that address the needs; assessment of strengths, weaknesses, and opportunities of the consortium.	Importance of partnership to CSC science and administration; what can be improved?	
11:30–11:45 am	Break		
11:45–12:50 pm	**Actionable Science: establishment of the climate change science and conservation** challenges that characterize the CSC operational area *This time slot includes a working lunch.* Selected presentations on significant climate change issues and conservation challenges that characterize the CSC operational area. • Richard Palmer, University Director • Toni Lyn Morelli, USGS Research Ecologist • Tony D'Amato, University of Minnesota • Radley Horton, Columbia University	Understanding of the main drivers of science-management needs that define the CSC and relevant other climate science providrs. What is the context of the CSC with regard to the most significant conservation challenges?	CSC director and university PI to identify and select presentation with conferral of Review Team chair.

Tuesday, October 31, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
	• Linda Deegan, Marine Biological Laboratory • Frank Thoompson, University of Missouri, USFS • Pete McIntyre, University of Wisconsin • Curt Griffin, University of Massachusetts • Q&A		
12:50–1:10 pm	**Communications** • Addie Rose Holland, Deputy University Director • Jeanne Brown, Communications and Outreach Manager • Alex Bryan, USGS Postdoctoral Fellow • Q&A	Understand the variety of audiences for CSC communication (including science literature); what is most important?	
1:10–1:30 pm	**Capacity Building** – Fellows and partners, workshops/trainings • Addie Rose Holland, Deputy University Director • Toni Lyn Morelli, USGS Research Ecologist (former Program Manager) • Tony D'Amato, University of Minnesota • Chris Caldwell, College of Menominee Nation • Q&A	Whose role is capacity building? What is the value of building capacity overall, and to current science output? What works/ what needs improving?	Partner university staff and leads
1:30–1:45 pm	Break		
1:45–3:45 pm	Partnership Dialogue #1 (Cornell Team) – **Science "producers":** • Adrian Jordaan, University of Massachusetts • Ben Letcher, USGS • Michael Notaro, University of Wisconsin (Remote) • Evan Grant, USGS (Remote) • Erika, Lentz, USGS (Remote) • Tony D'Amato, University of Minnesota • Pete McIntyre, University of Wisconsin (Remote) • Curt Griffin, University of Massachusetts • Frank Thompson, USFS, University of Massachusetts • Thomas Bonnot, University of Missouri (Remote) • Bill DeLuca, University of Massachusetts • Kristina Stinson, University of Massachusetts		Bruce Lauber and Rich Stedman

Tuesday, October 31, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
3:45–4:00 pm	Break		
4:00–5:00 pm	**Review Team only, closed session #1** 1. Gather initial thoughts and questions. Quick gathering of initial observations (e.g. lightening round of 2–3 minutes for each team member to share thoughts), compilation of shared observations, gathering of questions and information requests for day #2. 2. Initial discussion of report authorship. This will have been addressed on pre-site visit conference calls but should be leading to team members accepting authorship responsibility.		French
6:30 pm	Working dinner for Review Team	More of item #1 above	French
After-dinner discussion (informal)	Review Team working session to initiate planning of authorship for report, identify additional needs, and review the day's discussions		French

Wednesday, November 1, 2017

Time	Activity	Desired output	Lead entity/ person(s)
8:15–8:30 am	Gather on campus (Morrill 134) Review day-1 notes and day-2 schedule of activities.		Loftus, Austen, French
8:30–9:45 am	**CLOSED SESSION** Review Team briefing and discussion with **University/Host Institution** principal investigators and relevant other university partners only. List of participants: • Richard Palmer, University Director, University of Massachusetts • Curt Griffin, University of Massachusetts • Ray Bradley, University of Massachusetts • Keith Nislow, University of Massachusetts • Tony D'Amato, University of Minnesota • Pete McIntyre, University of Wisconsin • Frank Thompson, University of Missouri • Chris Caldwell, College of Menominee Nation • Linda Deegan, Marine Biological Laboratory	Hear about concerns, successes, and areas for improvement from university side of CSC.	Rick Palmer and others at UMass or university consortium

Wednesday, November 1, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
	• Radley Horton, Columbia University • Addie Rose Holland, Deputy University Director, UMass • Jeanne Brown, Communications and Outreach Manager, UMass		
9:45–10:00 am	Break		
10:00 am–noon	Partnership Dialogue #2 (Cornell Team) – **Science "users"** • Maria Janowiak, NIACS, USFS (Remote) • Brad Potter, USFWS/UMGL LCC (Remote) • Amanda Babson, National Park Service (Remote) • Gwen White, USFWS/ETPBR LCC (Remote) • Scott Schwenk, USFWS/NA LCC • Rebecca Quinones, Mass Fish & Wildlife • Chris Hoving, Michigan DNR (Remote) • Nancy Pau, USFWS/Parker River NWR (Remote) • Chris Hilke, National Wildlife Federation (Remote)	[Are we hearing about science projects here??] We might want to know: How important is CSC to personal science program of PI? What works/what needs improving?	Bruce Lauber and Rich Stedman
Noon–1:15 pm	Lunch – Off site		
1:15–2:30 pm	Role of Stakeholder Advisory Committees and other advisory bodies – Participants in Science Users focus group and members of SAC invited to continue discussions of the roles of advisory bodies. • Mary Ratnaswamy, Federal Director • Olivia LeDee, Deputy Director	Hear directly from SWC and user groups	Austen, Loftus, French to facilitate
2:30–3:00 pm	Review Team only – preparation of notes for closed session with USGS.		
3:00–3:15	Break		
3:15–4:30 pm	**CLOSED SESSION** Review panel briefing and Q&A with **<u>USGS staff only</u>** • Mary Ratnaswamy, Federal Director • Olivia LeDee, Deputy Director • Michelle Staudinger, Science Coordinator • Tony Lyn Morelli, USGS Research Ecologist	Review responses to submitted questions and information requests, open discussion of CSC. Hear about concerns, successes, and areas for improvement from university side of CSC.	Ratnaswamp and other appropriate staff

Wednesday, November 1, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
	• Alex Bryan, USGS Postdoctoral Fellow		
4:30–5:30 pm	Review Team only, closed session #2 – compilation of notes from day 2		
Evening	Group dinner		

Thursday, November 2, 2017

Time	Activity	Desired output	Lead entity/ person(s)
8:00–8:15 am	Gather. Review day-1 notes and day-3 schedule of activities.		
8:15–9:45 am	Flex time available for additional discussion topics. This may include 1. Products • Scott Jackson, University of Massachusetts 2. Education and training • Thomas Bonnot, University of Missouri • Marie Schaefer, College of Menominee Nation • Alex Bryan, USGS Postdoctoral Fellow • Kathryn Booras, University of Massachusetts • Ambarish Karmalker, University of Massachusetts 3. Particular testimonials • Scott Schwenk, North Atlantic LCC • Dustin Bronson, Wisconsin DNR • Kim Lutz, The Nature Conservancy	Time allocated to allow NE CSC to present material and hold discussions on any variety of topics that are unique to the CSC and haven't been addressed in other previous section.	Ratnaswamy and Palmer with input from French, Austen, and Loftus
9:45–10:00 am	Break		
10:00–12:00 pm	Review Team only, closed session #3	Identify key initial observations. Discuss writing assignments; prepare report-out key points.	French
12:00–1:00 pm	Working lunch		
1:00–2:30 pm	Report-out of Review Team to as needed. —Open dialogue between Review Team and hosts	• Open discussion and Q&A about initial observations • Develop list of follow-up items,	All participants are invited to this open presentation by the Review Team and

Thursday, November 2, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
		responsibilities, and timelines	discussion
2:30–5:00 pm	Working time for Review Team. Further compilation of comments, reflection on report-out, initial writing of key findings, assignment of additional writing and establishment of deadlines	Draft report development, review, and finalization timeline	NE CSC staff available to respond to questions or make clarifications as needed by the Review Team
5:00 pm	Complete working sessions of Review Team and adjourn		
6:30 pm	Dinner or departure of Review Team members		

Appendix C
Partnership Effectiveness Focus Group and Survey Questions

Focus Group Questions

Science Producers

1. Why did you become involved with the Climate Science Center?
2. What are the benefits of your involvement with the Climate Science Center? (probe for benefits to them as individuals, to scientific knowledge, to people who are in need of scientific information, to professional development of others)
3. What are the challenges you face in your involvement with the Climate Science Center
4. To what degree have you worked with the intended "users" of your climate science produced with/for the Climate Science Center?
5. Tell us more about your efforts to work with these potential climate science users. Why and how have you worked with them?
6. What challenges have you faced in working with or reaching out to science users?
7. How have you overcome (or tried to overcome) barriers to working with or reaching out to climate science users? [or to ensuring that the science you produce is used]? (probe for whether and how the CSC staff has played a role in overcoming barriers)
8. Generally speaking, what could generate more benefits from your involvement with the CSC—whether to you individually, to scientific knowledge, to people who use currently or could use climate scientific information, etc.?

Science Users

1. Why did you become involved with the Climate Science Center?
2. What are the benefits of your involvement with the Climate Science Center? (probe for benefits to them as individuals, to scientific knowledge, to people who are in need of scientific information, to professional development)
3. What are the challenges you face in your involvement with the Climate Science Center?
4. To what degree have you worked with climate scientists or used the science produced in association with the Climate Science Center?
5. Tell us more about your impressions of this climate science. Has it been useful? How have you used it?
6. What challenges have you faced in using the science as part of the CSC? (probe for challenges in working with scientists in using science)
7. How have you overcome (or tried to overcome) barriers to using climate science? (probe for whether and how the CSC staff has played a role in overcoming barriers)
8. Generally speaking, what could generate more benefits from your involvement with the CSC—whether to you individually, to scientific knowledge, to people who use currently or could use climate scientific information, etc.?

Survey Questions

These questions represent the standardized content used in surveys for all CSC reviews. Some slight variation in wording may have been made for region-specific clarity.

1. To what extent does your work involve climate adaptation science, or management or policy related to climate change adaptation? (Select one option)
2. How serious of a threat do you believe that climate change is to natural resources, relative to other stressors? (Select one option)

3. How important do you believe it is that managers or policy makers take action now in the region to address climate change threats? (Select one option)
4. How important do you believe it is that climate adaptation science inform decisions about natural resource management in the region? (Select one option)
5. Which statement best characterizes your relationship with the Climate Science Center (CSC)? (Select one option)
6. In what ways have you been involved with the CSC in the last five years? (Select all that apply)
7. How long (in years) have you been involved with the CSC? (Fill in number of years, or zero, if none)
8. How frequently did you interact with following representatives of the CSC in your region in the last year? (Select one option per row)
9. How important are each of the following benefits of the CSC to you? (Select one option per row)
10. What limits your involvement with the CSC? (Select all that apply)
11. To what extent do you agree or disagree with each of the following statements about the use of climate adaptation science in the region? (Select one option per row)
12. To what extent do you agree or disagree with each of the following statements about the science produced through the CSC (their staff, university affiliates, those funded by the CSC)? (Select one option for each row)
13. Is making decisions about natural resource policy, management, or programs part of your job?
14. Have you or your organization used climate adaptation science produced by the following sources to inform decisions about natural resource policy, management, or programs? (Select one option per row)
15. How have you used the climate adaptation science produced by the CSC, if at all? (Select all that apply)
16. To what extent do the following factors limit your use of the climate adaptation science and tools pro duced through the CSC? (Select one option per row)
17. In your opinion as a natural resource decision maker, how important is it that climate adaptation scientists and natural resource decision makers work together to produce science? (Select one option)
18. Some climate adaptation scientists collaborate with the end-users of their science in various stages of the research process. We are interested in whether you, as a natural resource decision maker, have any experience collaborating with climate adaptation scientists. To what extent have you or someone in your organization been involved in the following stages of research in one or more CSC projects (led by others)? (Select one option per row)
19. To what extent do you, as a natural resource decision maker, agree or disagree that the following items limit your involvement in research projects? (Select one option per row)
20. Have you produced climate adaptation science through an affiliation with the CSC (e.g., as CSC staff; university faculty, staff or students funded by or affiliated with the CSC; others funded by the CSC) or otherwise? (Select one option) As a reminder, by "climate adaptation science," we mean "science that helps fish, wildlife, ecosystems, and the communities they support adapt to climate change."
21. Has the climate adaptation science you produced been used in any of the following ways? (Select all that apply)
22. In other settings, various factors have been found to limit decision makers' use of science. From your perspective as a scientist, to what extent do the following factors limit the use of the climate adaptation science produced (not specifically by you) through the CSC? (Select one option per row)
23. In your opinion as a scientist, how important is it that climate adaptation scientists and natural resource decision makers work together to produce science research? (Select one option)
24. Some climate adaptation scientists collaborate with the end-users of their science in various stages of the research process. To what extent have you, as a climate adaptation scientist, had any experience collaborating with natural resource decision makers in the following ways? (Select one option per row)

25. To what extent has the CSC helped connect you with each of the following? (Select one option per row)
26. Do you agree or disagree that the CSC contributes to the following in your region? (Select one option per row)
27. What state(s) do you work in? (Select all that apply)
28. What scale(s) do you address in your work? (Select all that apply)
29. What is your affiliation? (Select all that apply)
30. What type of position do you hold in your agency, university, or organization? (Select one option that best describes your type of work)

Appendix D
Report from the Cornell University Human Dimensions Unit: Northeast Climate Science Center Results

Excerpted from Lauber, T. B., and R. C. Stedman. 2018. Quality and extent of partnership involvement in Climate Science Centers in the Northeast, South Central, and Pacific Island regions. Cornell University, Human Dimensions Research Unit, Ithaca, New York.

Respondents

We sought to survey both partners and potential partners of the Northeast CSC. Specifically, we attempted to include people who were working to address climate change either as "science producers" (those who produce climate adaptation science) or "science users" (those who make decisions about natural resource policy, management, or programs). This population is not well defined. As described above, we compiled our sample from three sources, but this approach may have yielded different numbers and types of partners from region to region. We characterize our respondents in the Northeast region in this section.

Forty-seven percent (n = 101) of the respondents reported that they make decisions about natural resource policy, management, or programs as part of their jobs. We refer to these individuals as science users. Forty percent (n = 84) reported that they have produced climate adaptation science through an affiliation with the Northeast CSC, while 18% (n = 38) have produced climate adaptation science but never with such an affiliation. We refer to both of these groups as science producers (58%; n = 122). Forty of the respondents (19%) were both science users and producers.

Fifty-two respondents (22%) were neither users nor producers. These individuals were less engaged in work involving "climate adaptation science" or "management or policy related to climate change adaptation" (Table NE-1).

All of our respondents did work that involved climate adaptation science, management, or policy to at least some extent. More than half of our respondents (52%, n = 123) were involved to a large or very large extent (Table NE-1). Thirteen percent (n = 31) were involved only to a small extent. Producers were more involved than users. Seventy-four percent (n = 61) of producers were involved to a large or very large extent. Seventy-one percent (n = 41) of users were only involved to a small or moderate extent.

Most respondents (77%; n = 174) reported that they have had at least some interest in or involvement with the Northeast CSC (Table NE-2). Just 18% (n = 41) reported that they had no involvement but

Table NE-1. Respondents' extent of involvement with climate adaptation science or management or policy related to climate change adaptation.

Extent of involvement	User	Producer	Both user and producer	Neither user nor producer	Total
To a small extent	15%	4%	10%	29%	13%
To a moderate extent	56%	22%	20%	40%	35%
To a large extent	21%	43%	40%	17%	31%
To a very large extent	8%	32%	30%	14%	21%

Table NE-2. Respondents' relationships with the Northeast CSC.

Extent of involvement	User	Producer	Both user and producer	Neither user nor producer	Total
Heard of the Northeast CSC, but no interest or involvement	7%	2%	3%	11%	5%
No involvement with the Northeast CSC, but someone else in my organization involved	33%	7%	18%	18%	18%
At least some interest or involvement with the Northeast CSC	61%	90%	80%	71%	77%

someone else in their agency or organization did, and another 5% (n = 12) had no interest or involvement at all.

Respondents worked in states throughout the Northeast region, but particularly in Massachusetts, New Hampshire, New York, Maine, and Wisconsin (Table NE-3). Relatively few worked in Kentucky and Iowa.

Table NE-3. States in which respondents work.

State	Percentage of respondents	n
Massachusetts	35%	83
New Hampshire	21%	49
New York	21%	49
Maine	20%	48
Wisconsin	20%	48
Vermont	17%	39
Minnesota	17%	40
Connecticut	16%	37
Pennsylvania	16%	37
Virginia	16%	38
Maryland	15%	34
Michigan	15%	36
Rhode Island	13%	31
West Virginia	13%	30
New Jersey	12%	28
Indiana	11%	26
Illinois	11%	26
Delaware	10%	23
Ohio	10%	23
Missouri	10%	23
Kentucky	6%	15
Iowa	6%	15

A majority of respondents worked at the regional/multi-state scale (70%; *n* = 164) and the state scale (60%; *n* = 140) for some or all of their work. Smaller percentages worked at the watershed (46%; *n* = 109), local (43%; *n* = 101), or national scale (32%; *n* = 75). Only about one-quarter (23%; *n* = 53) worked at the international scale.

The majority of respondents were affiliated with either federal agencies or universities (Table NE-4). Fewer were affiliated with state agencies or non-profit organizations. Very few were affiliated with private industry, tribal governments, or local governments. Nearly half of respondents held research positions (48%; *n* = 112). More than one-quarter (29%; *n* = 69) were in leadership/administration. Only a few were in operations (8%; *n* = 19) or policy (8%; *n* = 18).

Extent of Involvement with the CSC

On average respondents have been involved with the Northeast CSC for 3.4 years. Respondents reported a variety of types of involvement (Table NE-5). Most common was as a participant in a CSC training, webinar, workshop, or conference (37%; *n* = 86). Nearly one-fifth were resource managers or decision makers who had used the science produced by the CSC (19%; *n* = 44), and nearly as many (18%; *n* = 43) were CSC grant recipients, applicants, or partners on a grant.

The respondents reported on their frequency of interaction with five types of CSC representatives and affiliates (Figure NE-1). At least two-thirds of respondents interacted with each of four of the types (US Geological Survey CSC staff; University leads/PIs for the CSC; CSC-affiliated researchers; and CSC graduate or post-doctoral fellows) at least a few times a year. For their interactions with CSC Stakeholder Advisory Committee members, the modal level of interaction was "not at all," although 44% interacted with these individuals at least some of the time.

Benefits of Involvement

One of the most frequently identified benefits attributed to the CSC (Figure NE-2) was "access to a broader network of people interested in climate adaptation science" (74% described as "important" or "very important"; *n* = 127). During the focus groups, both science producers and science users frequently referred to the benefits of broader networks:

> Really, really important to have this community that's been created.... Now there's a central place to go, and it's people you know you can talk to. [NE Producer FG.]

> I think part of that is personal relationships. I know from my perspective working with Mary has been

Table NE-4. Respondents' affiliations.

Affiliation	Percentage of respondents	*n*
Federal agency	30%	70
University	28%	66
State agency	19%	44
Non-profit organization	15%	34
Tribal government	2%	5
Private industry	1%	4
Local government	1%	3

Table NE-5. Types of involvement with Northeast CSC in the last five years.

Affiliation	Percentage of respondents	*n*
Participant in a CSC training, webinar, workshop, or conference	37%	86
Resource managers or decision maker who has used the science produced by the CSC	19%	44
CSC grant recipient, applicant, or partner on a grant	18%	43
University member affiliated with the CSC	17%	39
CSC-funded graduate student or postdoctoral fellow	14%	33
LCC steering committee member	9%	21
CSC Stakeholder Advisory Committee member	6%	14
LCC staff member	6%	13
CSC-funded graduate student or postdoctoral fellow	6%	8
CSC USGS staff	2%	4

unbelievably productive. She's a fantastic point of contact and has really helped connect us to different folks and different resources.... So you know those sorts of relationships have just been huge in being able to sort of navigate that complex landscape. And we're tremendously thankful for that relationship. [NE User FG.]

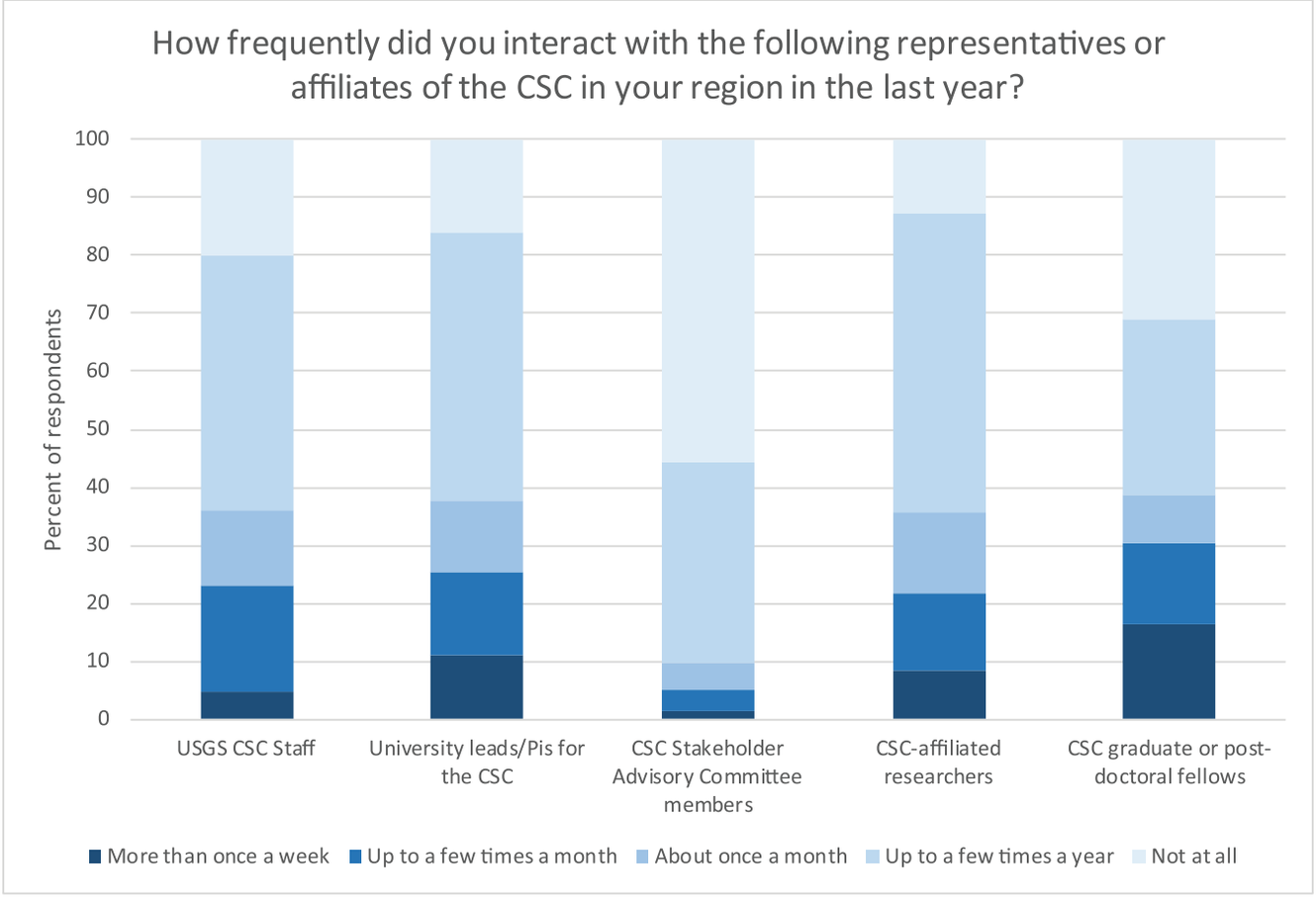

Figure NE-1. Based on survey question 8.

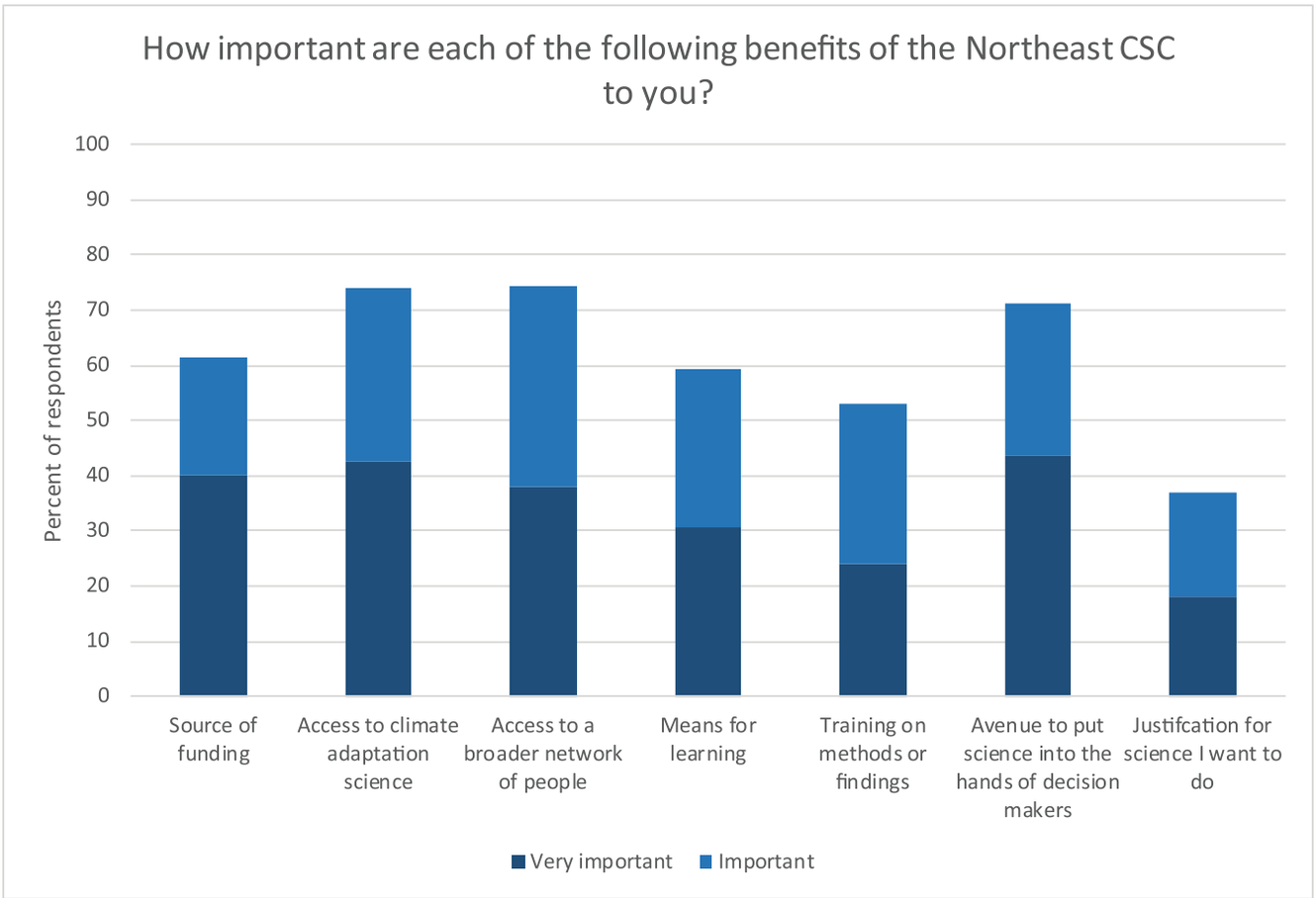

Figure NE-2. Based on survey question 9. Text in items shortened for presentation in graph, and only "important" or "very important" responses are shown.

Several participants observed that these networks often enable larger regional collaborations:

> Being able to plug into and establish a regional network is really valuable.... We're over on the west end of the CSC range, thinking about lake and stream issues.... It's kind of a no-brainer to connect with all of the people doing great work on the eastern end of that range.... It really helps solve the mechanism to get together to talk about shared interests and compare notes and collaborate so that has tremendous value to me. [NE Producer FG.]

> One of the great benefits for our project is that we were able to connect with other states within the Northeast Climate Science Center region. And this topic is really important not just within New York State, but the region interacts with other people across the Northeast who are dealing with the same questions. And also just really having that connection with climate scientists that I don't normally have in my day-to-day support. So that was really helpful. [NE User FG.]

"Access to climate adaptation science" was a benefit attributed to the CSCs by just as many survey respondents (74%; $n = 126$). Focus group participants also considered this one of the values of the CSC:

> I think that there have been some really tremendous gains made in this region with the science that's being developed by the CSC. And so it's being kind of a ... boundary-setting kind of translational science organization... It's been a pretty good and easy conduit for us to take the science that they're doing

> ... and be able to use that to speak to our audience and the people that we're working with as well. [NE User FG.]

> We're developing a landscape conservation design informed by future projections. A big part of that are climate projections, and to be able to lean on the CSC and the expertise that are found in the CSC was just completely important to that success of that project. [NE Producer FG.]

Nearly as many people who responded to the survey thought that the CSC also was an effective "avenue to put climate adaptation science into the hands of decision makers" (71%; $n = 121$). Science producers in the focus group identified communication with science users as an important benefit:

> Also, the CSC is an excellent avenue for facilitating communication and engagement with regional stakeholders facilitated through meetings and webinars. [NE Producer FG.]

A majority of survey respondents also believed that important or very important benefits of the CSC included serving as "a source of funding for climate adaptation science" (62%; $n = 104$), "means for learning about climate adaptation" (59%; $n = 101$), and "training on climate adaptation science methods or findings" (53%; $n = 90$).

Funding was discussed more often in the producers focus group than the users focus group. Participants who talked about funding often argued that it filled needs that other funding sources could not:

> The project that I'm working on primarily funded a postdoc.... What that allowed me to do in my research program was to do a project that is very closely tied to stakeholders and to a network of kind of end users ... in a way that has science behind it.... That kind of project would be almost impossible to fund anywhere else. [NE Producer FG.]

> There are several other I think unique aspects about the funding from the center that are worth mentioning as benefits. So as one of the consortium PIs we benefit in that we get a relatively stable level of base funding for the duration of the original 5-year study.... So that lets you do something or things you can't do with more intermittent funds. [NE Producer FG.]

During discussions of the value of learning and training opportunities, benefits to students and postdocs were frequently discussed:

> There are some benefits of the Climate Science Center to me that are really kind of intangible.... There's this informal interaction ... just interactions, consultations, picking brains kind of thing that really is invaluable to an early career person.... Just the times of exposure to the staff here, the focus on stakeholders, to an early career person is very valuable and constantly learning to approach the discussion that we're addressing from stakeholders' perspectives ... has been really valuable. [NE Producer FG.]

> I think one of the things that has been happening that's really important is the training and capacity building by supporting students and postdocs. And so there's a lot of more capacity of people who not only have been studying, doing their research on the climate science, but have been working with stakeholders.... Some of them have been getting this other thing communication training and I think we are building a bigger capacity of really having people who are you know starting to fill this real need we have nationally. [NE Producer FG.]

Limitations on Involvement

The most common limit on involvement with the CSC was not having enough time (41%; $n = 97$), followed by not having enough funds (26%; $n = 60$) (Figure NE-3). Being constrained by the amount of time that partners had available was a topic that came up in both the producers and users focus groups:

> We all work for another institution, so that is one more organization we have to coordinate and interact with. But we all do it by choice because of the great work we think we're doing through it. So it's a challenge. [NE Producer FG.]

> The amount of time I'm able to devote to it has been challenging.... I've seen that the Climate Science Center has grown and has been very active and has an incredible staff. And I have worked with some of them, and they have sent emails to me directly. But I haven't taken the time to understand the roles or position staff members at the Climate Center and I think that would be helpful to me going forward.... I just haven't had time to do that. [NE User FG.]

Even more frequently discussed was the closely related topic of the difficulties faced by some of the partners who worked in locations far from the University of Massachusetts:

> We're really, really lucky to be nearby, but, unfortunately, I think there are people who aren't right nearby. But there's a great advantage for local folks. [NE Producer FG.]

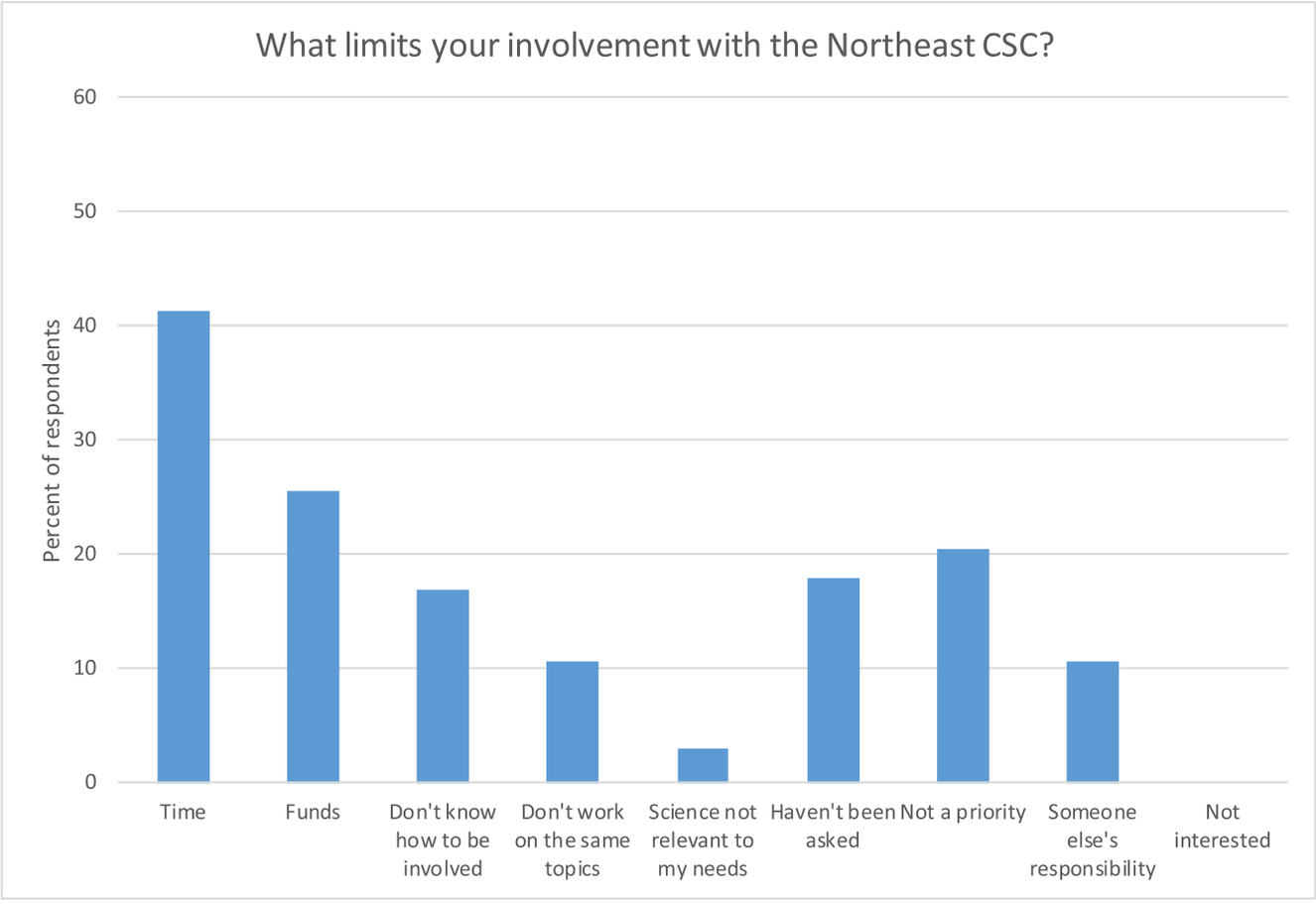

Figure NE-3. Based on survey question 10. Text in items shortened for presentation in graph.

> A challenge in a distributed network like this where you got the hub at UMass ... is there's a lot of attenuation as you, as you go ever ... further from that hub.... When your mandate is to cover 22 states and ... directly have a presence in 9 of them ... it's a big challenge that's difficult to overcome.... It's ... never going to be like the UMass model on every one of these campuses within the network. [NE Producer FG.]

From the science users' perspective, the distance led to many of the Northeast CSC projects being more relevant to the Northeast than other parts of the region:

> It certainly seems that a lot of the projects are either national or ... focused a lot of times in the northeast corridor.... It's certainly something we've seen where even some of the scientists who are from University of Minnesota or Forest Service of Missouri are actually working on projects that are based in the Northeast. [NE User FG]

> That's ... one of my top issues, a drum that I beat all the time, with the need for a Midwest focus.... Not that the Northeast Climate Science Center hasn't been great, but it is just a really key area and the issues that we have in the Great Lakes are very different or in the corn belt are very different from the Northeast. [NE User FG.]

One in five survey respondents said their involvement with the CSC was limited because working with the CSC was not as high of a priority as other work (20%; $n = 48$). Fewer than one-fifth of survey respondents reported that their involvement was limited because they had not been invited or asked to be involved (18%; $n = 42$) or did not how to be involved (17%; $n = 40$). Nevertheless, confusion about the functions that the CSC filled, which had implications for how partners would engage with it, was a topic that was discussed in the science users focus group.

> I think that for some partners, at least for folk that we engage with, there may still be some confusion as to the roles of the LCC vs. the Climate Science Center in terms of science generation. [NE User FG.]

Is Climate Adaptation Science Actionable?

Respondents shared their perceptions both of climate adaptation science, in general, and of the climate adaptation science produced by the CSC. With regard to climate adaptation science in general, nearly three-quarters of respondents (73%; $n = 155$) agreed or strongly agreed that climate adaptation science in the Northeast region is available to decision makers (Figure NE-4), and more than half thought that fish and wildlife managers, (55%; $n = 119$) and land managers (51%; $n = 110$) used this science to inform management. Only about one-third (31%; $n = 67$) believed that policy makers used this science to inform policies. A majority (58%; $n = 125$) maintained that what is known about climate adaptation does not necessarily influence actions taken by decision makers in the region. Nearly half (47%; $n = 102$), however, agreed that the CSC has helped to reduce the disconnect between what is known about climate adaptation and the actions taken by decision makers in the region.

In terms of the Northeast CSC science specifically, respondents (89%; $n = 191$) strongly or somewhat agreed the CSC science can contribute to policy or management (Figure NE-5). Respondents were also positive about other characteristics of the CSC science, finding it high quality (79%; $n = 168$) and appropriate to inform the types of decisions being made (82%; $n = 175$). A majority also thought that it integrated well with other information (69%; $n = 147$). Fewer than 20% thought that the Northeast CSC's science was irrelevant to management (13%; $n = 27$), and almost none thought it was biased (2%; $n = 4$).

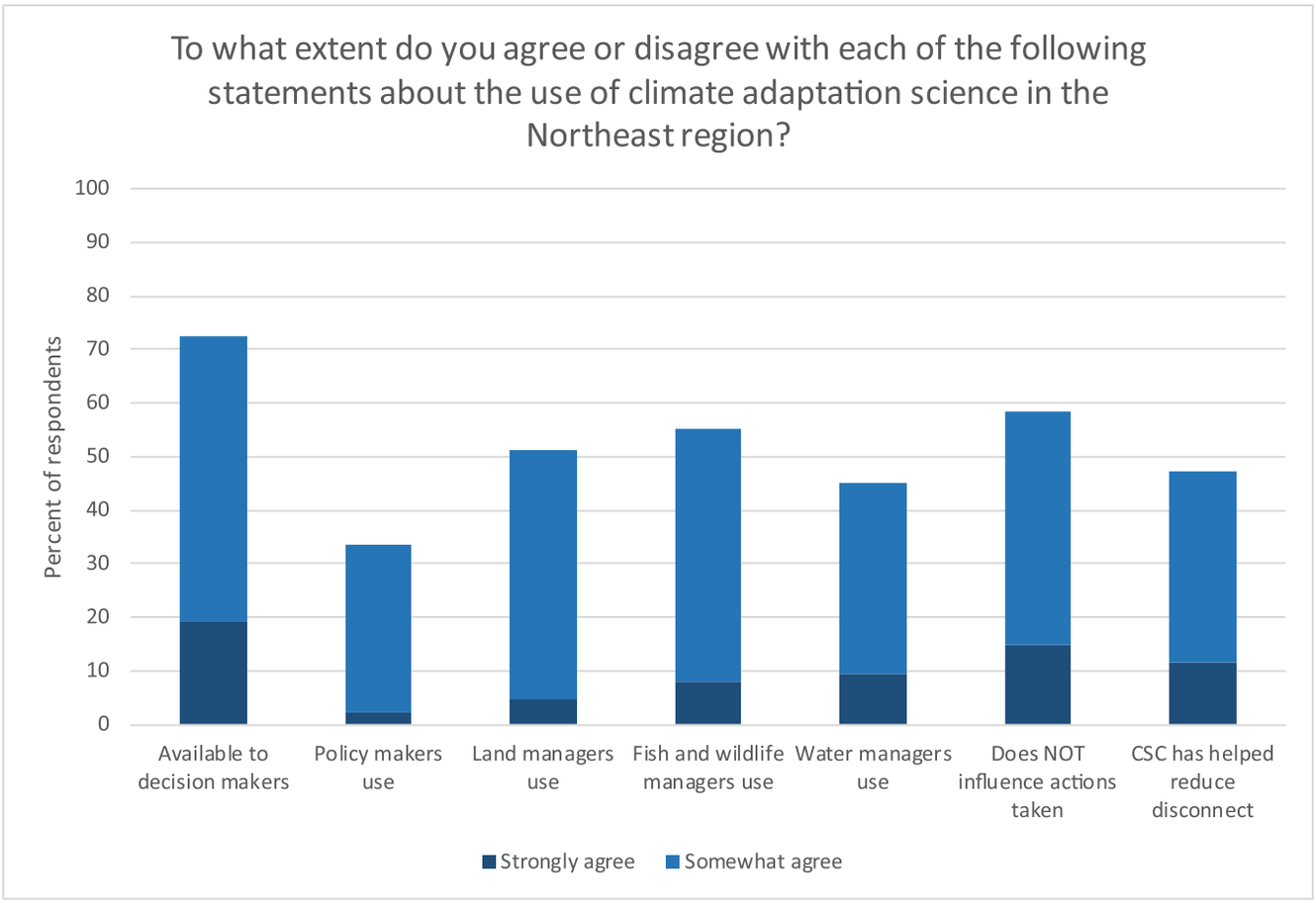

Figure NE-4. Based on survey question 11. Text in items shortened for presentation in graph.

Science Users' and Producers' Use of Climate Adaptation Science

Among respondents who reported that they were science users, 61% (n = 61) reported that they or someone in their organization used climate adaptation science from sources affiliated with the Northeast CSC. (Twenty-eight percent did not know whether they had.) More than three-quarters (77%; n = 76) reported that they or someone in their organization used climate adaptation science from sources not affiliated with the CSC.

The most common way science users reported using the Northeast CSC science (Figure NE-6) was to inform management plans (46%; n = 46). More than one-third reported using it to inform management actions (36%; n = 36) and inform training of conservation professionals (34%; n = 34). More than one-quarter (29%; n = 17) used it to inform the public about climate change and its impacts. It was less frequently used to inform policy (17%; n = 17) and inform land acquisition priorities (13%; n = 13).

When science producers were asked a parallel set of questions about how the science they had produced had been used, the relative frequency of different types of reported uses was similar, but the absolute frequency was greater. More than two-thirds (71%; n = 86) said their science had been used to inform management plans, and more than half said their science had been used to inform the public about climate change and its impacts (59%; n = 72), inform management actions (57%; n = 70), and inform training of conservational professionals (51%; n = 62). The differences between science users' and science producers' responses could reflect differences in perceptions about how frequently CSC science

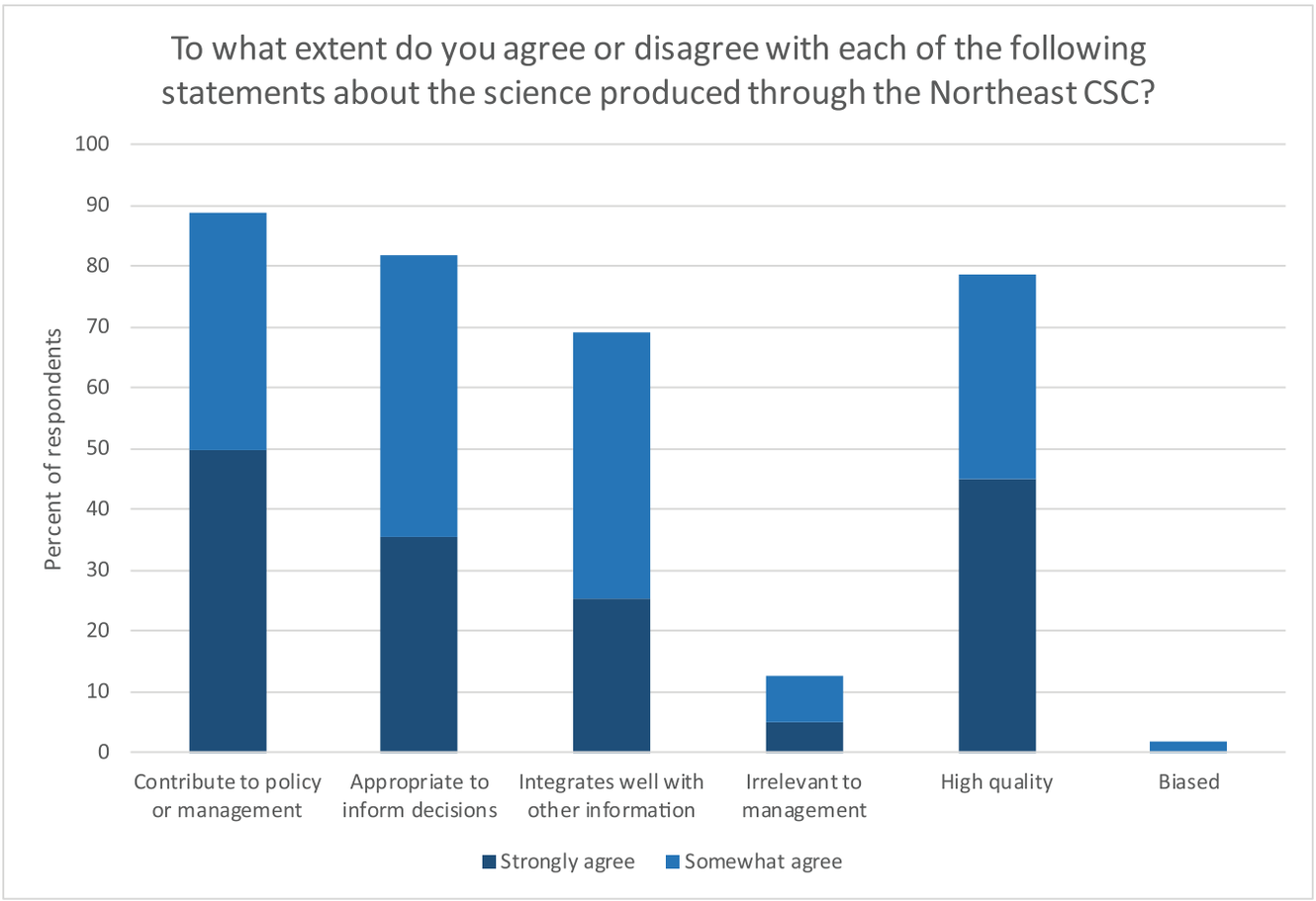

Figure NE-5. Based on survey question 12. Text in items shortened for presentation in graph, and only "strongly agree" and "somewhat agree" responses are shown.

is used. It could also reflect that the use of CSC science is concentrated in a subset of potential CSC science users.

Different perceptions of the use of Northeast CSC science also were evident in the focus groups. Many science producers characterized their science as actionable, sometimes providing examples of their efforts to make it actionable:

> We met with stakeholders once a month for two years and that slowed down the science. We knew it was going to be actionable as a landscape conservation design but when you're kind of exploring five or six different avenues every month to show the stakeholders that they can visualize what the outcome might be, that's not the typical academic research science schedule and so that kind of collaboration between a CSC and the LCC really allowed that process to take place which I think is pretty unique. [NE Producer FG.]

> Working at the Northeast CSC has allowed me to the do the science I've always wanted to do, which is work with a decision maker initially to make sure we're actually answering the question that they want answered ... And then to figure out ways of best presenting that research to the stakeholders so it's immediately digestible and supportive of decision making. [NE Producer FG.]

Science users, on the other hand, were more likely to question whether much of the CSC science was actionable:

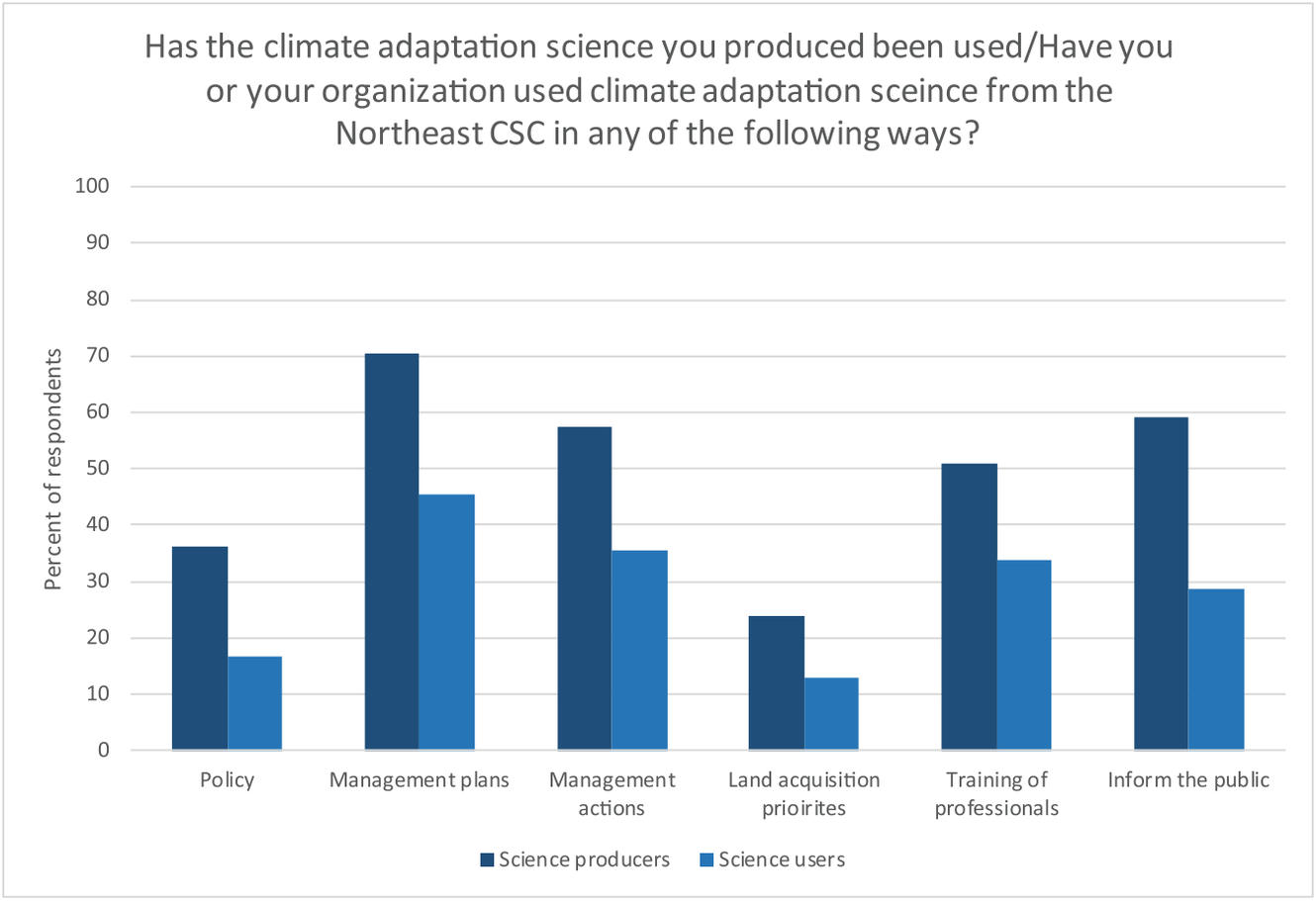

Figure NE-6. Based on survey questions 15 and 21. Text in items shortened for presentation in graph.

> To get climate science used, it's even beyond translation. You really have to have stakeholder-driven coproduction of science... My personal opinion is that many or even the majority of Northeast Climate Science Center projects are not really producing management-driven or actionable results, and it's really hard to do.... It takes a lot longer and it's more intense to bring the stakeholders and managers together to plan that out.... I've done a quick analysis of the Climate Science Center projects.... Of the 57 forest, wildlife, coastal projects that the center has focused on in our part of the geography, just kind of my rough cut, I mean you know this is my personal opinion, I'd say about 17 of those 57 look like, yes, they could have actual management implications and could be used right now for management. [NE User FG.]

Both science users and science producers recognized factors that could limit the use of CSC science. Science users and producers differed in their perceptions of what these factors were (Figure NE-7). In all cases, more science producers than science users perceived limits to the use (not necessarily their own use) of CSC science to a moderate, large, or very large extent. More than 60% of science producers thought that the use of CSC science was limited by lack of awareness of the science (78%), scientists not working closely enough with decision makers (75%), decision makers lacking the skills and training to use the science (73%), and the science not being communicated understandably (65%).

The only factor that a majority of science users thought was limiting the use of CSC science was management issues not being well defined (51%). Neither group considered a lack of quality of the science to be a problem (science users – 2%; science producers – 7%).

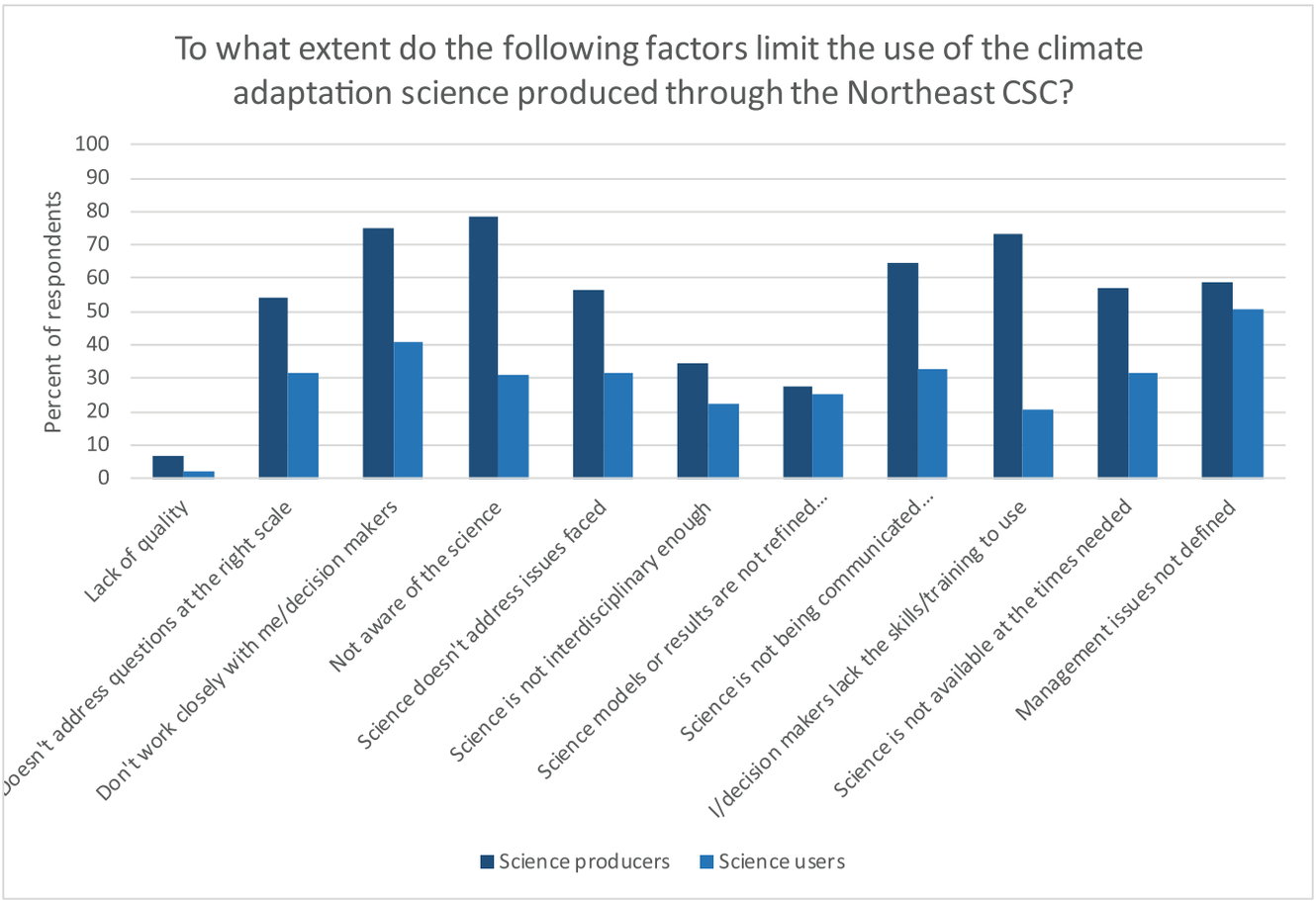

Figure NE-7. Based on survey questions 16 and 22. Text in items shortened for presentation in graph, and only "to a moderate extent," "to a large extent," or "to a very large extent" responses are shown. Also, text varied slightly for science producers and users.

The discussion of limitations on the use of CSC science in the focus groups surfaced a greater number of concerns. Both science producers and science users thought that making science accessible to users was a challenge:

> I think the challenge then comes back to us ... how do we take the science ... is there some way, some framework we can put it in, some tool we can use, that makes it easier for them? [NE Producer FG.]

> I just think that there's this inherent challenge to disseminating and translating that science and then perhaps to a lesser extent to make sure that the science is as user-friendly as possible. [NE User FG.]

> I'm really an end user.... The challenge has always been to take those products and ... step it down a level that is applicable to us, and also having that background and time to understand it and interpret it. [NE User FG.]

They believed that one reason for this challenge was the technical limitations of potential science users:

> The biggest challenge we've had is how to communicate uncertainty effectively... Lots of time they just don't like to deal with it because they haven't ... been able to understand it or figure out how to incorporate it into the decisions they're making.... If the Climate Science Center could come up with

> some kind of unified way of explaining variability that could be really, really powerful. [NE User FG.]

> These are not uncommon problems. Right, I mean science literacy is a major issue in our center and country.... I mean it's really hard to have conversations about all of these aspects whether it's variability or just climate change without having an informed public. And so I think that that's always, that's always a challenge. [NE User FG.]

Consequently, producers and users made efforts to translate the science into forms that were usable to decision makers:

> It's not enough to just create a model.... You have to take that model ... here's what the outcomes would be for those alternatives, being very explicit, prescriptive, is something that I think that was critical. [NE Producer FG.]

> I think when we're talking about the products that would be useful to managers, managers don't generally think in terms of the climate impact that's going to impact them. They think more in terms of the problems that they have. So the syntheses are oriented around Wildlife Action Plans or how you set waterfowl regulations or the sort of problems that they're dealing with makes it easier for them to integrate climate into all of the other factors at work. [NE User FG.]

Some focus group participants believed that more efforts of this type were needed:

> I would highly recommend some focus on data visualization at some level.... You could require that every project has a data vision component.... I was actually in this room a year ago talking about the visualization kind of approaches to the Climate Science Center and it hadn't really been thought about at all. And I was frankly shocked that ... they hadn't been taking it to that ... almost final step of how to communicate these very complicated things. So that's I'd say from my point of view the biggest deficiency in the Climate Science Center right now. [NE Producer FG.]

> Outlets beyond peer review publications, they could be either provided, developed by the CSC or developed through the other partner.... You know there's like a whole slew of ways they can get out there, but some non-peer review publications and sort of thing, like they kind of talk like normal people. [NE User FG.]

To some extent, the actionability of the CSC science was also limited by the diversity of ecoregions within the large geographic area:

> I think the geography of this particular Climate Science Center is a very big issue.... I count something like 22 states in the Northeast Climate Science Center.... It is virtually impossible for this Climate Science Center to really address all of those ecoregions effectively.... I think that's probably the biggest issue, that almost none of the climate science that's being produced is effective in the agricultural working lands of the lower Midwest. [NE User FG.]

Science Users' and Producers' Engagement in Coproduction of Knowledge

Respondents reported on their beliefs about co-production of knowledge in general. An overwhelming proportion of both science users (94%; $n = 91$) and producers (95%; $n = 114$) expressed support for co-production, indicating it was important or very important for climate adaptation scientists and natural resources decision makers to work together on scientific research.

Many science producers indicated experience in co-production in various phases of research projects, much more so than did science users[1] (Figure NE-8). For all phases of research projects except for "analyzing data," at least half of the science producers had experience collaborating with decision makers to a moderate, large, or very large extent. (These results apply to all types of research, not just CSC-sponsored research.) In contrast, when science users were asked about their experience collaborating on research with CSC science, there were only 3 phases of research with which at least 30% of science users had experience: communicating results of a research project (44%), applying research results (41%), and identifying research questions (37%).

During the focus groups, a number of science producers described their experiences with coproduction:

> The work tapped into a whole stakeholder network of sugar maple producers who were then involved in data collection for sugar maple, sugar content ... phenolics and the timing of sap flow all across this broad geographical latitudinal gradient. [NE Producer FG.]

[1] As noted in a previous section, the science producers in our sample were also more extensively engaged with climate adaptation science, management, or policy – as well as with the CSC itself – than the science users in our sample.

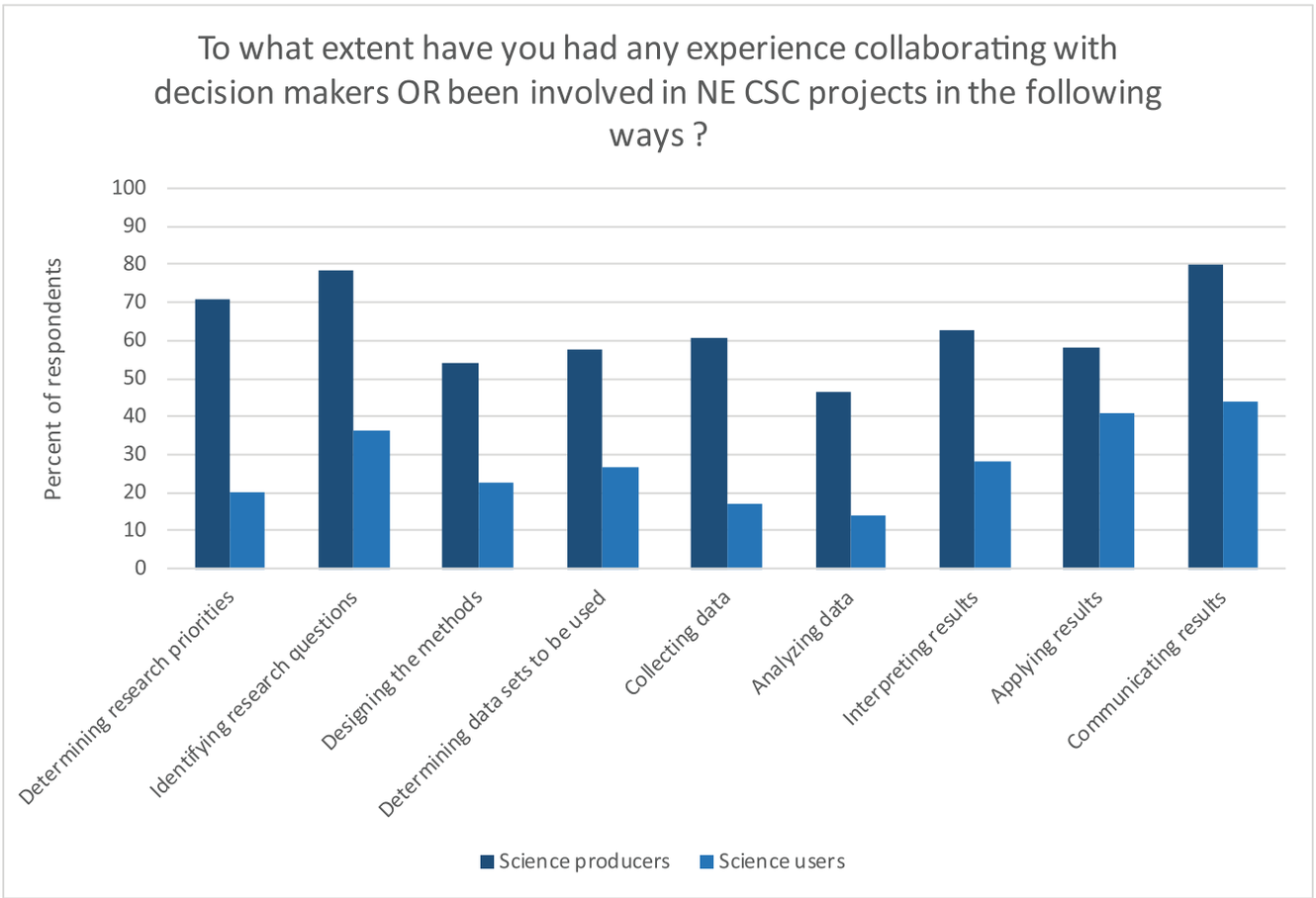

Figure NE-8. Based on survey questions 18 and 24. Text in items shortened for presentation in graph, and only "to a moderate extent," "to a large extent," or "to a very large extent" responses are shown. Additionally, the text of the question varied slightly for science producers and users (e.g., the users' version referencing "you or someone in your organization" and specifying a Northeast CSC project).

> I worked with eight resource managers from across the northeast where I got to really hear firsthand what their ... concerns were, what information they needed in order to make better informed decisions. [NE Producer FG.]

> One of our associates ... he's done a lot of these climate scenarios.... He's worked with the stakeholders ... to try to narrow them down to what it is they think they need.... So trying to get a complex climate science down to more digestible, that's the primary task of his. [NE Producer FG.]

Experiences with coproduction were also discussed in the science users focus group:

> We've actually brought together the invasive species managers, the land managers to talk about ... what kind of information they need ... how they even use that information. And now we're going to the science and think, okay, okay what do we know? What do we don't know? And how can we get that information that we need to answer those questions?... We've been coming in from a different angle and that has been really useful because we've gotten the stakeholders, the people who are going to use the information, really engaged right up front. [NE User FG.]

Nevertheless, CSC partners also recognized many constraints on coproduction. In the survey, the factors that science users thought were most likely to limit their involvement in research projects were scientists not reaching out to them (41% agreed or strongly agreed; $n = 38$), followed by funders not supportive of collaboration between scientists and science users (32%; $n = 30$) and different perspectives on what science is needed (28%; $n = 26$).

Focus group participants also recognized that coproduction was sometimes limited by lack of a shared understanding of what science was needed by scientists and science users. One science producer argued that users do not always know what kind of information they need:

> They don't always know what they need or want. So ... we're reaching out to the state.... They knew we're here. They knew we had lots of resources to bring to the table. But they weren't sure what they needed to help guide their state wildlife action plan. So they don't always know specifically what they need. [NE Producer FG.]

Other participants argued that scientists needed to make a proactive effort to learn about these needs if coproduction was to be successful:

> The ... proactive outreach to identify what the science needs are ... a time-consuming and boots-on-the-ground intensive process, but I think one that's really important to make sure that the science that's being generated addresses the needs at the practitioner level. Sometimes it's not as fancy or flashy as perhaps some researchers like, but still needed. So I think that's a sort of a tension point that exists. [NE User FG.]

> In terms of co-creation, I think it's not only being able to respond directly to the sort of demands or needs of stakeholders, but ... many people commented on the long, the ... relationship side of the partnerships that evolved.... And that leads to genuine co-creation of the ideas where you hear about an agency or an NGO's data, and then you bring some new ideas to the table, and then you inject a student or postdoc who has even better new ideas, and pretty soon you've gone beyond what any one partner could have done. So it's not only the sort of, "yeah, we're doing actionable stuff because we're responding to what an outside party said from day 1 they wanted...." We're helping them and they're helping us to evolve a new research goal that takes things to a higher level. [NE Producer FG.]

Some of the science users believed that scientists did not always make enough of this type of effort to learn about users' needs in their work:

> As projects get started ... they really need to be specific about the users/stakeholders.... Like who is actually going to use this. 'Cause I think there may be a disconnect there.... I think some projects have done a great job and some really probably haven't, but I think you know the way to address that is to really have the researchers, the project leaders, to be thinking about who's going to use it. I don't think they are going to be trying to reach the general public, but they may be interfacing with organizations like the Park Service.... Who are actual people in organizations that could be using this information? And work with them throughout the process and not have it kind of be, well sometimes I've seen proposals, they list a whole bunch of stakeholders that could use it but there's not really you know a sharp connection there and it doesn't actually happen. [NE User FG.]

Other factors were perceived to limit the involvement of smaller numbers of respondents: the science users not having enough time (25%; *n* = 23), scientists not interested in listening to them (14%; *n* =13), and different perspectives on how research projects should be conducted (13%; *n* = 12). The amount of time required for coproduction was also discussed in the focus groups:

> To speak to the challenge ... from the perspective of an early career scientist, the coproduction of science is very time consuming. Not only the process of going through that coproduction but oftentimes for that science to be actionable. It's a map, it's a report, it's not a publication. And so we're constantly on that balancing act between ... we live in an academic world and our measure of success are publications, but yet we're also primarily funded by the CSC and the LCC and their currency is the coproduction actionable science, which are often tools. [NE Producer FG.]

Perceptions of the Role of the CSC

The Northeast CSC has helped facilitate various connections (Figure NE-9). The most common connections reported were with climate adaptation science (57%; *n* = 117) and climate adaptation scientists (54%; *n* = 110). Nearly half also reported getting connected with resources needed to conduct science (47%; *n* = 94).

Most than half of respondents agreed that the Northeast CSC made a wide variety of contributions to the region (Figure NE-10). The contributions that were most widely perceived were awareness of available science (72%; *n* = 144), collaboration between scientists (68%; *n* = 135), communication between scientists and those who might use the science (66%; *n* = 132), and interdisciplinary science (62%; *n* = 126).

Summary of Northeast Results

Survey respondents were comprised of nearly one-half science users, more than one-half science producers, and some individuals who fell into neither group. All were involved with climate work to some extent, but producers were more involved than users. All were aware of the Northeast CSC, and most were involved with it; producers were more likely to be involved than users. Respondents included employees of a variety of types of organizations and agencies, but federal agencies and universities were most prominent.

Survey respondents were involved with the Northeast CSC in a variety of ways, but the most common was as participants in CSC trainings, webinars, workshops, or conferences. Nearly one-fifth were resource

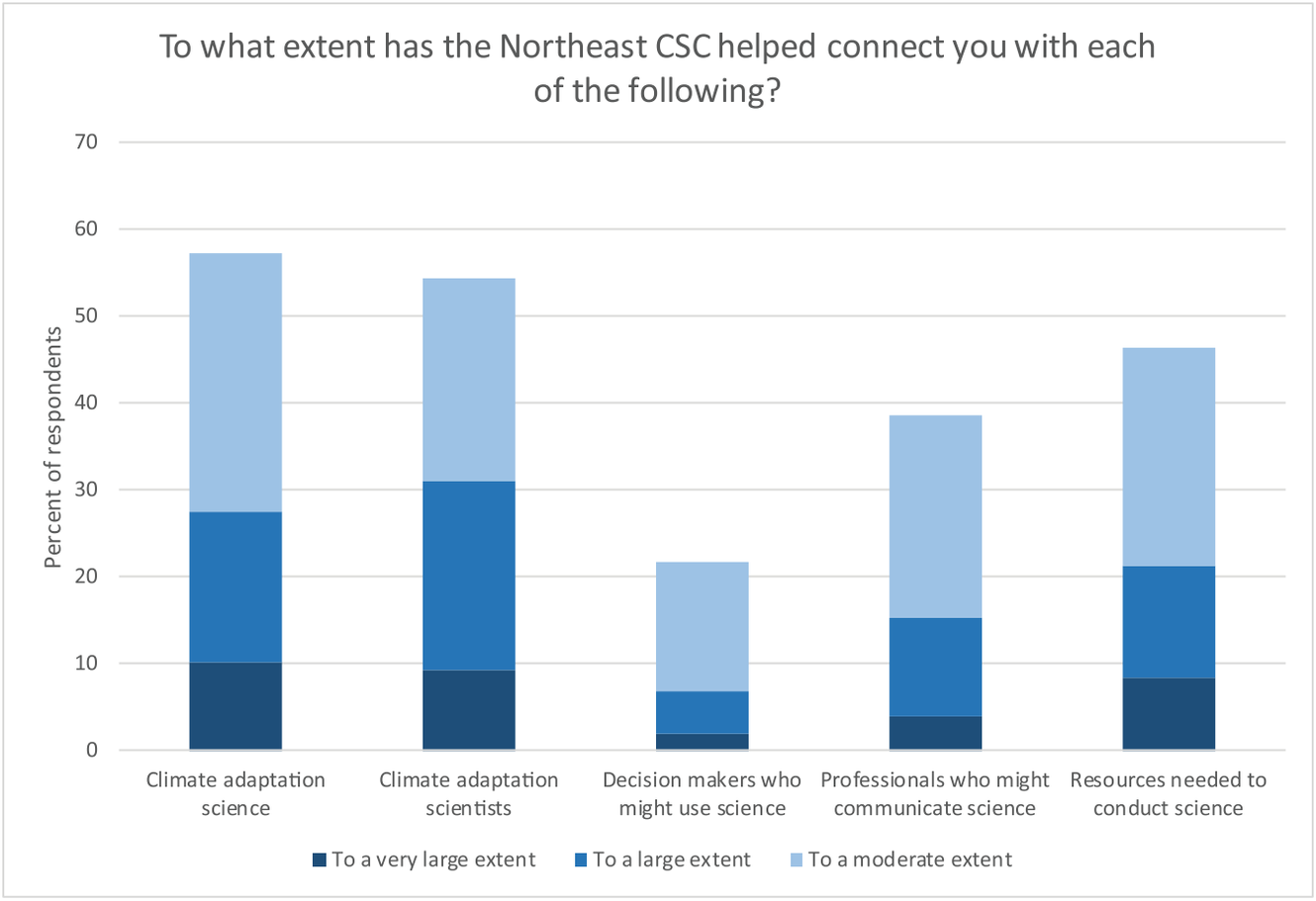

Figure NE-9. Text in items shortened for presentation in graph, and only "to a moderate extent," "to a large extent," or "to a very large extent" responses are shown.

managers or decision makers who had used the science produced by the CSC, and approximately the same number were CSC grant recipients, applicants, or partners. Partners interacted most frequently with CSC-affiliated researchers, university PIs for the CSC, and USGS staff.

The CSC provided many important benefits to partners with the top ones identified by survey participants being providing access to climate adaptation science, providing access to a network of people interested in climate adaptation science, and serving as an avenue to put science in the hands of decision makers. Focus group participants spoke at length about the value of the networks to which the CSC gave them access and the value of the science produced. Survey respondents reported they were limited in their involvement with the CSC by a variety of factors with the most common ones being time and funds.

Nearly three-quarters of the survey respondents felt that climate adaptation science in the Northeast region[2] was available to decision makers, and many also believed that decision makers, particularly fish and wildlife managers and land managers, use the climate adaptation science to inform policies and management. Nevertheless, more than half believed that climate adaptation science did not *necessarily* influence management actions taken, although almost half also believed that the Northeast CSC had reduced the disconnect between scientists and decision makers. When asked specifically about the science produced through the Northeast CSC, the vast majority of the survey respondents agreed it can contribute to policy or management. Respon-

[2] All climate adaptation science in the region, not solely the science produced by the CSC.

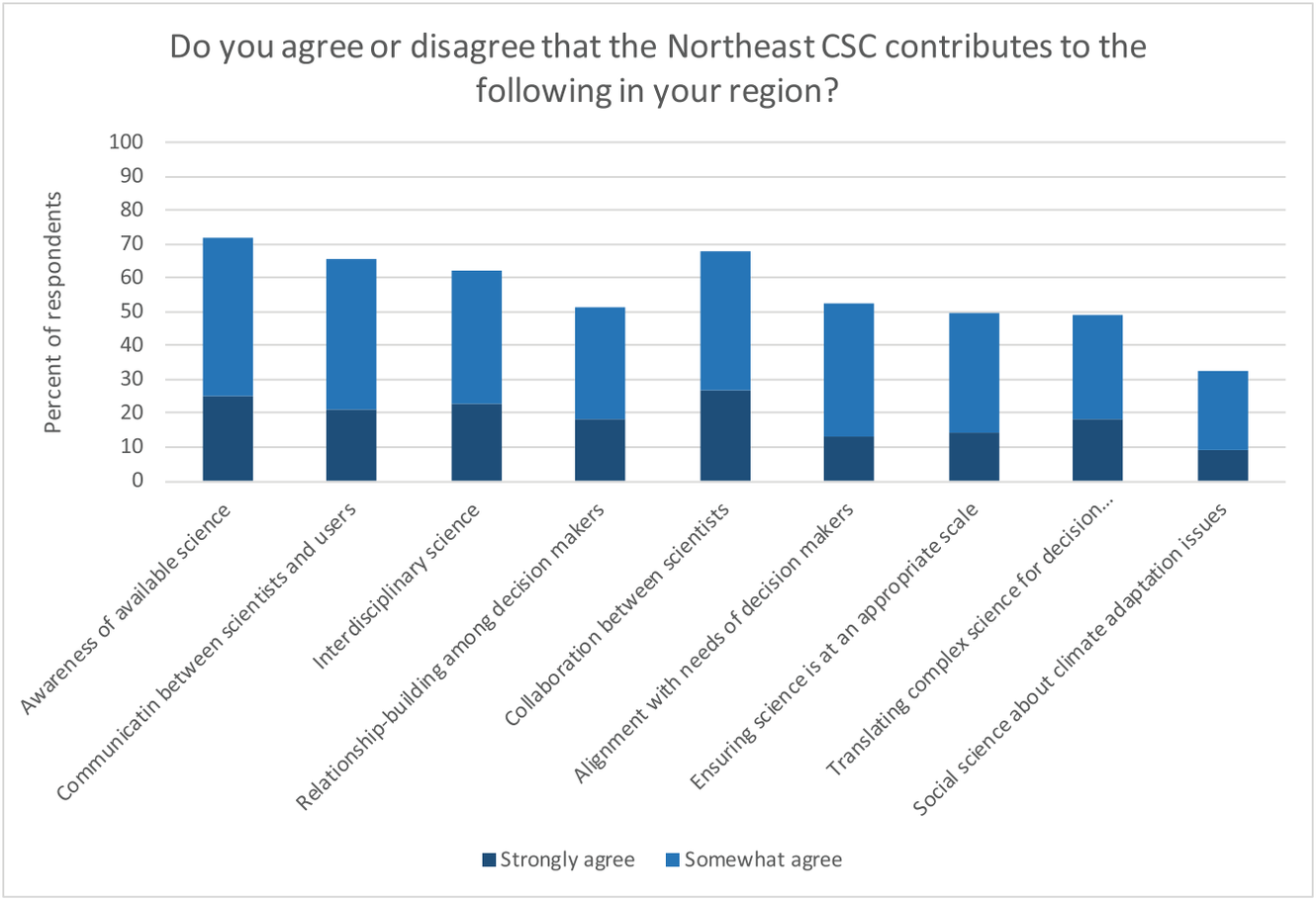

Figure NE-10. Text in items shortened for presentation in graph, and only "strongly agree" or "somewhat agree" responses are shown.

dents were also generally positive about other characteristics of the CSC science, and a large majority found it appropriate to inform decisions, high quality, and able to integrate well with other information.
The most common way science users and producers reported that the Northeast CSC science was used was to inform management plans. Science users and producers differed in their perceptions of what limits the use of CSC science. Science producers perceived more limits than users on the use of CSC science. Nevertheless, focus participants elaborated on factors that could limit the use of CSC science. Most prominent among these factors were the difficulty in making science accessible to users and the technical limitations of the users. In response to these challenges, CSC partners made efforts to translate the science into forms accessible to decision makers.

An overwhelming proportion of both science users and producers expressed support for coproduction of knowledge. While many of the science producers indicated experience in coproduction in various phases of research projects, many fewer science users reported first-hand experience. Coproduction was more common in the early stages (identifying research questions) and late stages (interpreting and communicating results) of research than the middle stages. Science users who responded to the survey reported that their involvement in co-produced research projects is most limited by scientists not reaching out to them to collaborate, funders not supporting collaboration between scientists and science users, and users having different perspectives from scientists on what science is needed. In the focus groups, discussions of the limitations on coproduction centered on users not always knowing what type of science they needed and scientists having to make more of a proactive effort to learn about these science needs.