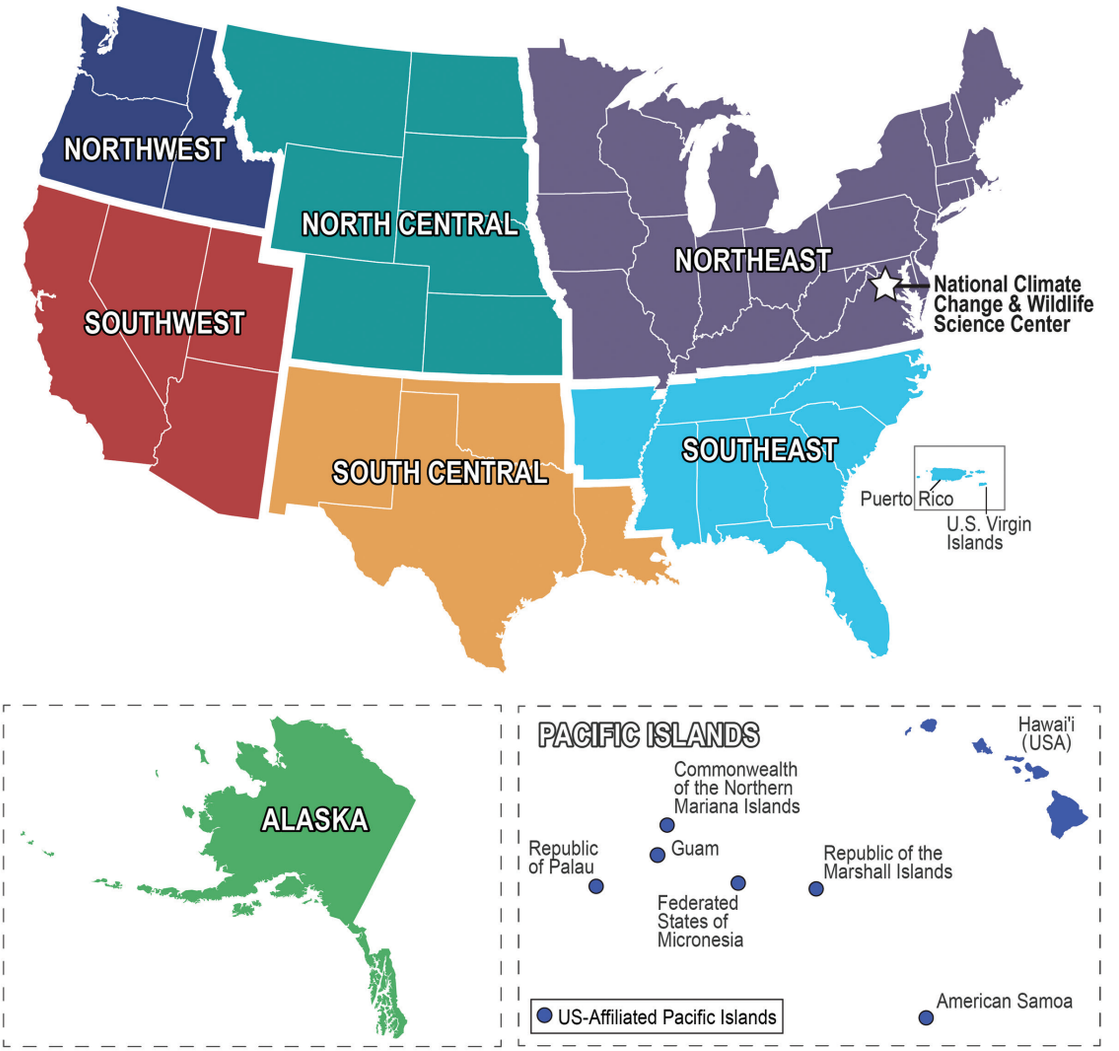
Five-Year External Reviews of the Eight Department of Interior Climate Science Centers

South Central Climate Science Center



Department of the Interior Climate Science Center Regions

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Cover image: 2016 map of the Climate Science Center regions and consortia. U.S. Geological Survey, www.sciencebase.gov.

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

South Central Climate Science Center*

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Contents

Acknowledgments . . . vii
Executive Summary . . . ix
Abbreviations and Acronyms . . . xi
List of Figures . . . xiii
List of Tables . . . xiii
Introduction . . . 1
Review Purpose . . . 1
NCCWSC and CSC Missions and Guiding Principles . . . 1
Review Process . . . 4
Roles of AFS, the HDRU, and NCCWSC . . . 4
Program Evaluation Measures for CSCs . . . 5
Survey and Focus Group Methodologies . . . 6
Group interviews . . . 6
Web-based survey . . . 6
Institutional Development . . . 7
SC CSC Development . . . 8
Institutional Coordination . . . 9
USGS . . . 9
OU . . . 10
Consortium . . . 11
Stakeholder Advisory Committee . . . 11
Institutional Coordination Summary Recommendations . . . 12
Tribal Engagement . . . 12
Accomplishments . . . 13
Recommendations . . . 13
Actionable Science . . . 14
Stategic Science Plan . . . 14
Climate Science Implementation . . . 15
Competitive grants . . . 15
Directed grants . . . 16
Host-consortium research project . . . 17
Leveraged funding . . . 18
SRT Observations on Science Strategy and Accomplishments . . . 18
Evaluation of Actionable Science Success . . . 20
Metrics . . . 20
Stakeholder perceptions and use of actionable science . . . 20
Summary Recommendations on Actionable Science . . . 25
Communications . . . 25
Internal Communication Opportunities . . . 27
Communication of Climate Change Information . . . 27
Communications Recommendations . . . 27
Capacity Building . . . 28
Online Courses . . . 29
Study Abroad Program . . . 29
Nurturing STEM Education in Underrepresented Groups . . . 29

Tribal Workshops 30
Tribal and Other Interns 30
Undergraduate and Graduate Staff 31
Capacity Building Summary 31
Partnerships 31
Concluding Comments 32
References 32
Appendix A: South Central Climate Science Center Review Team Members 34
Appendix B: South Central Climate Science Center On-Site Review Schedule 36
Appendix C: South Central Climate Science Center Research Funding by Mechanism 43
Appendix D: Partnership Effectiveness Focus Group Questions 46
Appendix E: Report from the Cornell University Human Dimensions Research Unit:
South Central Climate Science Center Results 47

Acknowledgments

This review involved substantial effort and time commitments from numerous individuals, particularly members of the Science Review Team (SRT) 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. South Central Climate Science Center (SC 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. Geological Survey SC CSC: Mike Langston, acting director; the staff of the University of Oklahoma SC CSC: Renee McPherson, university director/University of Oklahoma, Emma Kuster, program coordinator, and Jessica Blackband, communications specialist, and all of the SC 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. Collectively, the information provided about the SC CSC throughout the review afforded a comprehensive overview of the center's first 5 years of operation. While the information provided to the SRT was extensive, we recognize the challenge of fully appreciating many years of accomplishments and challenges. We are, however, hopeful that the observations and recommendations of the SRT represented in this report are helpful to the SC CSC in continuing to realize its vision for collaborative climate science. This review was conducted under the guidance of Janet Cushing, acting chief, National Climate Adaptation Science Center (formerly National Climate Change and Wildlife Science Center).

Executive Summary

In 2008, the U.S. Congress authorized the establishment of the National Climate Change and Wildlife Science Center (NCCWSC; as of April 2018, renamed 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, form the core mechanism through which this mission is carried out.

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 (SRT) 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 South Central CSC (SC CSC; as of April 2018, renamed the South Central Climate Adaptation Science Center), established in 2012, is based in Norman, Oklahoma, with the University of Oklahoma (OU) serving as host university, coordinating a consortium of six other entities (three universities, one federal research facility, and two federally recognized sovereign tribes) spread throughout the region. The SC CSC has completed its initial 5-year project cycle and is in its sixth year through a 1-year funding extension. The SC CSC encompasses a large geographic area focusing on four states in the South Central United States: Oklahoma, Texas, Louisiana, and New Mexico. This region is extensively diverse climatically as well as geopolitically, encompassing semi-arid ecosystems in New Mexico to sweeping grasslands in Oklahoma and swampy, humid bayous in Louisiana. In addition to the four states, the region is home to almost 70 sovereign, federally recognized tribes and pueblos.

Overall, the SRT believes that the SC CSC reflects an exemplary model of what a CSC partnership should look like. The tremendous resources and reputation in the field of weather and climate research that OU brings to the partnership provide a substantial base from which the USGS was able to build a vibrant CSC presence. In the 5 years represented in this review, the CSC has built a climate science program that, in a strategic way, helped to change the social environment that created a safe space in which to discuss climate change and land managers' responses to the challenges that it poses. The University of Oklahoma and the consortium partners have brought tremendous leveraging of funds that greatly extends the capacity of what could be accomplished solely with USGS funding (approximately $2 million annually). However, the SC CSC science program would be much further along had USGS provided the funding for staff that was originally planned when soliciting university-host institutions. Compounding this funding deficiency, until recently, the USGS SC CSC made the decision to forgo staffing (e.g., research coordinators) to fund other program areas, thereby lacking staff to provide support to stakeholders, fully implement the Strategic Science Plan (Winton et al. 2013), or participate in coproduced actionable science activities.

The personal and professional commitment of past and current USGS leadership of the SC CSC directors, combined with the leadership brought to the partnership by the university CSC director has been a significant force for establishing the success of the SC CSC. However, the SRT is concerned that ensuring retention/sustainability of the current university CSC leadership and recruiting faculty members to participate in the CSC will require reconsideration of the teaching load and/or compensation levels that recognize the added effort that is needed for these roles.

The members of the consortium bring considerable value and provide a foundation for bridging science across focal areas. A notable absence of any institution in New Mexico among consortium members may in part be reflected in the fewer number of science projects and the lesser involvement or engagement

of tribes and pueblos in that area. Overall, the apparent strong development of trust with tribes is positive and should be used as a foundation to expand to even more tribes and regions. The tribal undergraduate and intern programs provide a strong intergenerational connection for future engagement of tribal governments.

Stakeholders generally feel that the SC CSC is producing quality science. The SC CSC has learned from earlier experiences trying to engage stakeholders, which resulted in improved stakeholder engagement in later years, and has established a strong foundation for the SC CSC to be more strategic with science activities in the future. The stakeholder relationship could be further strengthened by articulating a general statement of accomplishments beyond individual project results and demonstrating the value and impact beyond individual project results (e.g., how have you "moved the needle" in specific areas of science?). Additionally, the Stakeholder Advisory Committee could be enhanced with additional state, local, and tribal members.

The SC CSC has established a strong capacity-building aspect to their program through various education and training programs. Online climate courses, a study-abroad program, and other educational offerings within the university are impressive and used to nurture STEM education in underrepresented groups in undergraduate, graduate, and early-career professional stages. Tribal workshops are valuable for bringing an understanding of the applicability of SC CSC products to tribal members who might otherwise not be engaged.

The relatively recent development of the strategic communications plan is encouraging and full implementation will greatly expand the impact of the science products produced by the SC CSC. In particular, having SC CSC communications staff work with principal investigators of SC CSC-funded projects to develop individual communications management plans will serve to expand the application of science products over a greater range of agencies and other science users. The online climate course is an exceptional effort—both as an educational accomplishment and a communications contribution.

These and other observations and recommendations are detailed further in this report and should be viewed as constructive input to help build an even more vibrant and robust SC CSC program in the future.

Abbreviations and Acronyms

ACCCNRS	Advisory Committee on Climate Change and Natural Resource Science
AFS	American Fisheries Society
BLM	Bureau of Land Management
CSC	Climate Science Center
CSC-Federal	Federal USGS-staffed component of the CSC
CSC-University	Host-university component of the CSC
DOI	U.S. Department of the Interior
FACA	Federal Advisory Committee Act
FG	focus group
FY	fiscal year
GCM	global climate model
GFDL	NOAA's Geophysical Fluid Dynamics Laboratory
HDRU	Cornell University Human Dimensions Research Unit
LCC	Landscape Conservation Cooperative
LSU	Louisiana State University
NCCWSC	National Climate Change and Wildlife Science Center*
NGO	nongovernmental organization
NOAA	National Oceanic and Atmospheric Administration
OSU	Oklahoma State University
OU	University of Oklahoma
PI	principal investigator
RFP	request for proposal
RISA	Regional Integrated Sciences and Assessments
SAC	Stakeholder Advisory Committee
SCIPP	NOAA's Southern Climate Impacts Planning Program
SC CSC	South Central Climate Science Center†
SRT	Science Review Team
STEM	science, technology, engineering, and math
TOR	Terms of Reference
TTU	Texas Tech University
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service

* As of April 2018, renamed National Climate Adaptation Science Center.
† As of April 2018, renamed South Central Climate Adaptation Science Center.

List of Figures

Figure 1. Map of the eight Climate Science Centers and consortia as constituted during the period under review (2012–2017). 2
Figure 2. Map of the 22 Landscape Conservation Cooperatives 4
Figure 3. Number of South Central Climate Science Center projects funded by science theme, 2012–2017. 16
Figure 4. Dollar amount of South Central Climate Science Center projects funded by science theme, 2012–2017. 17
Figure 5. Stakeholder perceptions of the use of South Central Climate Science Center climate adaptation science 22
Figure 6. Limitations to stakeholder involvement with the South Central Climate Science Center 23
Figure 7. Stakeholder perceptions of the quality of South Central Climate Science Center Science 24

List of Tables

Table 1. U.S. Geological Survey budget for the South Central Climate Science Center 8
Table 2. Membership in the Stakeholder Advisory Committee for the South Central Climate Science Center... 11

Introduction

Review Purpose

In 2008, the U.S. Congress authorized the establishment of the National Climate Change and Wildlife Science Center (NCCWSC)[1] within the U.S Department of the Interior (DOI).[2] 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 South Central Climate Science Center[3] (SC 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 SC 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.]

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[1] 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.

[2] 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.

[3] The South Central Climate Science Center was renamed South Central 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.

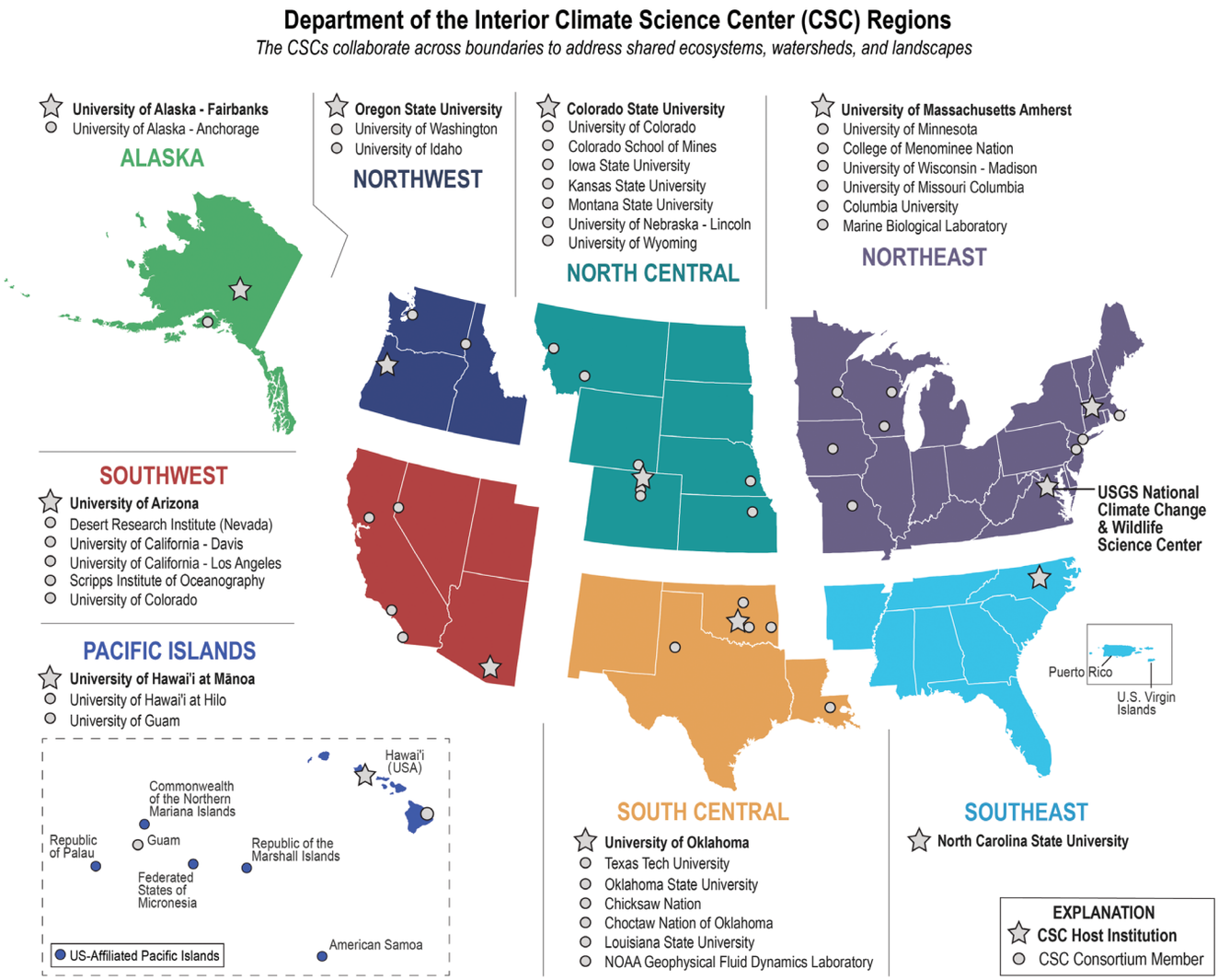

Figure 1. Map of the eight Climate Science Centers and consortia as constituted during the period under review (2012–2017).

> 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.]

The NCCWSC-proposed 5-year strategy (2009–2014; NCCWSC 2009) was developed to guide the efforts of the NCCWSC–CSC network (USGS 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 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, and others). 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

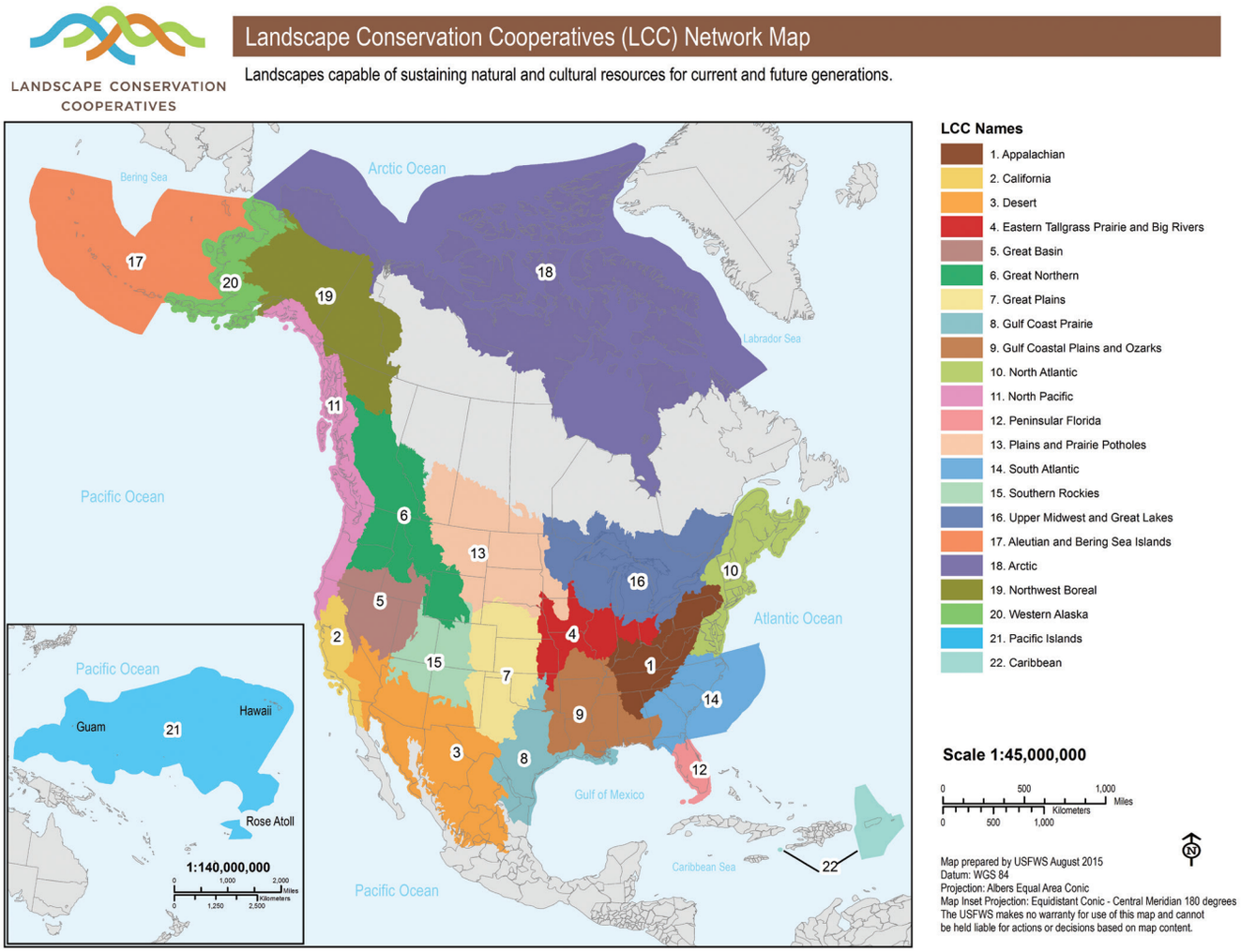

Figure 2. Map of the 22 Landscape Conservation Cooperatives.

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 science 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).

The HDRU 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 SC CSC on-site review was conducted over a period of 3 days (November 14–16, 2017) in Norman, Oklahoma, on the campus of the University of Oklahoma (OU; Appendix B). The review process was designed to develop a full understanding of the SC 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 SC 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 SC CSC initiation predates the ACCCNRS report, the original SC 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[4]

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 coproduction 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 SC 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 SC CSC. Two groups were included: science producers (or science partners) and science users (or conservation partners).

Participants were recruited by the SC 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 SC CSC. Participants in the science users group included representatives of agencies intended to benefit from the science produced by the SC CSC, including LCCs, federal natural resource agencies, state fish and wildlife agencies, tribal organizations, and NGOs. Sixteen science producers and 11 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 and lasted approximately 2 hours. The questions were designed to explore how partners contributed to the work of the SC CSC and the factors that influenced the ability of the SC CSC to work with their partners. The specific topics of questions focused on how participants have worked with the SC CSC, reasons for becoming involved with the SC CSC, benefits of involvement with the SC CSC, challenges to involvement, and what the SC CSC could do to promote even more benefits from involvement.

Particular focus was placed on exploring how the SC 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 SC 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 stakeholder 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

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

Fish and Wildlife Agencies Climate Science Committee. The South Central survey was sent to a total of 272 individuals, with 144 responding. The survey documented the ways in which partners were engaged with the SC CSC and the factors affecting their engagement. The survey questions 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
- 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 minutes) 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

The evaluation of institutional development measures the overall health of the SC CSC as an institution with regard to planning processes (e.g., 5-year strategic plans, annual science plans, advisory committees, and stakeholder engagement), management and operations (e.g., staffing, physical assets), finances (e.g., budget, hosting agreement), and institutional coordination (e.g., between CSC-Federal and CSC-University, among other consortia members, and with other federal agencies; ACCCNRS 2015). Overall, the SRT recognizes that the members of the SC CSC have done an excellent job of building a strong center for climate science research, particularly in a geographic region where climate change may be often questioned or denied.

SC CSC Development

The SC CSC has been charged to "develop science that addresses climate impacts on natural and human communities"[5] for an extensive and diverse section of the United States. The mission of the SC CSC is

> to provide decision makers with the science, tools, and information they need to address the impacts of climate variability and change on their areas of responsibility. The South Central CSC aims to transform how climate science is conducted and applied in the south-central United States. The Center supports big thinking, including multi-institutional and stakeholder-driven approaches to climate variability, change, impacts, mitigation, and adaptation research. [Kuster et al. 2017.]

The SC CSC was established in 2012, following the model established by NCCWSC: a university consortium (led by a host university) was established to form a partnership with the USGS office (co-located with the host university). The SC CSC is hosted by OU, centered in Norman, Oklahoma, in partnership with Texas Tech University (TTU), two land-grant universities—Louisiana State University (LSU) and Oklahoma State University (OSU), two sovereign federally recognized tribes—The Chickasaw Nation and The Choctaw Nation of Oklahoma, and one federal research facility—the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory (GFDL), collectively comprising the consortium. The SC CSC encompasses a large geographic area focusing on four states in the South Central United States: Oklahoma, Texas, Louisiana, and New Mexico. This region is extensively diverse climatically as well as geopolitically, encompassing semi-arid ecosystems in New Mexico to sweeping grasslands in Oklahoma to swampy, humid bayous in Louisiana. In addition to the four states, the region is home to almost 70 sovereign, federally recognized tribes and pueblos, each with their own unique cultural practices and resource management institutions.[6]

Funding for the SC CSC has ranged from $1.7 million in the first year to roughly $2.2 million in each of the four remaining years (Table 1). Approximately 35% of the funding supported the hosting agreement with USGS over the 5-year period, with 86% of this being spent by the nonfederal members (universities and tribes) of the consortium (Appendix C). Years 6–7 of the SC CSC have been funded as modifications to the hosting agreement, with a rebid process planned for 2018.

[5] SC CSC Vision Statement, http://southcentralclimate.org/.
[6] About Our Region, www.southcentralclimate.org/index.php/pages/about_us#about_our_region.

Table 1. U.S. Geological Survey (USGS) budget for the South Central Climate Science Center (from Kuster et al. 2017). FY = fiscal year; NOAA = National Oceanic and Atmospheric Administration; GFDL = Geophysical Fluid Dynamics Laboratory.

Funding type	Year 1	Year 2 (FY 2013)	Year 3 (FY 2014)	Year 4 (FY 2015)	Year 5 (FY 2016)	Total
USGS base funding	$249,899	$187,999	$376,102	$305,902	$321,994	$1,441,896
USGS personnel	$231,935	$164,277	$340,455	$273,829	$260,944	$1,271,440
USGS travel and operating expenses	$17,964	$23,722	$35,647	$32,073	$61,050	$170,456
Hosting agreement	$753,563	$685,109	$757,723	$775,511	$796,093	$3,767,999
Universities and tribes	$706,053	$637,305	$709,621	$727,108	$747,386	$3,527,473
NOAA's GFDL	$47,510	$47,804	$48,102	$48,403	$48,707	$240,526
USGS competitive grants	$665,162	$1,460,519	$1,105,796	$1,176,247	$1,164,299	$5,572,023
Total	$1,668,624	$2,333,627	$2,239,621	$2,257,660	$2,282,386	$10,781,918

At the time of the review, the USGS side is staffed by an acting director (Dr. Mike Langston) and two research coordinators (one of those part-time and both working remotely). The hosting agreement provides for only two full-time employees at OU[7] but, through additional support from the university, is staffed by a director (Dr. Renee McPherson), program coordinator, two tribal liaisons/sustainability scientists, a communications specialist (supported by a USGS grant to OU), a financial administrator and office manager, three postdoctoral associates, and three co-principal investigators (PIs), and affiliated faculty. The core USGS personnel and OU personnel are co-located in an office suite on the campus of OU, which also houses offices of the U.S. Fish and Wildlife Service (USFWS) and Bureau of Land Management (BLM).[8]

Institutional Coordination

USGS.—The capacity and functioning of the SC CSC far exceeds what would be expected from funding received from the USGS. The SRT attributes this success in part to substantial investments of time and energy by the former and current SC CSC federal directors (Allison Shipp, Kim Winton, and Mike Langston), who worked in concert with OU to establish and develop the strong USGS host-university relationship and ties with other consortium partners. These individuals worked early and often with their SAC to define climate change-related science priorities and support multi-stakeholder, collaborative research activities.

The personal and professional investments of time and energy by the former and current USGS US CSC directors to initially establish and subsequently develop the partnerships with OU provide fundamental underpinnings for success of the SC CSC.

Despite these efforts, the SC CSC's ability to fully develop its research portfolio has been limited by funding that has been lower than originally planned at the time that RFPs for hosting the CSC were issued. The SRT believes that the science program would have greater breadth and productivity had the USGS provided the financial support that was originally planned, which included funds for full-time USGS scientists and administrative staff. Over the years the USGS SC CSC has made the decision to invest funds in program areas other than staffing, and the resulting absence of staff scientists has likely hindered the ability to fully implement the U.S. Department of the Interior South Central Climate Science Center Strategic Science Plan of 2013–2018. Only recently (2017) has the SC CSC chosen to provide program management support with a full-time research coordinator (as well as a temporary half-time support position based in the headquarters office). Moving forward, the SRT recommends that the funding and staffing be increased to support SC CSC activities or expectations for operations and productivity potentially be adjusted accordingly.

The SC CSC science program would be much further along had the USGS provided the funding for staff that was originally planned (staff scientists and administrative staff).

The past and present SC CSC USGS staff members have done a remarkable job establishing relationships, understanding stakeholder needs, and delivering relevant climate adaptation science. Given the current federal funding environment, financial support for the SC CSC seems unlikely to increase. South

[7] "Funding Profile of the South Central Climate Science Center," from SC CSC webinar by M. Langston and R. McPherson, 2017.

[8] "Structure & Operations of the South Central Climate Science Center," from SC CSC webinar by M. Langston and R. McPherson, 2017.

Central Climate Science Center output should be considered in this context, and expectations should be commensurate with the limited funding level.

OU.—The University of Oklahoma has a strategic interest in becoming an organization of excellence in meteorology, climate, and local adaptation to changes in these conditions. A key reason that the capacity and functioning of the SC CSC far exceeds what would be expected at the level of funding received from the USGS is the significant contribution from the university-host institution and director. The SRT was considerably impressed by the support from OU for hosting the SC CSC, which sets a high bar (with faculty lines, space, financial support, etc.) that likely exceeds that of any other host-institution proposal/award in the first CSC funding cycle. The OU administration clearly views hosting of the SC CSC as an investment to move the university forward, providing direct funds and facilities to foster development.

The OU administration clearly views hosting the SC CSC as an investment to move the university forward, providing phenomenal support that sets a high bar, difficult to be replicated elsewhere.

The long-term success of the SC CSC is dependent on support from OU. Moreover, OU's goal of extending its excellence in meteorological studies into climate adaptation science will be more easily realized with the presence of the SC CSC. The SRT encourages both the USGS and OU to further develop long-term plans for support of the SC CSC on the OU campus to meet these mutually beneficial goals.

In large part, the success of the SC CSC can be traced to the leadership and dedication of Dr. Renee McPherson. The SRT was extremely impressed with her leadership in creating an outstanding work environment, dedication, creativity, strategic direction, ability to create durable partnerships based on trust (both within and beyond the university and USGS), and focus on science. All individuals with whom the SRT interacted clearly respected Dr. McPherson, and the admiration by the staff, researchers and students at the SC CSC was obvious. The SRT cannot overstate her importance to the success of the SC CSC.

However, the SRT has significant concerns regarding the appropriate recognition of her service by the university. Dr. McPherson appears to be carrying a teaching load and other obligations that are similar to regular university faculty while also investing a substantial amount of time directing the SC CSC; all of these activities have resulted in immense benefits accrued to the university through their affiliation as the SC CSC host university. While it is not the role of this review to comment on internal university personnel management issues, the SRT is concerned about maintaining the ability of Dr. McPherson, or any successor, to be successful in that role while being obligated to meet the multiple demands of the university and the SC CSC. The administration needs to consider implementing mechanisms (e.g., teaching loads, compensation, and incentives) to ensure retention of the current leadership and eventually entice others to serve the university in similar positions.

The SRT was impressed by the dedication of new faculty positions to serve as links between the university and the SC CSC. However, we encourage the university to develop new sets of expectations for faculty hired into these positions. "Coproduced actionable science" in contrast to "research science" involves additional skills that cut across traditional academic disciplines in order to ascertain stakeholder needs and nurture partnerships for conducting research and applying the results. The university is hiring faculty as interdisciplinary models, which is commendable, yet maintaining departmentally "siloed" expectations. From discussions with the university administration and faculty, the SRT perceives an apparent lack of departmental support of faculty engaging in the SC CSC's locally relevant climate projects. Moreover, the SRT is concerned that an uneven reward system for faculty participation in the SC CSC exists across departments.

Consortium.—South Central Climate Science Center consortium members bring considerable scientific and educational value to the enterprise. They provide a foundation for bridging science across focal areas because of the volume and diversity of programs that are not solely reliant on SC CSC funding support. This added value is critical to the breadth and success of SC CSC science delivery.

The science produced by the SC CSC related to New Mexico is notably sparse, which may in part be a reflection of the absence of a New Mexico institution within the consortium. This was also reflected in the participation in the HDRU survey where New Mexico responses were less than half of that from either Oklahoma or Texas. This has been attributed by the SC CSC to the absence of New Mexico in the original service area of the SC CSC. The SC CSC has already taken steps to rectify the absence of science in New Mexico by establishing a working relationship with scientists at the University of New Mexico as well as the USGS New Mexico Water Science Center. In addition to promoting science production in New Mexico, the SC CSC has also added a New Mexico tribal liaison with the purpose of understanding and delivering on the climate science and education needs of tribal partners. The SC CSC also intends to encourage New Mexico universities, as well as tribes and pueblos, to join the consortium competing for the next hosting agreement.

The absence of New Mexico is understandable, but this leaves a large gap in coverage. The SC CSC is aware of this gap and is taking action to rectify the issue.

Stakeholder Advisory Committee

Formation of the SC CSC SAC originally aimed for representation from each state as well as federal partners; multiple individuals from states were invited depending on their resources. However, some states turned down the invitation, potentially over differences in political or professional approaches or stances on climate change, while others fully engaged. Those that did engage in the first round were invited to continue to participate after the first 2-year period (Table 2).

The SC CSC has used their SAC primarily to identify knowledge gaps in climate-change-related research and to develop priorities for requests for proposals. Stakeholder Advisory Committee members felt that their role was somewhere between guiding (for example, reviewing funding opportunity priorities) and engaging in networking and coordinating activities between their various agencies and organizations. All SAC members interviewed by the SRT felt that they were benefiting from participation in the SAC and especially appreciated the opportunity that this participation provided for networking and sharing

Table 2. Membership in the Stakeholder Advisory Committee for the South Central Climate Science Center (Kuster et al. 2017). LCC = Landscape Conservation Cooperative.

Gulf Coast Prairie LCC	Eastern Tallgrass Prairie and Big Rivers LCC
Bureau of Reclamation, Great Plains Region	Oklahoma Water Resources Board
Gulf of Mexico Alliance	Cheyenne and Arapaho Tribes
U.S. Environmental Protection Agency	U.S. Geological Survey
Great Plains LCC	U.S. Department of Agriculture
U.S. Department of Agriculture, Agricultural Research Service	U.S. Army Corps of Engineers
Gulf Coastal Plains and Ozarks LCC	Bureau of Indian Affairs
New Mexico Office of Archaeological Studies	Oklahoma Division of Agriculture, Food, and Forestry
Desert LCC	National Park Service
Southern Rockies LCC	Texas Parks and Wildlife Department

knowledge. The role of the four LCCs on the SAC was identified by review participants as being critically important as a vehicle for conveying the needs of many other partners, including states. If LCCs are diminished or dismantled in the future, the SC CSC will need to develop new relationships and proactively engage with resource agencies to ensure that the full range of conservation interests is represented on the SAC.

Stakeholder Advisory Committee members felt that they had adequate and appropriate interactions with SC CSC university consortium members. For example, the SC CSC host university director would attend SAC meetings but would leave the room during discussions about developing funding opportunities. Stakeholder Advisory Committee members were also invited to participate in SC CSC undergraduate forums or consortium meetings. Some concern was expressed by participants in this review, however, that meeting fatigue and burnout could develop among SAC members who are participating in two or more advisory committees for other boundary organizations in the region (e.g., LCCs or U.S. Department of Agriculture [USDA] Climate Hubs). The SRT applauds the SC CSC's intention to establish a joint advisory committee with the Southern Plains Climate Hub to address this.

The SRT applauds the intent to build a joint CSC/USDA Climate Hub SAC to improve efficiencies and coordination between the programs while reducing duplicate burdens on stakeholders.

Institutional Coordination Summary Recommendations

- The SRT recommends that funding and staffing to the SC CSC be increased or expectations for operations and productivity be adjusted accordingly.
- The SRT is concerned about maintaining the ability of Dr. McPherson, or any successor, to be successful in the role of SC CSC university director while being obligated to meet the multiple demands of the university and the SC CSC. The USGS and OU should develop a strategy or incentives to ensure retention of the current leadership and encourage others to serve in CSC university leadership positions.
- The SRT supports the SC CSC's intention to establish a joint advisory committee with the Southern Plains Climate Hub to improve efficiencies and coordination between programs and avoid overtaxing current and future advisory committee members.
- The SC CSC should consider further integrating New Mexico institutions into programs and projects.
- The SC CSC should consider strategies to continue to proactively engage multiple resource agencies toward common climate adaptation goals in the event that LCCs are dismantled.

Tribal Engagement

The SC CSC's commitment to actively and meaningfully collaborate with tribes in the region is evident in all aspects of the SC CSC's work, from research to communications to education and training. The SC CSC consortium includes two tribes—The Chickasaw Nation and Choctaw Nation of Oklahoma—and is the only CSC with sovereign federally recognized tribes in its organizational leadership. At the time of this review, the SC CSC housed two full-time tribal liaisons to serve the 68 sovereign federally recognized tribes and pueblos in New Mexico, Texas, Oklahoma, and Louisiana. The liaisons convene tribes and university and/or federal researchers to develop partnerships for climate science projects, help build tribal capacity for managing resources under climate change through trainings and workshops, and conduct tribal youth programs.

The SC CSC Tribal Engagement Strategy (Andrews et al. 2014) identifies ways in which Native Americans are often disproportionately affected by climate change; describes how tribes are included

in stakeholder discussions regarding SC CSC-sponsored research priorities; and identifies climate-related topics, such as changes in phenology and availability of tribal first foods, in which the SC CSC can benefit from tribal expertise. The SC CSC Tribal Engagement Strategy and tribal liaison positions have served as models for the other seven CSCs, which speaks to the center's strong leadership and commitment in this realm.

A primary goal of the SC CSC has been to achieve full tribal engagement. The SRT was impressed with the integration of tribal members and goals into the operations of the SC CSC, particularly through the use of permanent tribal liaisons. While relationships with tribal groups are impressive, the establishment of trust between the university, federal government, and tribal members is an ongoing challenge. However, some concern was evident that the tribal liaisons were not as impactful as possible because of the amount of their time spent on the OU campus as compared to other locations in the SC CSC region. The SRT recognizes that one of the tribal liaisons is now focusing efforts on New Mexico, but being based in Norman, Oklahoma and spending 1 week per month visiting tribes in New Mexico may not allow adequate time for face-to-face relationship building.

Accomplishments

- The SC CSC has initiated an exemplary tribal outreach program, starting with several Oklahoma tribes and expanding to other nationwide connections.
- The SC CSC has one consortium member (The Chickasaw Nation) that invested in supporting the tribal liaison position at the CSC. They are also supporting tribal interns at the SC CSC.
- The SC CSC has developed workshops for tribal nations to understand the potential effects of climate change. To date, they have conducted 28 training sessions with 554 tribal attendees, engaged 91 tribes, and had 5,100 contact hours with tribes.
- The tribal undergraduate program is a strong positive.
- The SC CSC has established credibility with tribal nations in the region and potentially across the United States.

The SC CSC's importance in engaging tribes in climate change discussions was highlighted by participants in the HDRU survey and focus groups (FGs) as reflected in the following comment:

> There's no organization to bring those tribes together. So you have tribes becoming more sovereign and less communicative amongst tribes.... There's really no real forum for tribes and tribal representatives to have these kind of discussions. So I think this really plays a very important role for that networking, and it's not just networking between and amongst tribes, it's also networking between tribes, government, and industry. (SC User FG)

Recommendations

- The SC CSC should use the trust and partnerships that they have developed with tribal partnerships as a foundation to expand their engagement with tribes and pueblos in New Mexico, Texas, and Louisiana, although the SRT recognizes the limitations of budgets. The SRT recognizes that these efforts are already underway and encourages continued attention to this issue.
- The SC CSC should evaluate how to shift tribal engagement from the start-up phase to long-term support, information distribution, education, and training. A challenge will be to identify which activities fit within the CSC mission and budget.
- The SC CSC should continue efforts to identify activities that support tribal empowerment, planning, decision making, adaptation, and management and refine approaches to further strengthen tribal engagement. Building tribal capacity through workshops may provide greater benefits than adding more tribes and pueblos to the consortium.

- The SRT suggests the development of a strategy for assessing tribal interests, concerns, and needs to determine an appropriate level of engagement and communication with potential stakeholders and partners.
- The SC CSC should continue building tribal technical capacity to work with climate data for use in vulnerability assessment and planning. Guidance from tribal technical experts will define what climate information would be useful to tribes and the appropriate communication tools to disseminate this information.
- The success of developing tribal technical expertise for using climate data for tribal planning should be evaluated.

Given the potential demand for SC CSC products from tribes, the SC CSC should consider how to prioritize activities relevant to tribal capacity building and knowledge development.

The SC CSC has developed an apparent strong level of trust with tribes, which should be used as a foundation to expand to even more tribes and regions (e.g., New Mexico).

Actionable Science

Strategic Science Plan

The SRT is pleased to note that from the beginning, the SC CSC developed its priorities for science in consultation with regional stakeholders, thereby increasing the likelihood that the science and products are those that decision makers need in order to address the impacts of climate variability and change. Specifically, priorities for the first funding opportunity announcement were based on science questions developed by the regional LCCs with a focus on both short-term (3–5 years) and long-term (15–20 years) knowledge needs. The SC CSC 2013–2018 Strategic Science Plan (Winton et al. 2013) identifies 10 science priorities developed by assessing climate-change related information needs that were previously outlined in approximately 40 publications from state, federal, and nongovernmental partners, such as agency strategic planning documents, State Wildlife Action Plans, and LCC operational plans (Kuster et al. 2017):

1. Climate change adaptation, mitigation, resiliency, and vulnerability assessments
2. Climate change effects on ecosystems
3. Hydrologic response to climate change
4. Climate change effect on human populations, socioeconomics, urbanization, cultural resources, and agricultural issues
5. Improved monitoring networks for resources affected by climate change and management actions
6. Improved management and sharing of climate change and geospatial data
7. Imperiled and rare communities and invasive species
8. Coastal response to sea level rise and changing geomorphology
9. Biological response to climate change and disturbance, conservation design, and delivery
10. Land-use and land-cover change

The Strategic Science Plan, supplemented by input from partners about emerging issues and priorities, is used as a basis for annual work plans, which are developed by the USGS SC CSC director in consultation with the SAC. Partner input is solicited at SAC meetings, other regional meetings and collaborations attended by SC CSC staff and scientists, and at an annual consortium research meeting, a 2-day workshop for SC CSC researchers and resource managers. If technical expertise is necessary to review proposals, a temporary Science Implementation Panel may be formed to provide technical reviews of the proposed science projects.

The SRT notes that one of the biggest challenges for the SC CSC in upcoming years will be deciding on how, and to what extent, to focus or prioritize its efforts. The 10 science priority areas are sufficiently broad as to encompass a predominance of climate-science-related information needs across the SC CSC region for decades to come. However, with its broadness comes a challenge: how will the SC CSC evaluate its success at addressing these science priorities? How will it know when it has made enough progress to retire a specific priority? Future science strategy refinement might be enhanced by a gap analysis that identifies the relative roles of the SC CSC and other research and outreach entities in the region. This should be supplemented with a partner/network analysis that identifies opportunities to partner with other scientists, institutions, or entities to further "translate" the SC CSC science into impacts on species, systems, and geographies so as to multiply the impact of SC CSC climate science.

The SC CSC will be challenged in the future to prioritize the focus of its research and should conduct a gap analysis or other exercise to help refine a strategic direction.

Climate Science Implementation

The SC CSC has advanced climate science through four pathways:

1. competitive grants restricted to PIs from the university host, consortium members, and USGS entities;
2. directed grants (noncompetitive USGS-directed funds award for specific research needs);
3. host-consortium research activities (university-directed funds from the hosting agreement); and
4. leveraged external grants.

Competitive grants.— A limited competitive grant program using USGS funds is a primary mechanism for the USGS to support research of PIs from the university host, consortium members, and USGS entities (Kuster et al. 2017). Competitive grants have been used to fund 48 projects over 5 years (Figures 3 and 4; Appendix C). The requests for proposals for this program have evolved over time but typically specify science priorities, priority geographies (currently Rio Grande/Rio Bravo, Red River, and Gulf Coast), evaluation criteria, and submission guidelines. The SRT is encouraged that sequential RFPs have required applicants to demonstrate increasing levels of collaboration among researchers and regional stakeholders. For example, while early RFPs required a letter of support from the LCCs and encouraged collaboration among university departments, universities, as well as universities and USGS, the most recent (fiscal year [FY]) RFP specifies that

> [i]ntended users of the scientific output of the project (i.e., resource managers, decision makers) should be adequately engaged in the planning and administration of the proposed project. Proposals should include expressed strategies to inform and engage relevant members of the potentially affected communities and stakeholders in order to learn from their experience and on-the-ground observations and build understanding of climate change as it relates to resource conservation and use. … The proposal should identify collaborative partnerships (federal, state, tribal, or other) that will participate in the project; include any outreach components to disseminate research findings and information; and include information on how scientific findings can be used to implement new management strategies or decision frameworks.

Proposal review teams are convened by the USGS SC CSC director and include both experts and stakeholders who are asked to provide two ratings "(1) based on the quality of the proposal and the researchers' qualifications, and (2) based on the value of the research to their organization or constituency" (Kuster et al. 2017). The USGS SC CSC director makes the final selection based on these rankings.

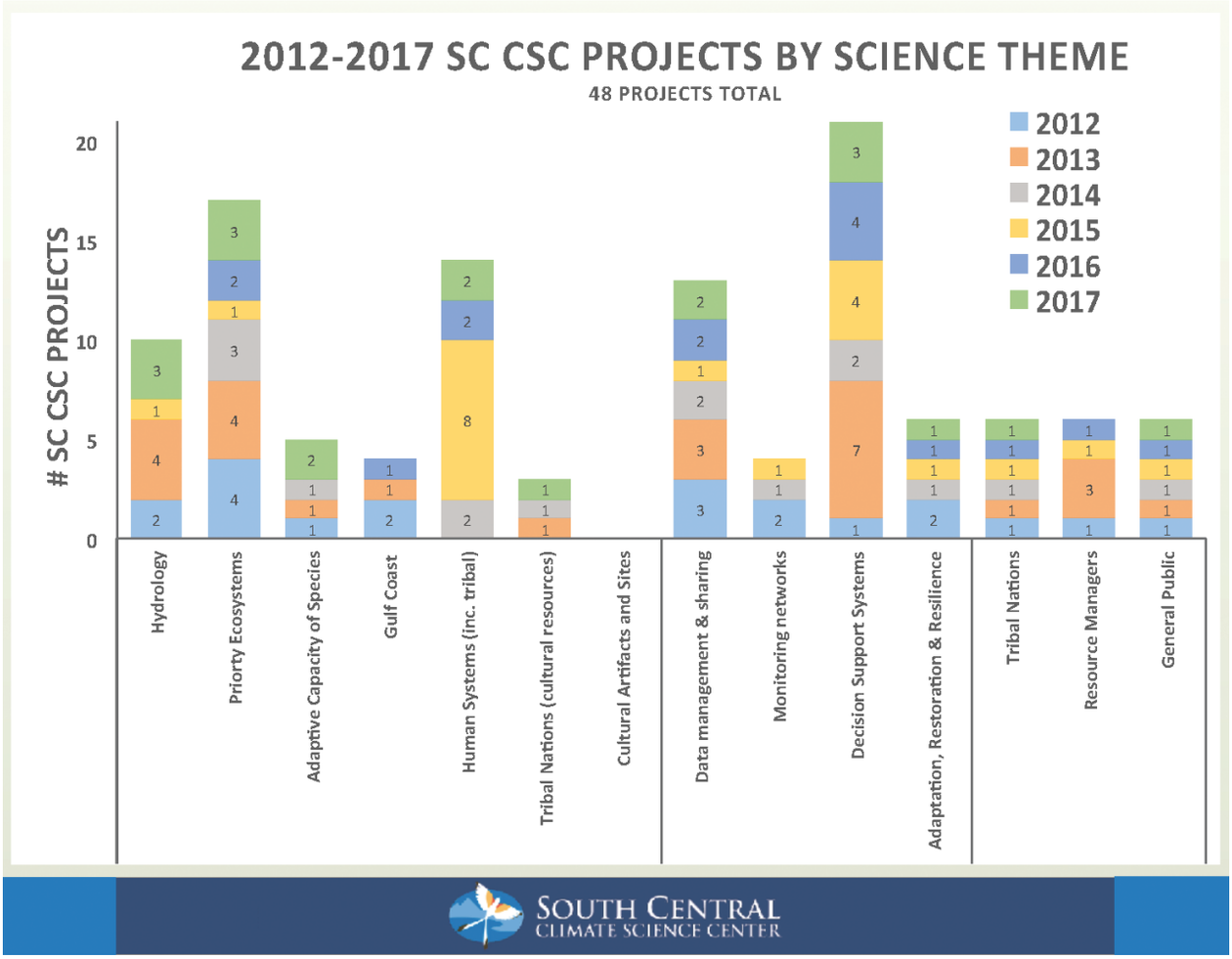

Figure 3. Number of South Central Climate Science Center (SC CSC) projects funded by science theme, 2012–2017. Source: "Research Development Process of the South Central Climate Science Center." Webinar presented to the Science Review Team by R. A. McPherson, M. Langston, E. Glenn, and K. Donahue, 2017.

Because a focus on the actionability of science is relatively new and not yet a widespread metric for academic and agency scientists, the SRT commends the SC CSC for gradually increasing the requirements for collaboration (coproduction) in their science RFPs. This will help gradually build the interest in and skills for this collaboration amongst researchers and managers (e.g., similar to how the National Science Foundation has gradually strengthened their criteria and evaluation of broader impacts of proposed work.) For example, science producers mentioned that the RFP requirements stimulated collaborations that likely would not otherwise have occurred and participants in the FGs spoke to the steps that the SC CSC took to ensure that at least some level of coproduction occurred:

> I was able to participate in both the Southwest and South Central proposal review process.... Part of the ... scoring of the proposals was collaboration, and specifically collaboration with the LCCs.... Essentially the proposals were given extra points if they had a clear framework for collaboration laid out in advance. And because that was laid out in RFP, several of the science producers reached out to me and my coordinator directly to talk about forum for getting partner input on the products. (SC User FG)

Directed grants.—At the discretion of the USGS SC CSC director, projects are occasionally funded directly instead of through open competition between eligible participants. In most of these cases, "a spe-

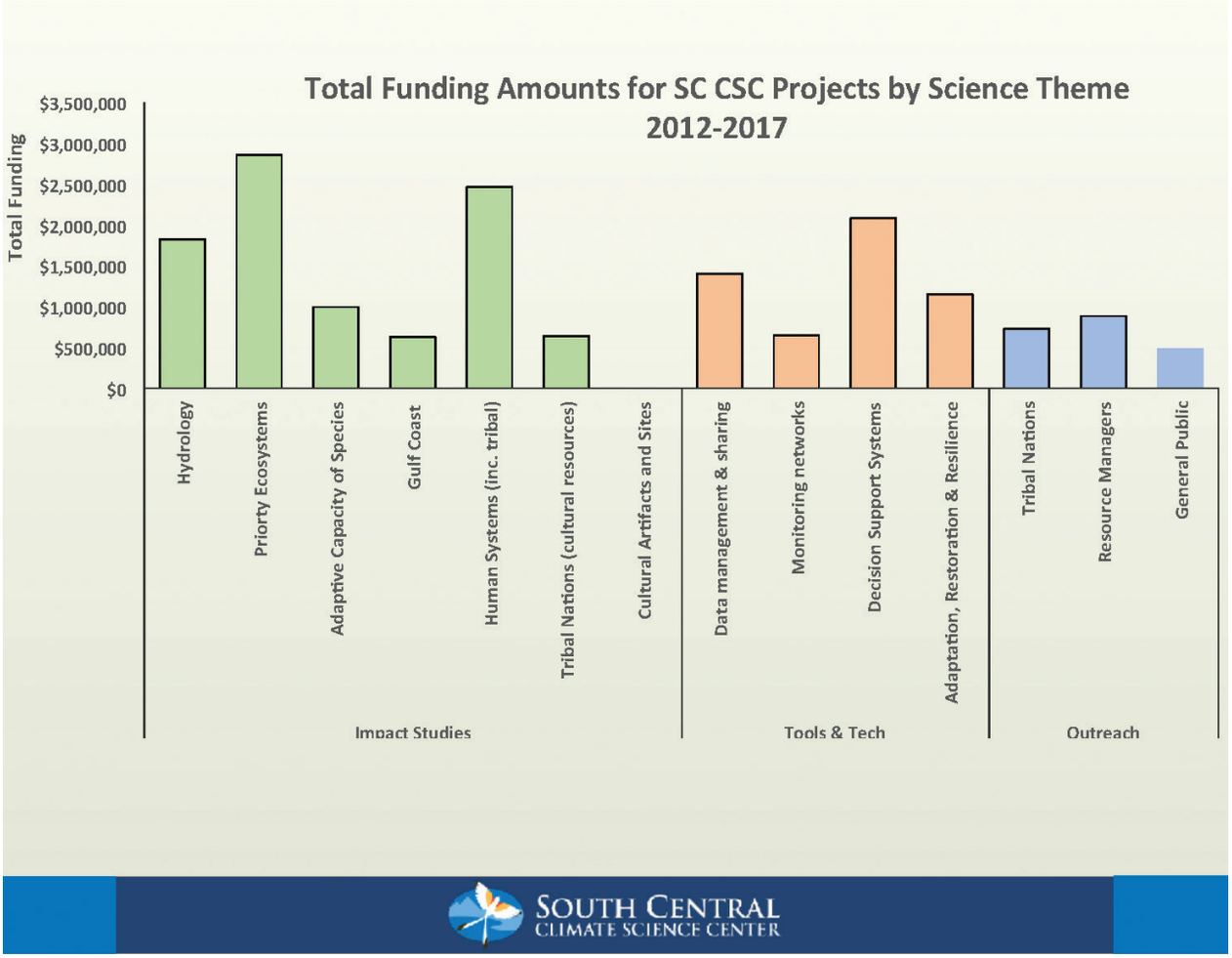

Figure 4. Dollar amount of South Central Climate Science Center (SC CSC) projects funded by science theme, 2012–2017. Source: "Research Development Process of the South Central Climate Science Center." Webinar presented to the Science Review Team by R. A. McPherson, M. Langston, E. Glenn, and K. Donahue, 2017.

cific research or outreach need has been brought to our attention by a stakeholder and, in the judgment of the USGS SC CSC director, it merited an award to address it" (Kuster et al. 2017). These grants are reviewed by subject matter experts prior to a decision being made.

Directed funding was used to support one project in fiscal year (FY) 2014 and seven in FY16 (Appendix C; Kuster et al. 2017), some from a targeted grants competition aimed at drought impacts on the social, ecological, and hydrological system of the Rio Grande/Bravo basin through focused, additional funding. However, these are included in the 48 projects described above, and it was unclear to the SRT what percentage of the total amount of funding was distributed in this way, or which themes these projects supported beyond the five drought projects in the Rio Grande/Bravo.

The SRT believes that the use of directed grants and targeted grants competitions is an agile way of addressing emergent stakeholder needs, directly engaging relevant scientists in SC CSC science priorities and nimbly responding to rapid-turnaround funding opportunities. It may be instructive for the SC CSC to review the degree to which targeted and directed grant funding reflected the priorities identified in the Strategic Science Plan (Winton et al. 2013) as a way of evaluating the degree to which those priorities reflected the needs expressed by the community subsequent to the development of that plan.

Host-consortium research support.— A portion of university-directed funds from the hosting agreement were allocated to research at the host and consortium partners. How much of the hosting agreement

this represents for each university, which science priorities or themes they are directed to, and how the distribution of these funds or their use was decided were not made clear to the SRT.

Leveraged funding.—The SC CSC host and consortium partners leveraged the USGS funding to obtain a reported $218,045,935 in "additional funding for CSC-related research and outreach that align with the goals of USGS" (Kuster et al. 2017; Appendix C). The SC CSC reports that this leveraging enhanced research capacity by adding graduate students and postdoctoral associates, improving cyberinfrastructure and networks of stakeholders, and providing other benefits. However, it was not specified how these leveraged funds mapped to the SC CSC priorities and themes.

While alignment with the goals of USGS is an important criterion for counting leveraged funds, it was unclear to the SRT the proportion of the specific research and outreach efforts supported by these funds that were (1) *directly* applicable to current SC CSC priorities and activities; (2) *indirectly* beneficial to SC CSC priorities and activities by, for example, increasing the general scientific knowledge base, number of potential collaborators, or cyberinfrastructure; or (3) beneficial to the host and consortium members by enabling them to leverage their participation in the SC CSC to increase their funding in other areas.

SRT Observations on Science Strategy and Accomplishments

Although the objective of coproducing actionable science with stakeholders and delivering it directly to them has become increasingly embedded in the national CSC program, and is therefore a standard against which the SC CSC could potentially be compared, the SRT recognizes that this standard has been established relatively recently. Therefore, our comments focus on not only the accomplishments to date, but also the development, positioning, and likely effectiveness of the SC CSC in advancing actionable science in the future.

Due to the typical delay between the development and application of actionable science, efforts to evaluate the likely actionability of new science often focus on the process used to develop that science. "Coproduction" of knowledge, i.e., the '*process of producing useable, or actionable science through collaboration between scientists and those who use science*' is believed to be one of the most effective methods of producing usable scientific knowledge" (Meadow et al. 2015).

The SC CSC has engaged in numerous activities, to date, that build the necessary internal capacity for successful coproduction of actionable science and strongly position it for continued success. Some examples include

- Cultivation of a diverse and engaged SAC (see above). In conversations with the SRT, SAC members described themselves as willing partners, valuing and desiring CSC work.
- Demonstrated internal focus on questions such as "How do you make research readily available and useable? How do you inform researchers about needs of decision makers?"
- SC CSC self-identification as a boundary organization providing knowledge production and dissemination and translation of research results for stakeholder needs, as well as building connections be tween research communities and decision-maker communities.
- Investment in communication infrastructure and resources to support researchers' engagement with practitioners during the course of a project
- Capacity-building efforts at all levels, for example,
    - Building leadership skills and coproduction capacity in early-career professionals.
    - Tribal partners and tribal youth.

The SC CSC has engaged in numerous activities that build the internal capacity for successful coproduction of actionable science and would benefit from delineating how projects are building from, or leveraging, research being conducted by other organizations.

Recognizing that the expectations regarding the scientific focus and approach for the CSCs have changed during the tenure of the SC CSC is important. The original USGS calls for proposals to host the regional CSCs required applicants to document their existing climate science research capacity and relevant research and stakeholder partnerships, but not to propose specific scientific activities. Potential hosts were asked to describe their existing climate change science programs and expertise, linkages with the DOI (and other federal science) programs, potential CSC partners, and their observational and computational resources, scientific accomplishments, and climate science education programs. The CSCs were envisioned as developing and providing climate science to LCCs and other partners who would coalesce and communicate the climate science needs of a large number of conservation partners (states, nonprofits, federal agencies, etc.) to the CSCs. For example, from the Strategic Science Plan (Winton et al. 2013):

> The South Central CSC was established in 2012 to address the regional challenges presented by climate change and variability in the south-central United States. As such, the center focuses on fulfilling science needs that apply across the entire south-central United States and providing regional-scale science products that can inform the local needs of the LCCs and other partners. The South Central CSC will provide scientific information, tools, and techniques that managers and other parties interested in land, water, wildlife, and cultural resources can use to anticipate, monitor, and adapt to climate change, actively engaging LCCs and other partners in translating science into management decisions.

More recently, coproduction of actionable science has been articulated as a priority of the CSCs. The ACCCNRS (2015) report advocated for actionable science to be a core service provided by the NCCWSC and CSCs, defined as follows:

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

The SC CSC mapped the 48 projects from the RFP and directed grants into 14 themes across three areas: impacts studies, tools and techniques, and outreach and education (Figure 3 and 4; Kuster et al. 2017). However, these themes do not directly map to the 10 *science priorities* identified in the Strategic Science Plan, although they can be roughly correlated. Therefore it was difficult to crosswalk the RFP themes and directed funded projects with the master plan of the 10 science priorities. With only a few projects (sometimes just one) in each area, the effort seems spread thin. The SRT acknowledges that all CSCs and Regional Integrated Sciences and Assessments (RISA) programs are in the same situation.

It was difficult for the SRT to evaluate the cumulative impact of SC CSC-funded science except in a few examples (e.g., key products). Research reports were typically project-specific and have not been synthesized to describe cumulative impact within the research priority area. For example, how do the 17 projects on priority ecosystems advance the science priority of "imperiled and rare communities and invasive species" and "biological response to climate change" (Winton et al. 2013)? Furthermore, do they have a greater impact, or do groups of projects in the themes add up to more than the sum of the parts? With regard to geographic coverage, the SC CSC encompasses such an extremely large, diverse region with wide-ranging climatic and ecological conditions that complete coverage would be difficult at the current funding levels. Based on material presented in the review, the SRT believes that New Mexico could benefit from additional scientific focus, in addition to the recognized need for increased focus on stakeholder engagement in that state (as discussed previously).

It was also difficult to tell how the projects funded by the SC CSC were complemented by the host funding agreement support and leveraged funding. Were the priorities and decisions about what to fund competitively influenced by what was already being done (or not) by these other funding sources? Much

was made about the advantages of these other streams of funding, but it was not clear how they contributed to the science priorities or outcome.

Understanding the *processes* that are in place to coordinate among funding streams would also be useful. The SRT heard from partners that one process has been the consortium research meeting (held annually in 2013, 2014, and 2015) that was intended to allow researchers to engage with managers and understand their needs with the goal of producing project ideas that can be submitted to USGS or other funding sources. During the on-site review, some partners expressed that reinstating or continuing these meetings "where all the consortium members and scientists can meet each other" would be useful.

The SRT noted that the SC CSC may benefit from demonstrating the degree to which SC CSC researchers and the program, as a whole, build on previous work related to creating and evaluating applied climate science, social science studies on boundary organizations, eliciting user needs, use of information, communication of uncertainty, and delivery of results. For example, it was unclear whether the SC CSC was leveraging the NOAA RISA experience working with stakeholders—either in general or from specific personnel common to both the SC CSC and NOAA's Southern Climate Impacts Planning Program (SCIPP).

Evaluation of Actionable Science Success

The SC CSC's process for tracking project effectiveness includes identifying how projects align with funding priorities. For capacity-building efforts, the SC CSC tracks contact hours with tribal liaisons. Reporting of SC CSC-funded research (e.g., in annual reports) focuses on the titles, topics, and short synopses of results from a handful of projects. More attention could be paid to documenting the potential or actual use of the outputs. The SC CSC is currently asking researchers for feedback on what stakeholders and partners are saying about the value of the work. While efforts to date have been more anecdotal than rigorous, the SC CSC is funding research to define a suite of implementable evaluation metrics to ascertain the value of projects to stakeholders.[9] Further, the CSC network is considering developing metrics nationally; the SC CSC indicated an intent to follow those when available. Understanding what is of value to stakeholders will become increasingly important as demand for SC CSC services and products increases and prioritization of allocation of staff and financial resources intensifies.

Metrics.—The SC CSC asked the SRT for guidance on useful metrics for evaluating success in developing actionable science. At a minimum, the SC CSC should seek input from intended users of the science. While scientists are increasingly describing their own work as "actionable," users of that science would be better judges. More rigorous evaluation will require investing in evaluation and social science to rigorously track use over longer time horizons. In addition to the anticipated metrics being developed by the national CSC network, there is a growing body of work on this topic, including work by McNie et al (2016), Wall et al (2017), and others. Successfully meeting the increasing regional demands for decision-relevant science will require increasing coproductive research capacity. The SC CSC should evaluate how they will continue to cultivate and expand the community of researchers and practitioners who are both motivated and able to collaborate to coproduce actionable science. This will likely require efforts to motivate, train, and equip a larger community of researchers for this work.

Stakeholder perceptions and use of actionable science (see Appendix E for complete results of the HDRU survey and focus group process).—Many, if not most, of the stakeholders participating in the review believe that the SC CSC is producing quality and useful science, as well as supporting its use. Typical comments heard by the SRT include the following:

- "We have used products of the CSC."
- "The CSC helps to understand climate and water long-term."

[9] "Approaches to Evaluate Actionable Science for Climate Adaptation" (no date), Aparna Bamzai-Dodson, University of Oklahoma, Norman.

- "We use the CSC to get science needs out there."
- "A lot of the products that the LCC looked to develop were built on the products from the CSC."
- "When I had questions about specific data … I could just contact the CSC directly."

The SRT observed a number of tangible examples of SC CSC science being used. Several other projects are potentially useful but were described more as research results than in terms of how they were or could be used or actionable.

- The National Park Service is using SC CSC downscaling data sets for scenario and adaptation planning—however, this use is dependent on the individual park staff who understand the benefits of the data.
- Results of a project on future Red River streamflows were used in developing the Arbuckle-Simpson Aquifer Drought Contingency Plan (The Choctaw and Chickasaw Nations et al. 2017). The Sac and Fox Nation will build on this work for their region of eastern Oklahoma, using Bureau of Indian Affairs funds; The Choctaw and Chickasaw Nations contributed funding to the project and are using the results in planning.
- Results of a project on modeling the effects of environmental change on wildlife habitat have been integrated into the New Mexico Crucial Habitat Assessment Tool (NM CHAT, http://nmchat.org/) and the USGS ScienceBase catalog (www.sciencebase.gov/catalog/item/57db2cbde4b090824ffc337b). The investigators hope to explore how practitioners respond to the availability of data in a decision support system on future climate change effects for wildlife.
- Several partners described the usefulness of maps of changes produced with SC CSC downscaled or sea level rise analyses. In some cases, SC CSC produced the maps as communication tools; in other cases, USFWS or others did.
- SC CSC's downscaling and guidance on which global climate models (GCMs) to use was critical in a 2-year scientific study by the USFWS because the USFWS lacked the appropriate climate background to make the determination. The USFWS was studying a temperature-sensitive species that had declining population, but no other obvious impacts to it. South Central Climate Science Center products were critical to predicting how the temperature line would move northward. The USFWS now understands why the species range is moving northward. This work is nationally recognized because of the work of the SC CSC.

Stakeholders generally find the science produced by the SC CSC useful and valuable.

To the SRT, several other projects seemed potentially useful but were described more as research or projects results than actionable. One partner said "reports should have a clear translation of how this science is intended to be used by management" in order to be more useable and actionable. That said, the SRT recognizes that some produced science might not be *immediately* actionable but is a needed, foundational component to produce future actionable science. It will be important for the SC CSC to think strategically about how best to allocate its future research funding amongst scientific efforts that are immediately actionable versus those that are necessary preconditions for other actionable knowledge while maintaining the policy that science be policy-relevant, not policy-prescriptive.

Review participants also indicated a number of factors that would improve usability:

- The practical application of SC CSC science could be enhanced with communication throughout—from beginning to end—focusing on "what's the benefit to me" (resource managers [tribal], government, etc.).

- There is a need to aggregate the results of all projects (not just present individual project results) to the level of themes, or into stakeholder-relevant topics, to increase the utility of the information.
- Implementation of the new SC CSC Communications Strategic Plan (SC CSC 2017) is a positive step to support continued progress in actionable science. It intends to support the CSC in
- Fostering relationships between researchers and users across the larger network
- Translating science for use
- Improving communications throughout SC CSC-funded projects, by implementing a project-focused communications planning template

Nearly half of the respondents to the HDRU survey (46%; n = 56; Lauber and Stedman 2018) "somewhat" or "strongly agreed" that the SC CSC has helped to reduce disconnect between what is known about climate adaptation and the actions taken by decision makers in the region. With regard to climate adaptation science in general, nearly two-thirds of respondents (65%; n = 81) "agreed" or "strongly agreed" that climate adaptation science in the South Central region is available to decision makers, and about half thought that water managers (52%; n = 64) and fish and wildlife managers (51%; n = 62) used this science to inform management. Only about one-quarter (23%; n = 29) believed that policymakers used this science to inform policies. A majority (59%; n = 72) maintained that what is known about climate adaptation does not necessarily influence actions taken by decision makers in the region (Figure 5).

According to the HDRU survey (Lauber and Stedman 2018), the most common limit on involvement with the SC CSC was not having enough time (36%; n = 48) followed by working with the SC CSC not being as high of a priority as other work (24%; n = 32) (Figure 6). Eighteen percent (n = 24) did not have enough funds, and 15% (n = 20) had not been asked.

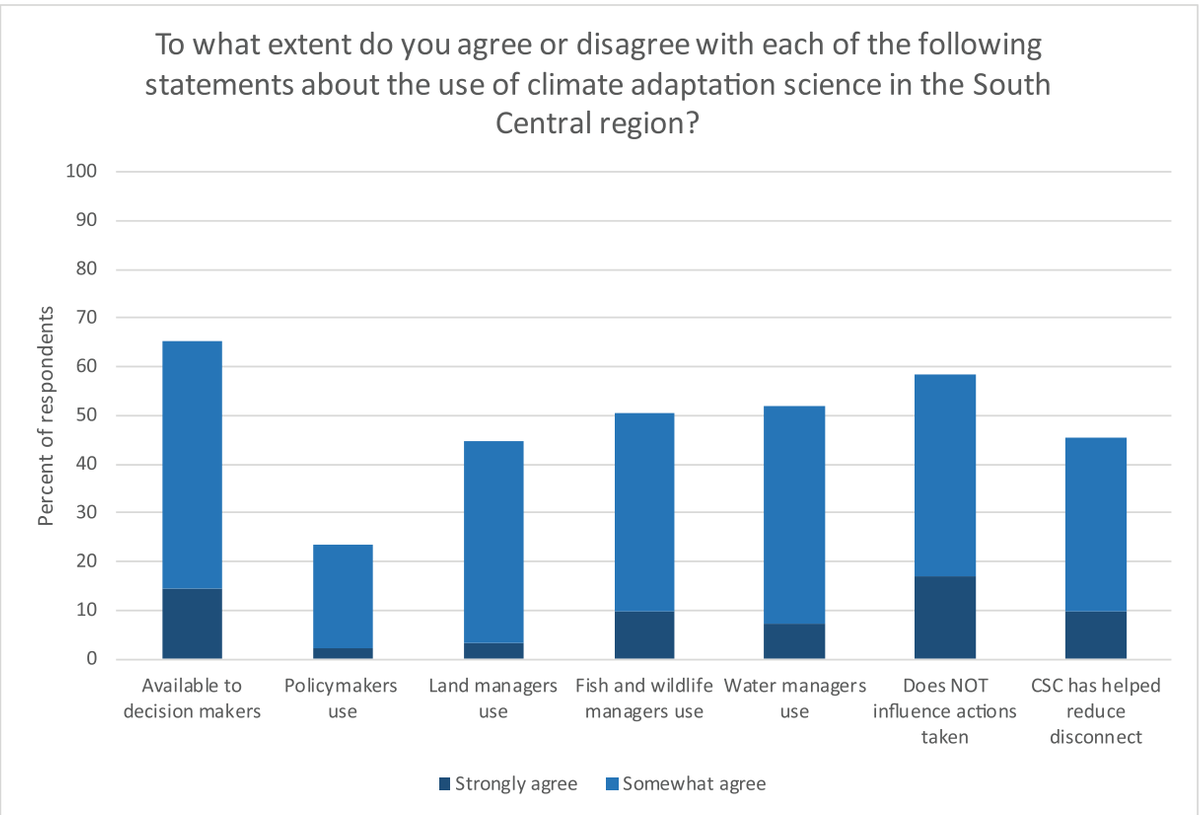

Figure 5. Stakeholder perceptions of the use of South Central Climate Science Center climate adaptation science (Lauber and Stedman 2018). Note: Based on survey question 11. Text in items shortened for presentation in graph.

The SC CSC has established strong connections with stakeholders that provide opportunities for further growth. Some examples presented include the following:

- The relationship with West Texas cotton farmers (in the vicinity of Lubbock, Texas) has shown the importance of connecting with stakeholders. The soil studies have major relevance to climate adaptation for agricultural stakeholders to develop better management practices for their crops and local conditions.
- The study with farmers for planting winter wheat is a template for identifying relevant information for stakeholders. This study illustrates the vital connections of climate science, social science, and economics. The study also shows the current limitations of modeling of important climate parameters for stakeholders.
- The Gulf Coast risk studies have focused on the potential for loss of shoreline due to rising sea level. These studies do a good job of identifying and illustrating the practical implications of climate change. Further development of adaptation measures (i.e. building wetlands) with economic analyses distributed through the appropriate agencies to stakeholders and the general public should increase awareness and develop tools for adaptation.

Results of the HDRU survey reflect the SRTs observations that stakeholders believe that the SC CSC is producing quality science and has established a strong foundation to be more strategic with science activities in the future.

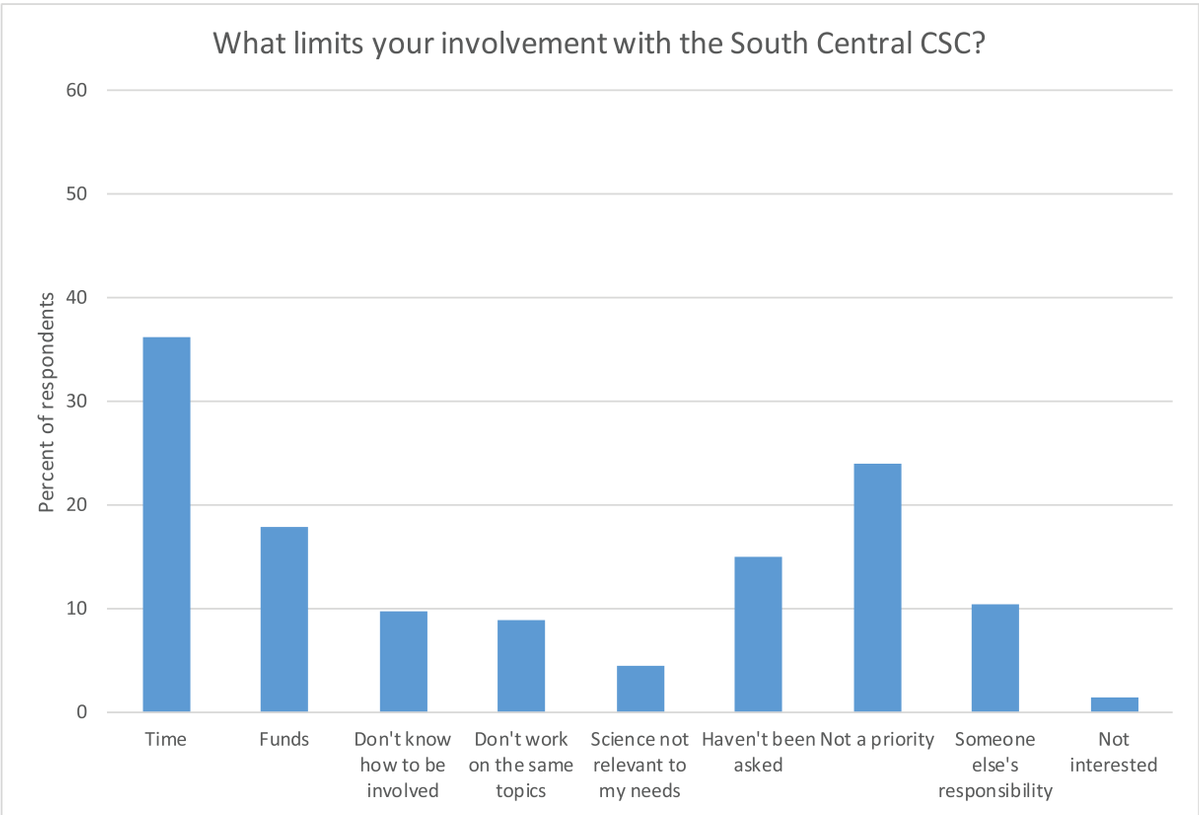

Figure 6. Limitations to stakeholder involvement with the South Central Climate Science Center (CSC; Lauber and Stedman 2018). Note: Based on survey question 10. Text in items shortened for presentation in graph.

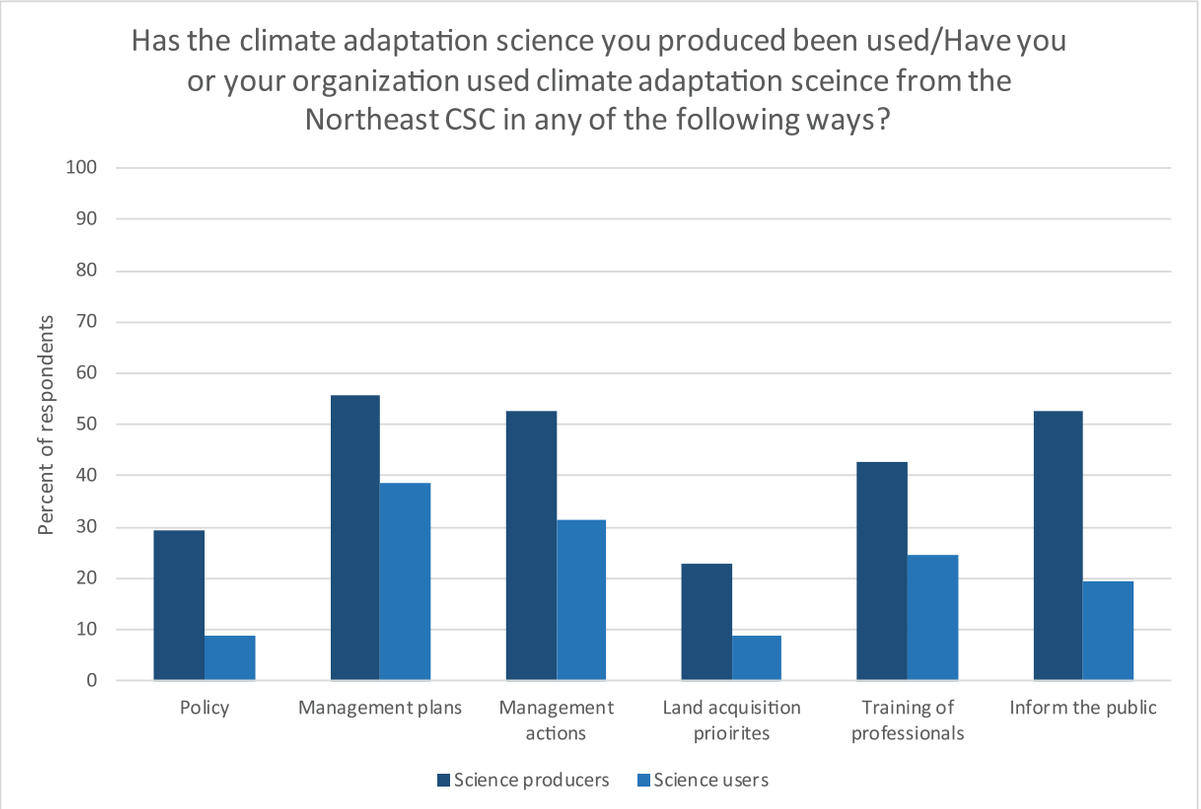

Figure 7. Stakeholder perceptions of the quality of South Central Climate Science Center (CSC) science (Lauber and Stedman 2018). Note: Based on survey question 12. Text in items shortened for presentation in graph, and only "strongly agree," "somewhat agree," or "I'm unfamiliar with the science" responses are shown.

Three-quarters of respondents (74%; n = 93) strongly or somewhat agreed that the SC CSC science can contribute to policy or management (Figure 7).

Respondents were also positive about other characteristics of the SC CSC science, with large majorities finding it high quality (65%; n = 81) and appropriate to inform the types of decisions being made (69%; n = 86). A majority also thought that it integrated well with other information (55%; n = 68). Only a minority thought that the SC CSC's science was irrelevant to management (14%; n = 17) or biased (4%; n = 5).

The CSC needs to articulate a general statement of accomplishments beyond individual project results to demonstrate value and impact beyond individual project results; how have you "moved the needle" in specific areas of science?

The SRT heard requests from many partners and stakeholders for "more teaching" (about appropriate use of CSC data and products), that the CSC "needs to explain," to "enhance communication," and to "provide a clear message of how would a resource manager *use* the science." Rather than a criticism of existing communications efforts, these requests reflect a desire on the part of stakeholders for the CSC to play an increasingly consultative role, providing technical and pragmatic guidance on appropriate information use. While this would require that the CSC acquire additional expertise (in, for example, the role of science in environmental decision making, risk management, etc.), the degree of uptake of CSC science over the long term will depend, in part, on whether CSC stakeholders are ultimately provided this support, either by the SC

CSC or other entities. Recognizing the USGS focus on science, the SRT also heard from one individual on the "need to remember that the CSC's main function is science. Investing funds in forums is great, but it's a problem if that comes at the expense of the core mission of the CSC, which is to provide science." Resolving the apparent tension between delivering and supporting the *use* of science, may require a clarification of the SC CSC mission—is it simply to provide science or to provide science that is used by DOI stakeholders?

Summary Recommendations on Actionable Science

Overall, the SC CSC has developed a strong, robust, and widely accepted program for developing actionable science products that are applicable to stakeholders in the region. Some of the key recommendations outlined are as follows:

- The SC CSC will benefit by conducting an evaluation that will help to decide how, and to what extent, to focus or prioritize science efforts in coming years.
- The use of directed grants and targeted grants is an agile way of addressing emergent stakeholder needs, and it may be instructive for the SC CSC to review the degree to which projects funded through these means are reflected in the priorities identified in the Strategic Science Plan (Winton et al. 2013);
- The SC CSC consortium has excelled in leveraging funds with other efforts, and it would be helpful to understand and map these projects to the SC CSC priorities and themes.
- Clearly articulating the *processes* that are in place to coordinate among funding streams would be helpful to all SC CSC partners, stakeholders, and future strategic planning efforts.
- The SC CSC is positioned to continue fostering coproduction of actionable science. The program would be strengthened by working with PIs to demonstrate the extent to which projects build on previous work related to applied climate science;
- Stakeholders strongly supported SC CSC-developed science products, and the SRT suggests continuing to emphasize to investigators the need to demonstrate meaningful coproduction in all funding requests.
- Partners and stakeholders reached during this review expressed a desire for the SC CSC to provide increased assistance with appropriate application and use of CSC data and products.

Communications

The SC CSC considers communication to be essential to its mission of providing actionable science to its stakeholders. A combination of digital, print, and in-person communication channels are employed for sharing research outcomes, engaging stakeholders, and leveraging partnerships (Kuster et al. 2017).

> *The SRT applauds the SC CSC perspective that thoughtful and strategic communication is essential to their success in all areas.*

The Strategic Communications Plan (SC CSC 2017) is a clear specification of the communication goals and objectives, the specific internal and external audiences the SC CSC strives to reach, and the tactics and channels used to reach those audiences. The SRT endorses the SC CSC perspective that thoughtful and strategic communication is essential to the SC CSC's success in all areas. The SRT commends the SC CSC for developing this plan and encourages its continued refinement and strategic implementation. Importantly, the SRT believes that the SC CSC communication program should always be considered a tool for enabling effective development and delivery of scientific information (i.e., a *means* to an end, rather than the *end* itself).

The Strategic Communications Plan lays out a series of guiding principles, including one—"The SC CSC has a unique role in the context of other, similar, regional boundary institutions"—that the SRT

perceives as aspirational at this point. The plan recognizes that "[i]n communications efforts, it is important to emphasize both what the SC CSC uniquely offers and how it collaborates with other climate-focused boundary organizations in the landscape. Ideally, this will result in stakeholders knowing exactly who to call when they need climate information tailored to their sector or decision." However, this unique role is not specified in the plan, nor was it clear to the SRT during the review, especially relative to the NOAA RISA teams in the region, which were rarely mentioned during the review.

The Strategic Communications Plan provides an excellent framework for continued honing and prioritizing of communications actions, audience by audience and objective by objective. The Implementation section, however, is not yet developed beyond stating that "communications staff should revisit the plan every six months to ensure that their areas of focus align with the listed goals and objectives, make the necessary adjustments to refocus on goals and objectives, choose new tactics to focus on, and develop metrics for these new tactics on a six month timeline" (SC CSC 2017). These are the right ideas, but the SRT recommends that the SC CSC explicitly state what constitutes success for their communications program, given the level of resources dedicated to the effort, and then develop metrics to measure progress towards success. This will be increasingly important as stakeholder demands, which are already high, continue to increase and as those demands evolve from requests for basic information about regional climate projections to more complex needs to understand, and address, climate impacts on valued resources.

Understanding what constitutes success in the communications program will be increasingly important as stakeholder demands, which are already high, continue to increase and as those demands evolve from requests for basic information about regional climate projections to more complex needs to understand, and address, climate impacts on valued resources.

Expanding the outreach to a broader group of stakeholders will require identification of a target audience to better understand what information and format is useful, and integration within the communication plan for effective delivery. The Strategic Communications Plan recognizes that communicating with many stakeholders will require strategically utilizing a network of networks (e.g., by routing information through appropriate state and federal agencies and other partner organizations). The SC CSC will need to develop a component of the communication plan process to prioritize new stakeholders for outreach, appropriate agencies for delivering the products, and credible dissemination pathways for broadcasting information to larger general audiences.

The communication plan will need to define boundaries and pathways for distributing science to users (for implementation) and to providing general information to a larger public. Systematic outreach to non-tribal rural communities via integrating organizations like the soil and water districts and acequia associations[10] can support capacity building within these communities to work with and evaluate climate data for their issues. Identifying credible messengers to distribute climate information will become an important component of social media communication.

The SC CSC is moving forward with developing a communication plan template for all of its funded projects. This document will require principal investigators, working closely with SC CSC communications staff, to describe the project team's communications capacity, the communication products to be created (e.g., publications, Web sites, webinars), and the ways in which the products will be disseminated. The SRT applauds the continued development and use of these plans and recognizes that the SC CSC is leading the CSC network on this front.

[10] Acequias are essentially community water ditches managed by a local association and recognized as political subdivisions of the state of New Mexico (www.ose.state.nm.us/Acequias/isc_acequias.php).

Internal Communication Opportunities

South Central Climate Science Center-funded researchers requested opportunities to learn about other SC CSC-funded projects since many of those projects are relevant to their own work. They also noted that there was room to improve SC CSC project management so that, for example, an ecologist who is waiting for climate or hydrologic projections is not impeded in completing his or her part of the project in the timeframe allowed. Better communication with the project team throughout its lifecycle would help alleviate this problem.

The SRT applauds the development of, the strategic communications plan and encourages many of the proposed refinements, including a Web site overhaul and communications management plans for funded projects.

Communication of Climate Change Information

The SC CSC develops and delivers climate change projections to the regional and national community through various communication channels, with varying levels of sophistication in communication of the nuances of those projections. The SRT saw uneven evidence of learning from the past (e.g., RISA) or current literature with respect to, for example, communicating uncertainty and observed concerning paternalistic tendencies (e.g., potential limits on data availability, scientific staff conflating their scientific expertise with deep understanding of management priorities and objectives). For example, while there may be good scientific (or practical) reasons to limit the number of GCMs used to develop climate projections and to report only the average of those projections, this does not mean, as the SRT heard during a review presentation, that stakeholders should plan for the average. By carefully identifying the nature and limits of the evidence base and expertise, the SC CSC can ensure continued salience and credibility with its management stakeholders. Further, the SC CSC must anticipate that certain data products will be in high demand (as is apparently the case in the Three-to-the-Fifth (3^5) project (PIs Adrienne Wootten, Renee McPherson, and Keith Dixon) to create downscaled climate projections for the region that incorporate multiple sources of uncertainty) and must develop means to provide open access to those data and results rather than requiring individual stakeholders to request data sets from specific researchers. While the national USGS ScienceBase (https://sciencebase.usgs.gov/) does provide access to most data, the SC CSC will facilitate the availability and application of data generated specifically for the region by developing communications tools to point regional stakeholders to where to access the data and how to apply it in order to ensure the SC CSC's ability to meet future demand increases.

The SC CSC would extend the use of their products by exploring avenues to make data, tools, and information accessible to those who were not directly involved in particular projects (i.e., increase the applicability and accessibility of SC CSC-funded science to the larger SC CSC region beyond simply posting data to ScienceBase).

Communications Recommendations

Strategic:

- The SRT applauds and encourages continued development of the Strategic Communications Plan. The SRT suggests making the communication goals more central to the document and fleshing out the Implementation section by explicitly stating what constitutes success for their communications program and then developing metrics to evaluate progress towards that success.

- The SRT agrees with the provision of the Strategic Communications Plan to multiply the SC CSC's impact by utilizing existing trusted messengers rather than attempting to cultivate and maintain its own relationships with multiple individual end-users. However, care should be taken to ensure appropriate branding and credit to the SC CSC for its materials and resources so that the ultimate users of that information are aware of the ultimate source of information they value.
- Because "[s]takeholders and staff have expressed a need for a better representation of how the CSC is unique in the landscape of similar boundary institutions" (SC CSC 2017:4), the SC CSC should work with other climate-focused boundary organizations in the region to identify and clearly communicate what each of them SC CSC uniquely offers and to whom.
- Explore ways to make data, tools, and information accessible to those who were not directly involved in a particular funded project so as to increase the applicability and accessibility of SC CSC-funded science to the larger SC CSC region.
- Consider Science Communication training workshops for investigators and staff (Baron 2010).

Tactical:

- Conduct an overhaul of the SC CSC Web site (SC CSC staff affirmed that this is a high priority)
- Ensure that public access to SC CSC data meets standards for publicly funded data and SC CSC objectives for improving end-user and partner access to SC CSC science and tools (Kuster et al. 2017). Revisit whether (and, if so, when) data delivery is restricted behind a firewall (e.g., for the climate change projections developed by the 3^5 project.
- Continue promoting the online course *Managing for a Changing Climate*. This is a stellar example of a successful and impactful communications product and could be held up as a best practice for other CSCs to use or develop in their regions.
- Expand the Messaging Guidance for Primary Audiences section (SC CSC 2017:12) to include researchers/scientists as a primary audience.
- Refine SC CSC's and member scientists' communication of climate change uncertainty, clearly distinguishing uncertainty about society's future choices from uncertainty about the climate system response. In other words, take care not to conflate policy uncertainty with climate variability with model uncertainty.

Capacity Building

One of the goals listed in the 2011 call for proposals soliciting host institutions for the CSCs was to identify organizations that are willing to host a DOI SC CSC that would foster and educate the next generation of climate science professionals by supporting graduate students and postdoctoral researchers at each center. The SC CSC has benefitted through their partnership with the host institution and other universities in the area of educational programs that support traditional education of undergraduates and graduate students, and in research and training of Native Americans. The following observations and comments are based on presentations of SC CSC and USGS staff, OU faculty and staff, students, and partnership organization representatives.

The SC CSC partnership has benefitted from the extensive education and outreach programs offered by OU and other partner universities. Likewise, OU has benefitted from the unique opportunity that SC CSC has provided for training future scientists with a particular focus on providing opportunities for tribal community members. During the on-site review, the SRT met with multiple faculty and students funded by the SC CSC partnership and discussed recent applied research and outreach programs in which they have participated that either provided training for students or outreach to affected stakeholders. The SC CSC communication specialist noted that through SC CSC-supported research and education programs, students are provided the following benefits and opportunities:

- Students gain better access to researchers conducting climate research;
- Students have the opportunity to learn communication skills;
- Students begin to build professional networks that they carry through their careers.

The SC CSC has also developed an internship program for underrepresented groups and research experiences for undergraduates that have included opportunities for tribal members. The SRT was particularly impressed with the thoughtful approach to these programs as well as the obvious commitment by the staff at the SC CSC to mentoring the next generation of scientists. The undergraduates with whom the SRT interacted during the on-site visit were consistently professional and appeared fully engaged in the SC CSC endeavor. The SC CSC has also conducted an early-career professional development program that has served more than 50 participants. We encourage the SC CSC to continue this program as a means to perpetuate the professional ranks of climate scientists.

Online Courses

One online course, developed and offered multiple times starting in the fall of 2016, was designed to provide an integrative understanding of the components of the climate system. The course included videos of diverse set of speakers from all across the South Central United States. More than 500 individuals were reached through this online course, including students at other SC CSC- and LCC-related institutions, natural resource managers, and tribal environmental professionals. The course covered an overview to the physical climate system, an introduction to downscaling techniques and how to use them, and known impacts of a changing climate. The report noted future plans to build and develop new videos on related topics during 2017. This was confirmed by SC CSC staff during the on-site visit.

The impact of online course reaches far beyond the boundaries of the SC CSC. Although online courses are becoming more common, the number of students participating in SC CSC courses is impressive. The leadership and developers of this course should be commended for their efforts and educational impacts both within and outside of the SC CSC.

During the on-site review, the SRT was also told that some of the training videos are on YouTube and that some programs (e.g., Managing for Climate Change) engaged students from as far away as Zimbabwe.

Study Abroad Program

The SRT met with the vice-president for research at OU, Dr. Kelvin Droegemeier, SC CSC Director Dr. McPherson, and other faculty to discuss university support and administration of the SC CSC. The vice-president for research at OU and faculty provided information on how OU supports the SC CSC. Among other programs, Dr. Droegemeier described the OU Study Abroad program, which he has helped build over many years and strongly supports.[11] Some SC CSC-affiliated students have participated in the Study Abroad program focusing on environmental issues. It was very obvious from interviews with the vice-president for research and other faculty that OU and the SC CSC value opportunities to expose students to international issues related to climate change. The opportunities presented by this study abroad program are an outstanding example of the value to capacity building that has been developed as a result of the strong relationship established between the SC CSC and OU.

Nurturing STEM Education in Underrepresented Groups

The SC CSC 2016 annual report documented that the program supported a total eight postdoctoral researchers at three affiliated institutions; 23 graduate students at five institutions, including seven students from one Native American tribe; and 27 undergraduate students at five institutions, including 15 students from two tribes. The high percentage of students from Native American tribes supported by the SC CSC (22/58 = 38%)

[11] The Study Abroad program is one of many university programs that, while not funded with CSC funds, provides benefits to the SC CSC and students affiliated with the SC CSC.

demonstrates the strong commitment to providing STEM education to underrepresented groups (e.g. Native Americans). During our visit, the SRT met several students from Oklahoma tribes who are currently studying at OU and working on SC CSC projects who provided summaries of their undergraduate research projects.

The continuing commitment to these students is remarkable. The SRT was particularly impressed with the mentoring that undergraduate students were receiving and the apparent pipeline of training that was available to these students. Quite often, undergraduates are brought into training programs and rotated in and out without much preparation or development for the next stages of their careers. This is not the case at the SC CSC; students are brought into the program, supported for extended periods, and provided experiences and exposure to future career opportunities that reflects exceptional care and consideration by the leaders of the SC CSC. The SRT was uniformly impressed by the quality of the undergraduate students in the SC CSC.

The 5-year report (Kuster et al. 2017) further documents efforts by the SC CSC during years 3–6 when the universities within the consortium hosted a 3-week internship for underrepresented students in science, technology, engineering, and math (STEM). During years 3 and 5, the SC CSC led week-long professional development workshops for early-career professionals.

Tribal Workshops

During the on-site review, the SC CSC described the various workshops that they have provided to Native Americans in Oklahoma. Additional information was also obtained from the 2016 annual report. The SC CSC has co-hosted the annual Tribal College Conference Series on Climate Change at the College of the Muscogee Nation entitled "Native American Water and Food Security Research." This conference was attended by 98 individuals, primarily tribal college students. The attendees heard from professionals in native science research. The 5-year report (Kuster et al. 2017) further documents that in 2015, the SC CSC partnered with OU, The Chickasaw Nation of Oklahoma, and The Choctaw Nation of Oklahoma to host two interactive workshops designed to provide researcher with a framework of best practices for working in Indian Country. The workshops were entitled "Shifting Landscapes: Protocol Training for Building Long-Term Research Relationship in Oklahoma Indian Country."

The SRT recognized that the tribal workshops were successful and the SC CSC should be commended for their efforts in this area. However, trusting relationships between federal and state agencies and tribal groups is an ongoing challenge, an issue that is certainly not limited to the SC CSC. Additionally, as mentioned previously (under Tribal Engagement), the SC CSC has only been able to engage a fraction of the 68 federally recognized sovereign tribes and pueblos in the region through these workshops. We encourage continued development of tribal workshops based on stakeholder input.

The online climate course, study abroad program, and other educational offerings within the university are impressive; the SC CSC is clearly nurturing STEM education in underrepresented groups and the tribal workshops are extremely valuable.

Tribal and Other Interns

Based on the 2016 annual report, the SC CSC program provided support for four PIs and two staff positions recently. At least 12 individuals from two tribes have served at the SC CSC office (56 staff total) over the 5-year period (Kuster et al. 2017). The hard work that the SC CSC has invested in reaching out and providing opportunities for students from tribes to become engaged in climate issues through internships, assistantships, and staff positions is very apparent. The integration of tribal interns has seemingly been extremely successful, and the SRT repeatedly discussed how impressive these students were during the on-

site review. The SRT observes that this excellent training will likely create opportunities for jobs that take students outside of the region, and while it is hoped that some of them remain to apply their knowledge to South Central tribal issues, others will inevitably apply their skills elsewhere. Whether the SC CSC shares this view is unknown, but if possible, some consideration should be given to ways to retain a long-term impact of these interns on their tribal communities.

The SC CSC has nurtured tribal and other students from undergraduate, graduate, and early-career professional stages, which provide a strong intergenerational connection for future engagement of tribal governments; consideration should be given to ways to retain the long-term impact of these interns on their tribal communities.

Undergraduate and Graduate Staff

The SRT observed that several undergraduate and graduate students concurrently serve as staff members for the SC CSC, all being members of the Oklahoma tribes. The SC CSC has recognized the need to reach out to other tribes in Oklahoma and New Mexico. The great distances and limited funding and staffing are the likely primary reasons that more student involvement has not occurred, especially for tribes and pueblos in New Mexico.

Many of the students interviewed described how their projects—either by design or topic matter—involved extensive interaction with faculty, community leaders, and various federal and tribal organizations. Also, as previously described, the SC CSC has supported conferences and supported student travel to professional society meetings, which provide critical networking opportunities. In addition, the online training programs provide another opportunity for students to gain wide exposure of their work. The SRT is impressed with these aspects designed to nurture students and early career professionals in the climate science programs.

Capacity Building Summary

The SRT is very impressed with the program elements of the SC CSC devoted to academic, community educational, and professional training programs to Native American tribes on the topic of climate research and management. The efforts and achievements in these areas are outstanding, and the SC CSC staff should be commended. The fact that this is accomplished with very few dedicated staff (e.g. April Taylor—tribal partnership liaison) is even more remarkable. The geographic area covered by the SC CSC covers multiple large states and 68 tribes, with a large proportion found in Oklahoma and New Mexico. These tribes have a very diverse background culturally. Tribal cultural biases and preferences may also limit the use of long-distance learning and training programs. One of the primary general criticisms expressed by the New Mexico Pueblo representatives for the SC CSC was the paucity of face-to-face meetings, which would of course include any education programs. However, based on the existing funding and limited resources, the various indicators provided during our visit, and annual and CSC reports, it is clear that the SC CSC has done an exemplary job of supporting educational, training, and outreach objectives.

Partnerships

The SC CSC has developed an extensive array of partnerships, as has been documented earlier in this report. Additional partnerships to communicate the science products to conservation partners who will implement the results on the ground would extend the utility of the products that are developed. For example, building partnerships with extension agencies may help to focus on understanding what information is important for stakeholders while the agency develops processes to build climate resilience for

the stakeholders. These partnerships are one step toward increasing state, local, and private stakeholder involvement. The SC CSC may consider developing demonstration events with state extension agencies as a component of the communications plan to extend partnerships even further.

Engaging state extension agencies and many nongovernmental partners will also help to develop credible messengers with established credentials who effectively communicate objective information to large audiences. The co-location of the BLM office with the SC CSC supports the potential for collaboration on public lands and rangeland issues. Building grassroots connections to other federal agencies such as the Department of Defense and U.S. Army Corps of Engineers (USACE) would result in an expanded partner network. Periodic progress reports to the Institute of Water Resources (www.iwr.usace.army.mil/) and Engineer Research Development Center (www.erdc.usace.army.mil/) of research relevant to their respective missions would broaden application of products.

Concluding Comments

Despite having substantially less funding than was anticipated at the initiation of the SC CSC, the USGS, OU, and consortium partners have developed a strong, vibrant, and exemplary program for generating stakeholder-driven climate adaptation science. The SRT was greatly impressed by the progress that the SC CSC has made in five short years, which is a reflection, in large part, of the strong personal and professional commitment of the SC CSC university director and current and past SC CSC USGS directors. Additionally, the OU administration has demonstrated substantial support for hosting the SC CSC, which has proven to be a win–win for OU and the USGS: an already-strong weather and climate program at OU has benefitted from the additional capacity brought by the CSC, and the USGS has benefitted from the world-class reputation of an established climate and weather research program. As with any program, particularly one addressing dynamic issues such as climate adaptation science, the SC CSC must continually strive to improve to meet emerging demands and issues. The SRT recommendations contained within this report are offered in that spirit, and it is hoped that they will lead to an even stronger program in the future.

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Appendix A
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Appendix B

South Central Climate Science Center On-Site Review Schedule

November 13–16, 2017
University of Oklahoma
5 Partners Place
201 Stephenson Parkway, Suite 2100
Norman, Oklahoma 73019, USA

Monday, November 13, 2017

Time	Activity	Desired output	Lead entity/ person(s)
	Travel day. Review Team arrives.		
5:00–6:30 pm	Pre-meeting of **Review Team members and USGS-Reston staff only**. • Review schedule of meetings/ discussions • Overview of goals and expected products • Writing expectations • Identification of additional information needs		
6:30–8:00 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?		

Tuesday, November 14, 2017

Time	Activity	Desired output	Lead entity/ person(s)
8:00–8:30 am	All gather		
8:30–9:00 am	Welcome, introductions, and short background statements by Review Team member Review charge to the committee Welcoming remarks – Langston/ McPherson		Austen, Cushing, Langston, McPherson
9:00–10:00 am	Brief review of main points from preparatory conference calls focusing on structure, funding, staffing, and related	Ensure that SRT has full understanding of the structure of the	Austen

Tuesday, November 14, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
	aspects of the Norman component of the SC CSC. • Q&A and discussion of issues raised from the calls. • Identification of additional information needs.	CSC including core documents and key processes.	
10:00–10:15 am	Break		
10:15–11:15 am	**Establishment of the climate change science and conservation context of the CSC.** Selected 10-minute presentations on significant climate change issues and conservation challenges that characterize the CSC operational area. 1. Drs. Renee McPherson (OU) & Mike Langston (USGS) – Introduction 2. Drs. Mike Osland (USGS) – Wetland Migration Project (*on audio/visual) 3. Dr. Barney Austin (Aqua Strategies) – Red River Project 4. Bill Bartush (DOI FWS) – Conservation Challenges 5. April Taylor (Chickasaw) – Tribal Partnerships	Presentations and discussion will enable the SRT to recognize the linkage between these issues and the strategic plan and science agenda of the SC CSC	Austen
11:15 am–noon	**Consortium Discussion** – review of partners, mechanisms for engagement, assortment of strengths, weakenesses, and opportunities of the consortium. Oveview of university work. 1. Dr. Renee McPherson (OU) 2. Emma Kuster (OU) 3. Dr. John Zak (TTU) 4. Dr. Natasha van Gestel (TTU) 5. Dr. Kristine DeLong (LSU) 6. Dr. Victor Rivera-Monroy (LSU) 7. Dr. Jim Ansley (OSU) 8. Dr. Keith Owens (OSU) 9. Wayne Kellogg, P.E., P.G., CSP (Chickasaw) 10 Kara Berst (Chickasaw) 11. April Taylor (Chickasaw) 12. Tye Baker (Choctaw) 13. Dale Jackson (Choctaw) 14. Dr. Keith Dixon (GFDL) (*on audio/visual connection) 15. Dr. Chris D'Elia (LSU) (*on audio/visual connection??)	Status of consortium coordination, involvement, management, adequacy of coverage, etc. <u>Discussion points</u>: Engagement of Partners Benefit for partners of being in SC CSC • Value of CSC consortium partnerships • Value of having multiple universities involved (diverse experts) • Better able to address the needs of the the region because we have the expertise and their relationships/trust with the stakeholders • Unique nature of consortium with GFDL and CN • Can have representative from the tribe when major decisions are being made • Value of partnership between federal and university • Stability of USGS funding that allows for the leveraging that university can do with other grants	

Tuesday, November 14, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
		• Cutting edge research in university environment – collaborative environment (where climate science and biological sciences are conducted) • Connectivity to supercomputing and data storage infrastructure and educational learning platforms (e.g., Janux) • Diversity of people and perspectives • Value of having federal at host university • Connection to NCCWSC • Consistency throughout the academic year into the summer, especially with the stakeholder engagement	
12:00–1:30 pm	CSC and host-university research forum – graduate and postdoctoral research updates, outreach, and engagement ***This time slot includes a working lunch*** Introduction: Jessica Blackband Series of presentation highlighting projects (5-min talk, 5-min Q&A) 1. Chantelle Davis (University of Kansas) (*on audio connection) 2. Clay Tucker (LSU) (*on audio connection) 3. Toni Klemm (OU) 4. Aaron Fournier (Chickasaw) 5. Dr. Derek Rosendahl (OU) 6. Dr. Adrienne Wootten (OU) 7. Jessica Blackband (OU)	Understanding of the main drivers of science-management needs that define the CSC and relevant other climate science providers. 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.
1:30–1:45 pm	Break		
1:45–3:45 pm	Partnership Dialogue #1 (Cornell Team) – **science "producers"** 1. Dr. Elinor Martin (OU) 2. Dr. Jennifer Koch (OU) 3. Dr. Barney Austin (Aqua Strategies) 4. Dr. John Zak (TTU) 5. Dr. Natasha van Gestel (TTU) 6. Dr. Kristine DeLong (LSU) 7. Dr. Victor Rivera-Monroy (LSU) 8. Dr. Mark Shafer (OU/SCIPP) 9. Dr. Shannon Brewer (USGS/OSU) 10. Dr. Adrienne Wootten (OU) 11. Dr. Derek Rosendahl (OU)		Bruce Lauber and Rich Stedman

Tuesday, November 14, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
	12. Dr. Caryn Vaugn (OU) 13. Dr. Ming Xue (OU) 14. Dr. Lei Qiao (OSU) 15. Dr. Mike Osland (USGS) (*on audio/visual connection) 16. Dr. Keith Dixon (GFDL) (*on audio/visual connection) 17. Dr. Jack Friedman (OU) (*on audio/visual connection)		
3:45–4:00 pm	Break		
4:00–5:00 pm	**Review Team only closed session #1** (SC CSC team and partners meet elsewhere) 1. Gather initial thoughts and questions. Quick gathering of initial observations (e.g., lightning 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.		
6:30 pm	Dinner (SC CSC personnel invited to attend)		

Wednesday, November 15, 2017

Time	Activity	Desired output	Lead entity/ person(s)
8:00–8:15 am	All gather Review day-1 notes and day-2 schedule of activies		Austen
8:15–8:45 am	SC CSC suite tour (5PP, Suite 2100)		McPherson
8:30–9:30 am	**CLOSED SESSION** Review Team briefing and discussion with **university/host institution principal investigators** and relevant other university partners only 1. Dr. Renee McPherson (OU)		McPherson and other university representatives

Wednesday, November 15, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
	2. Dr. Kelvin Drogemeier (OU) 3. Dr. Berrien Moore (OU) 4. Dr. Alicia Knoedler (OU) 5. Andrea Deaton (OU) 6. Emma Kuster (OU) 7. Dr. Elinor Martin (OU)		
9:45–10:00 am	Break		
10:00 am–noon	Partnership Dialogue #2 (Cornell Team) – science "users" 1. Jonna Polk (DOI FWS-Tulsa) 2. Bill Bartush (DOI FWS GCP) 3. Crystal Keys (DOI BIA) 4. Roger Fragua (Pueblo of Jemez) 5. Dr. David Brown (USDA Climate Hub) 6. Brian Trustry (Texas Audubon) 7. Nathan Kuhnert (Bureau of Recreation) 8. Dr. Matthew Grabau (DOI FWS) 9. Dr. James Collard (Climate Potawatomi Nation) 10. Pam Benjamin (DOI Park Service) (*on audio/visual connection) 11. Debbie Dotson (Wyandotte) (*on audio/visual connection) 12. Dr. James Broska (FWS Albuquerque) (*on audio/visual connection)		Bruce Lauber and Stedman
Noon–1:15 pm	Lunch		
1:15–2:45 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. 1. Bill Bartush (DOI FWS GCP) 2. Crystal Keys (DOI BIA) 3. Dr. David Brown (USDA Climate Hub) 4. Dr. Matthew Grabau (DOI FWS) 5. Allison Shipp (DOI USGS) 6. Dr. Jean Steiner (USDA ARS) 7. Pam Benjamin (DOI Park Service) (*on audio/visual connection)		Austen, Loftus to facilitate
2:45–3:00	Break		
3:00–3:15 pm	**Review Team only** – preparation of notes for closed session with USGS		
3:15–4:30 pm	**CLOSED SESSION** Review panel briefing and Q&A with **USGS staff only**	Review responses to submitted questions and information	Langston

Wednesday, November 15, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
	• Dr. Mike Langston (USGS) • Kristen Donahue (USGS) • Dr. Betsy Glenn (USGS) • Dr. Kim Winton (Retired USGS)	requests, open discussion of CSC	
4:30–5:30 pm	**Review Team only closed session #2** – compilation of notes from day 2		
Evening	Working Dinner – for Review Team only		
Evening working session	Review Team session to further refine authorship, take time for drafting of material, identification of additional questions to CSC hosts. Initial identification of key findings and observations to be reported out on Thursday.	Location at discretion of Review Team	

Thursday, November 16, 2017

Time	Activity	Desired output	Lead entity/ person(s)
8:00–8:15 am	Review day-2 notes and day-3 schedule of activities		
8:15–9:45 am	Flex time available for additional discussion topics. This may include • Communications and engagement of constituents. • Capacity development – training opportunities provided to partners, building the next generation of climate science trained conservation managers and administrators 1. April Taylor (CN) and Atty Phleger (OU) (20 min) 2. Jessica Blackband (OU) (15 min) 3. Dr. Renee McPherson (OU) (5 min) 4. Dr. Elinor Martin (OU) (5 min) 5. Emma Kuster (OU) (5 min)	Time allocated to allow for SC CSC to hold discussions on any variety of topics that are unique to the CSC and haven't been addressed in other previous session.	Langston, McPherson. Input from Austen and Loftus
9:45–10:00 am	Break		
10:00 am–	**Review Team only closed session #3 – working lunch**	Identify key initial initial observations. Discuss writing assignments	
1:00–2:30 pm	Report out of Review Team to SC CSC	• Presentation of key observations, findings and recommendations	**All participants are invited** to this open presentation

Thursday, November 16, 2017 (continued)

Time	Activity	Desired output	Lead entity/ person(s)
		• Open discussion and Q&A about initial observations • Develop list of follow-up items or other additional needs of the Review Team	by the Review Team and discussion
2:30–2:45 pm	Break		
2:45–5:00	Working time for Review Team only Address comments from report out, complete report outline, make writing assignments, establish schedule for report completion		Langston, McPherson available to respond to questions or make clarifications as needed by the Review Team
5:00 pm	Complete working session s of Review Team		
6:00 pm	Dinner or departure of Review Team members		

Appendix C
South Central Climate Science Center Research Funding by Mechanism

Table C.1. Summary of hte U.S. Geological Survey (USGS) Request for Proposal-Funded Grants. Abbreviations: RFP = request for proposal; SOI = statement of interest; FWS = U.S. Fish and Wildlife Service; USBR = U.S. Bureau of Reclamation; LCC = Landscape Conservation Co-operative (SR = Southern Rockies, GP = Great Plains, GCP = Gulf Coast Prairie); BIA = Bureau of Indian Affairs; TX PWS = Texas USACE = U.S. Army Corps of Engineers; USDA = U.S. Department of Agriculture. Source: From Kuster et al. 2017.

RFP	Submission period	SOI due	Proposal invites sent	Proposals due	Notice of award	Reviewers	Total SOIs	Invited	Accepted	Funded
2012							57	20	7	8
2013	Jan 9, 2013–Mar 25, 2013	Feb 1, 2013	Feb 25, 2013	Mar 25, 2013		FWS, USBR, USGS	76	20	8	9
2014	Jul 23, 2013–Aug 24, 2013	Jun 25, 2013	Jul 23, 2013	Aug 21, 2013	Oct 15, 2013	FWS, USBR USGS	48	12	4	5
Directed Funding 2014	Jun 21, 2014–Sep 30, 2014						3	1	1	1
2015	Apr 28, 2014	Jun 20, 2014	Aug 1, 2014	Oct 1, 2014	Dec 15, 2014		44	22	8	8
Two Basin Project	May 13, 2015–Jul 31, 2015					FWS, USBR USGS, SR LCC	6	6	2	4
2015 Directed Funding	Jul 1, 2016–Jan 31, 2017						7	7	7	7
2015	Dec 1, 2016–Jan 18, 2017	Jan 18, 2017	Feb 3, 2017	Mar 30, 2017	May 15, 2017	FWS, USBR Fort Collins USGS Science Center LCCs (GP, Desert, GCP), BIA, USGS, TX PWS USACE, USDA	65	16	6	6

Table C.2. South Central Cimate Science Center (SC CSC) base funding per year. Across the first five grant years, the nonfederal members of the SC CSC consortium expended $3,521,681 of the budgeted $3,527,473 (85.9%) in our hosting agreement. The total budget expenditure amounts are itemized by year (years 1–5) below for all non-federal consortium members. Source: From Kuster et al. 2017.

Year 1	Received	Carryover	Expended	Percent expended
University of Oklahoma	$351,592	$0	$229,963	65.4%
Texas Tech University	$96,710	$0	$68,083	70.4%
Louisiana State University	$75,033	$0	$24,540	32.7%
Chickasaw Nation	$108,061	$0	$58,598	54.2%
Oklahoma State University	$74,657	$0	$31,102	41.7%
Total	$706,053	$0	$412,286	58.4%

Year 2	Received	Carryover	Expended	Percent expended
University of Oklahoma	$276,153	$121,629	$352,460	88.6%
Texas Tech University	$98,525	$28,627	$127,152	100.0%
Louisiana State University	$78,265	$50,493	$81,071	63.0%
Chickasaw Nation	$109,550	$49,463	$95,476	60.0%
Oklahoma State University	$74,812	$43,555	$44,112	37.3%
Total	$637,305	$293,767	$700,271	75.2%

** Includes carryover from year 1. Carryover resulted from the time it took to staff the center.*

Year 3	Received	Carryover	Expended	Percent expended
University of Oklahoma	$247,699	$45,322	$302,077	103.1%
Texas Tech University	$150,910	$0	$143,530	95.1%
Louisiana State University	$108,780	$47,687	$156,467	100.0%
Chickasaw Nation	$111,069	$63,538	$172,911	99.0%
Oklahoma State University	$91,163	$74,255	$163,048	98.6%
Total	$709,621	$230,802	$938,033	99.7%

** Includes carryover from year 2. Carryover reslted from position turnover and hiring process.*

Year 4	Received	Carryover	Expended	Percent expended
University of Oklahoma	$252,244	-$9,056	$243,158	100.0%
Texas Tech University	$154,905	$7,380	$132,728	81.8%
Louisiana State University	$113,701	$0	$113,701	100.0%
Chickasaw Nation	$112,618	$1,696	$112,617	98.5%
Oklahoma State University	$93,640	$2,370	$82,083	85.5%
Total	$727,108	$2,390	$684,287	93.8%

** Includes carryover from year 3. Carryover reslted from position turnover and hiring process.*

Year 5	Received	Carryover	Expended	Percent expended
University of Oklahoma	$256,883	$30	$255,431	99.4%
Texas Tech University	$161,241	$29,557	$190,798	100.0%
Louisiana State University	$118,868	$0	$118,665	99.8%
Chickasaw Nation	$114,200	$1,697	$114,194	98.5%
Oklahoma State University	$96,194	$13,927	$107,716	97.8%
Total	$747,386	$45,211	$786,804	99.3%

Table C.3. South Central Climate Science Center (CSC) funding from non-U.S. Geological Survey (USGS) grants: The total funding listed above from USGS was leveraged to obtain $218,045,935 in additional funding for CSC-related research and outreach that align with the goals of USGS. Below is the total dollar amount received by the consortium from non-USGS grants. Abbreviations: NCAR = National Center for Atmospheric Research; NOAA = National Oceanic and Atmospheric Administration; DOE = U.S. Department of Energy; NSF = National Science Foundation; USDA = U.S. Department of Agriculture; ODWC = Oklahome Department of Wildlife Conservation; BIA = Bureau of Indian Affairs; EPSCoR = Established Program to Stimulate Competitive Research; NP-OUORA = University of Oklahoma Office of Research Administration; FWS = U.S. Fish and Wildlife Service; OWRRI = Oklahoma Water Resources Research Institute; BOR = Bureau of Reclamation. Source: From Kuster et al. 2017.

Year 1	Received	Funding agencies
University of Oklahoma	$413,903	U.S. Army Corps of Engineers; NCAR; NOAA
Texas Tech University	$267,327	DOE; NSF; USDA
Choctaw Nation of Oklahoma	$50,000	BIA
Oklahoma State University	$12,428,898	USDA; ODWC
Total	$13,160,128	

Year 2	Received	Funding agencies
University of Oklahoma	$2,104,405	BIA, NOAA
Oklahoma State University and University of Oklahoma	$24,000,000	NSF EPSCoR, Oklahoma State Regents
Texas Tech University	$34,000	USDA; Cotton Inc.
Louisiana State University	$10,000	Louisiana EPSCoR
Oklahoma State University	$2,325,446	USDA; ODWC
Total	$28,473,851	

Year 3	Received	Funding agencies
University of Oklahoma	$199,944	Oklahoma EPSCoR; NP-OUORA; FWS
Texas Tech University	$4,654,013	USDA; NSF; NOAA; Cotton Inc.
Louisiana State University	$200,000	Coypiu Foundation; Global Green; NSF
Choctaw Nation of Oklahoma	$146,992	BIA
Oklahoma State University	$913,014	OWRRI; NSF; ODWC
Total	$6,113,963	

Year 4	Received	Funding agencies
Texas Tech University	$171,257	NSF; Cotton Inc.
Louisiana State University	$101,227	Louisiana Board of Regents
Chickasaw Nation	$265,607	BIA, BoR WaterSmart
Total	$538,091	

Year 5	Received	Funding agencies
University of Oklahoma	$167,935,175	NSF, NASA
Texas Tech University	$44,644	NOAA; Cotton Inc.
Louisiana State University	$1,500,000	NASA EPSCoR; Lousiana Board of Regents
Oklahoma State University	$280,083	ODWC; USDA; Pheasants Forever, Inc.
Total	$169,759,902	

Appendix D
Partnership Effectiveness 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.?

Appendix E
Report from the Cornell University Human Dimensions Unit: South Central Climate Science Center Results

NOTE: See Introduction to this report or refer to Lauber and Stedman (2018) for methodology.

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 South Central 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. Consequently, we characterize our respondents in this section.

Forty-six percent (n = 57) 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. Thirty-three percent (n = 38) reported that they have produced climate adaptation science through an affiliation with the South Central CSC, while 20% (n = 23) have produced climate adaptation science but never with such an affiliation. We refer to both of these groups as science producers (52%; n = 61). Twenty-one of the respondents (18%) were both science users and producers.

Twenty-eight respondents (24%) 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 SC-1).

All of our respondents did work that involved climate adaptation science, management, or policy to at least some extent. Fewer than half of our respondents (42%, n = 56) were involved to a large or very large extent (Table SC-1). Twenty-six percent (n = 34) were involved only to a small extent. Respondents who were both producers and users were more involved than other respondents.

Almost all respondents (84%; n = 106) reported that they have had at least some interest in or involvement with the South Central CSC (Table SC-2). Just 11% (n = 14) reported that they had no involvement but

Table SC-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	26%	20%	24%	29%	26%
To a moderate extent	28%	28%	14%	39%	32%
To a large extent	32%	34%	38%	25%	30%
To a very large extent	14%	18%	24%	7%	12%

Table SC-2. Respondents' relationships with the South Central CSC.

Extent of involvement	User	Producer	Both user and producer	Neither user nor producer	Total
Heard of the South Central CSC, but no interest or involvement	7%	0%	0%	7%	6%
No involvement with the South Central CSC, but someone else in my organization involved	18%	8%	14%	7%	11%
At least some interest or involvement with the South Central CSC	75%	92%	86%	86%	84%

someone else in their agency or organization did, and another 6% (n = 7) had no interest or involvement at all.

Respondents worked in states throughout the South Central region, but they were more than twice as likely to work in Oklahoma or Texas than New Mexico or Louisiana (Table SC-3).

A majority of respondents worked at the regional/multi-state scale (66%; n = 87), the state scale (54%; n = 72), and the watershed scale (51%; n = 68) for some or all of their work. Smaller percentages worked at local (43%; n = 57), national (26%; n = 35), or international scales (15%; n = 20).

The majority of respondents were affiliated with either federal agencies or universities (Table SC-4). Fewer were affiliated with non-profit organizations or state agencies. Very few were affiliated with tribal governments, private industry, or local governments.

More than one-third of respondents held positions in leadership/administration (38%; n = 51) and research positions (35%; n = 47). Only a few were in operations (11%; n = 14) or policy (6%; n = 8).

Extent of Involvement with the CSC

On average respondents have been involved with the South Central CSC for 3.7 years. Respondents reported a variety of types of involvement (Table SC-5). Most common was as a participant in a CSC training, webinar, workshop, or conference (34%; n = 45). One-quarter were CSC grant recipients, applicants, or partners on a grant (25%; n = 33), and one-fifth were LCC steering committee members (20%; n = 26).

The respondents reported on their frequency of interaction with five types of CSC representatives and affiliates (Figure SC-1). At least 70% of respondents interacted with each of three of the types (US Geo-

Table SC-3. Locations in which respondents work.

Location	Percentage of respondents	N
Oklahoma	42%	56
Texas	41%	54
New Mexico	20%	27
Louisiana	16%	21

Table SC-4. Respondents' affiliations.

Affiliation	Percentage of respondents	*n*
Federal agency	35%	46
University	26%	34
Nonprofit organization	12%	16
State agency	11%	14
Tribal government	6%	8
Private industry	2%	2
Local government	2%	2

logical Survey CSC staff; University leads/PIs for the CSC; and CSC-affiliated researchers) 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 47% interacted with these individuals at least some of the time.

Benefits of Involvement

The most frequently identified benefit attributed to the CSC (Figure SC-2) was "access to climate adaptation science" (73% described as "important" or "very important"; $n = 76$). Both science producers and science users in the focus groups described the value of the scientific expertise within the CSC:

> You know for the Choctaw and Chickasaw Nations I think it's great to have this partnership and for them to be able to access whenever they want the technical expertise and the data in order to be able to do their planning work, their water resources work, things like that, instead of bumping from project to project working different institutions. Now they've got a center of expertise ... that they can jump into. (SC Producer FG)

> Water is one of the cornerstones of economic development.... That's one of the reasons that we got involved with the center, to help us understand climate change long term and then integrate that into our comprehensive water management strategy as well as a comprehensive economic development strategy.... We have been very pleased with the work that they have produced. (SC User FG)

Table SC-5. Types of involvement with South Central CSC in the last five years.

Affiliation	Percentage of respondents	*n*
Participant in a CSC training, webinar, workshop, or conference	34%	45
CSC grant recipient, applicant, or partner on a grant	25%	33
LCC steering committee member	20%	26
CSC Stakeholder Advisory Committee member	15%	20
Resource managers or decision maker who has used the science produced by the CSC	14%	19
LCC staff member	14%	18
University member affiliated with the CSC	12%	16
CSC-funded graduate student or postdoctoral fellow	5%	6
CSC USGS staff	3%	4

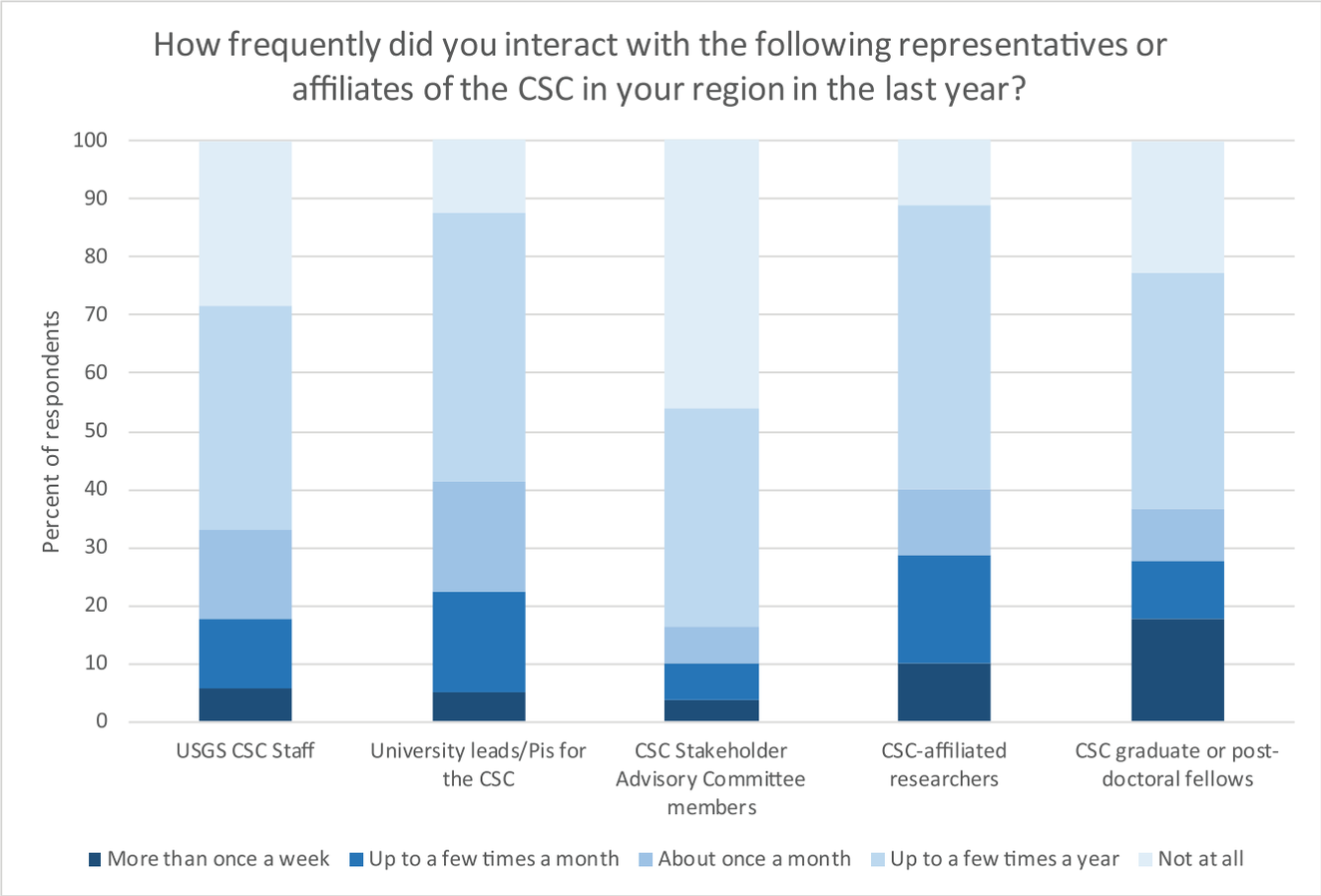

Figure SC-1. Based on survey question 8.

Nearly as many respondents identified "access to a broader network of people interested in climate adaptation science" (68%; $n = 71$) as being another important benefit. Participants in the focus groups spoke at length about this benefit. They maintained that the network provided by the CSC allowed them to get to know and communicate with other people interested in climate science:

> We have the annual meetings, actually meeting people, that is really helpful when you are a new person who is coming into it that other people don't know.... Meeting in person is much easier to make a connection. (SC Producer FG)

> There's no organization to bring those tribes together. So you have tribes becoming more sovereign and less communicative amongst tribes.... There's really no real forum for tribes and tribal representatives to have these kind of discussions. So I think this really plays a very important role for that networking, and it's not just networking between and amongst tribes, it's also networking between tribes, government, and industry. (SC User FG)

They also argued that the network provided an opportunity to combine and expand capacities:

> Each of the consortium members has sort of a reputation in terms of what it's capable to.... So what that allows them to do is to go after and deal with larger issues. So that that trust is already established.... So now the network becomes the ... mechanism through which activities get accomplished.... We're dealing with issues that are multilevel and so we need that capacity. (SC Producer FG)

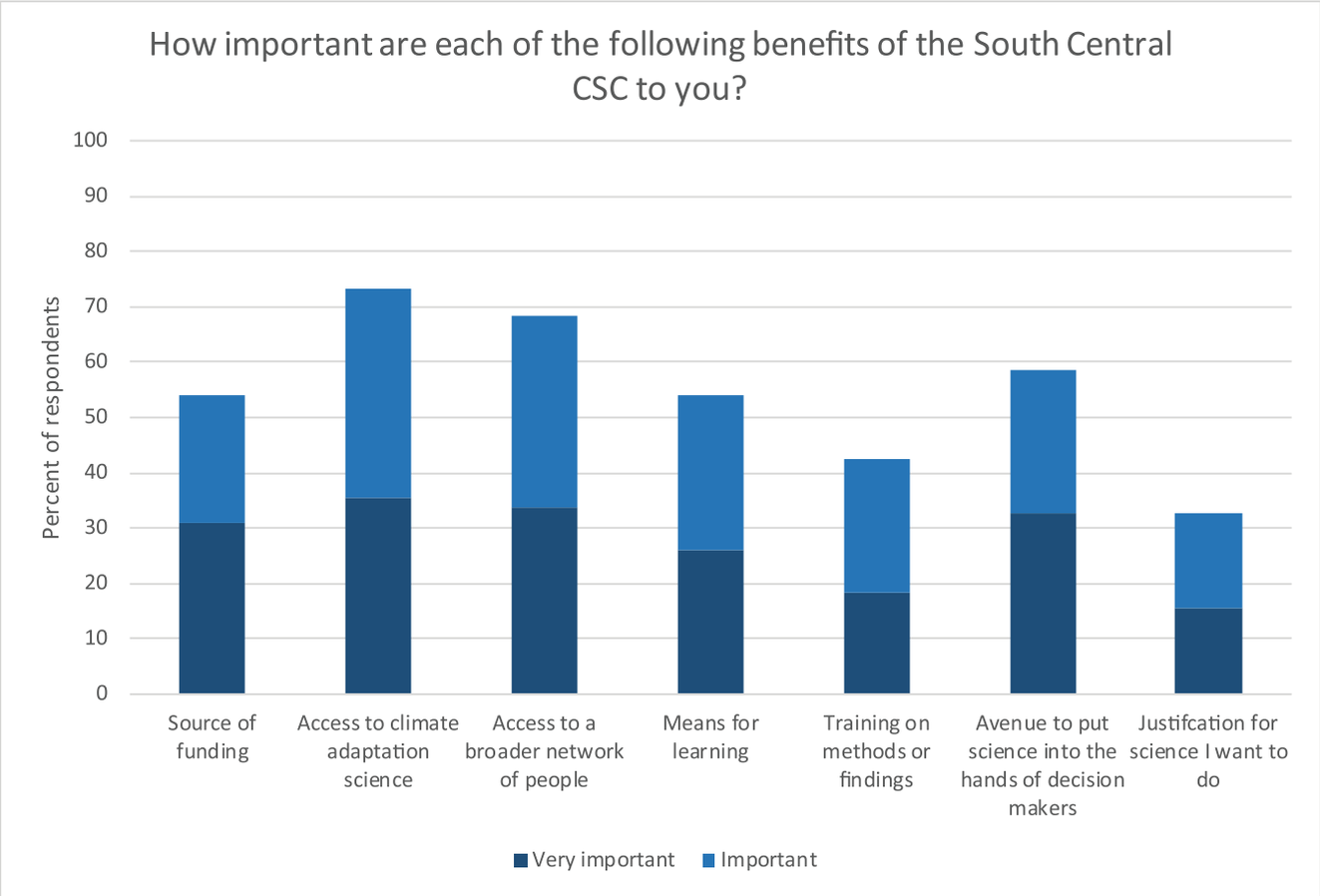

Figure SC-2. Based on survey question 9. Text in items shortened for presentation in graph, and only "important" or "very important" responses are shown.

> I think for me that's one of the biggest benefits of working with the Climate Science Center is those new opportunities for collaboration.... As an ecologist, the ability to work with climate scientists and get the climate data that I need to combine with the ecological data that I have has been really advantageous for a lot of different projects. (SC Producer FG)

> Tribal capacity is job #1. And that's really a ... pretty heavy lift, and we can't do that alone. So we know that we're going to have to reach out.... So that's the reason why we're reaching out and trying to build ... a stronger relationship... you know, various internships and, you know, exporting and importing the ... scientists to come in and be within the community. Those kinds of things I think are more important as we continue to build our capacity. So really for us it's about capacity. (SC User FG)

A majority of survey respondents also believed that important or very important benefits of the CSC included serving as an "avenue to put science into the hands of decision makers" (59%; $n = 61$), "a source of funding for climate adaptation science" (54%; $n = 56$), and a "means for learning about climate adaptation" (54%; $n = 56$).

With regard to funding, participants in the focus groups maintained that the CSC funding played an important role in enabling their activities:

> With that ... project, we received some funding to work with that sort of partners across the Gulf. And the LCCs provided input regarding which partners to work with. And so one LCC would say we'd like you to work with the Nature Conservancy, another would say we'd like you to work with this Fish and Wildlife Refuge, and so on and so forth. And the Climate Science Center involvement facilitated that. (SC Producer FG)

> My engagement with the Climate Science Center started actually when I worked for NOAA.... We at that time looked to the CSC network as an opportunity to leverage investments that USGS and DOI were making in regional climate science.... I think it would be remiss not to say that many of us looked to the CSCs when they created as an opportunity for funding things. (SC User FG)

The CSCs also provided students with the opportunity to learn more about science and its application:

> We come from the State of New Mexico where we're ranked 50th for education in terms of funding and performance and everything else.... In modern times, I think a lot of our youth grew up thinking we're not very good at math, we're not very good at science.... We come from really strong science and understanding of science and technology, but somehow we've learned we're not very good at math and science. And I think when you have the Science Center staff in the water with ... nets talking to the youth about science, the benefits from that ... you can't quantify it. (SC User FG)

> Our program ... for a couple years we had a summer internship that we would fund to send a student somewhere to work with an organization.... So there were areas where climate expertise from the university here existed, and we want our students to get hands-on experience. And by putting a call out through their network we were able to identify some opportunities there. (SC Producer FG)

Limitations on Involvement

The most common limit on involvement with the CSC was not having enough time (36%; $n = 48$), followed by working with the CSC not being as high of a priority as other work (24%; $n = 32$) (Figure SC-3). Eighteen percent ($n = 24$) did not have enough funds, and 15% ($n = 20$) hadn't been asked.

During the focus groups, there was considerable discussion of limitations on participation related to funding. Some commented on a lack of funding making it difficult to participate:

> We're also beginning to see some of the diminishing dollars related to travel and that can make it difficult to come to all these different meetings. And put up a choice between coming to these meetings or going to a park, and I'd rather not have to do that because I find the meetings very important. (SC User FG)

Others spoke to the challenges of utilizing funds from the CSC. Some maintained that the requirements for obtaining this funding were onerous:

> I think there's mechanically a couple of challenges related to the funding.... The ... core funding that comes into the CSC from USGS has to stay within the consortium, and there are some ways to kind of partner with consortium members on collaborations but if someone who's not a member of the consortium wanted to propose a project or an activity to the CSC there would be challenges in the CSC funding.... It is fantastically difficult to pool federal resources around a common project. I don't know how many times we have talked about the LCC, the Hub, NOAA and the ... folks in the CSC ... just trying to have a common pot to do something together we could all benefit from. It's so hard. (SC User FG)

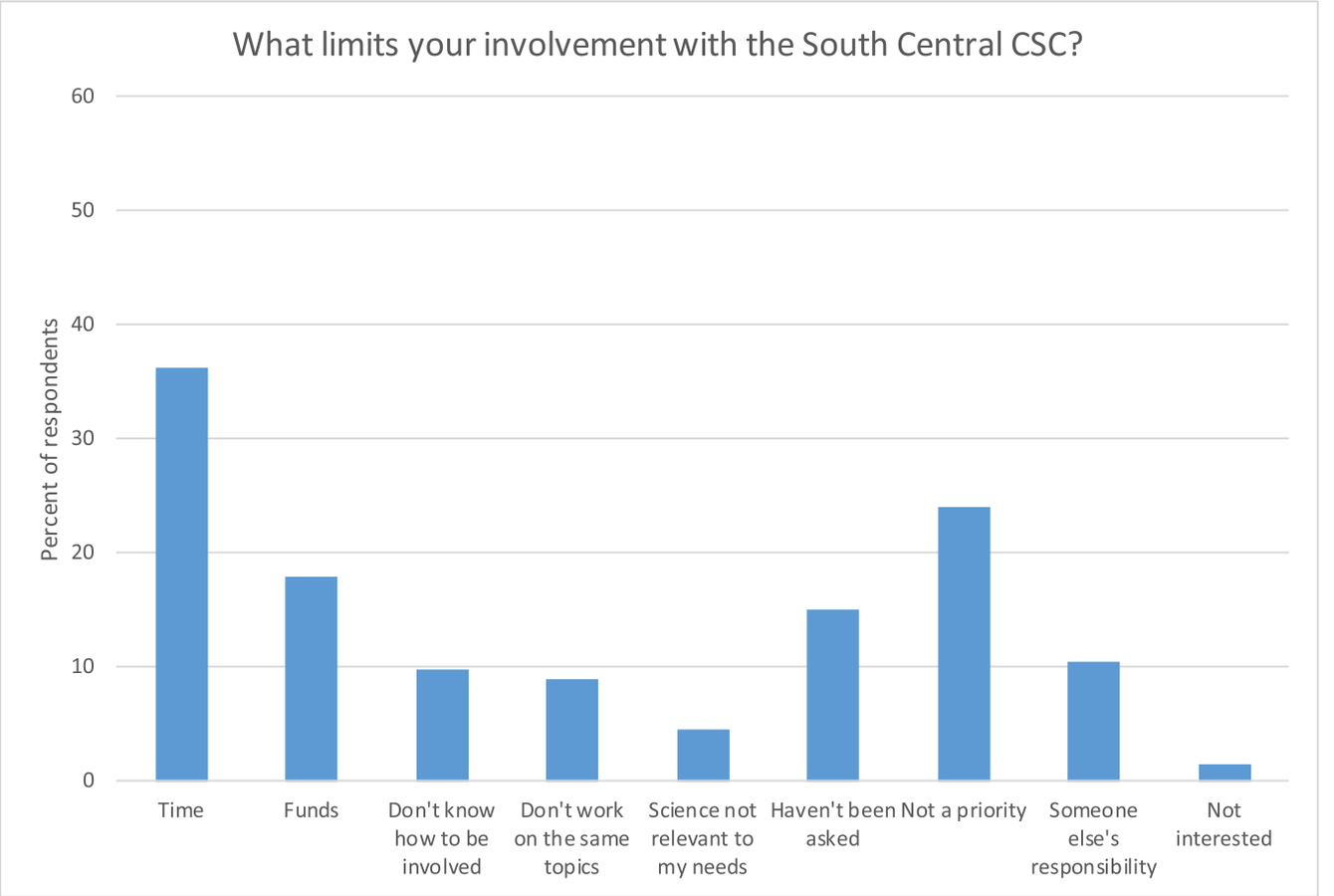

Figure SC-3. Based on survey question 10. Text in items shortened for presentation in graph.

> With our Climate Science Center, we start our fiscal year March 1. That's ludicrous. We'll actually pay somebody from January 1 to August because the new money doesn't start until March 1.... So the question is how do you pay graduate students, how do you pay postdocs? And it just so happens that's the way USGS physically operates, so you have to know that and that can raise some tension. (SC Producer FG)

Some participants thought that the funding that could be obtained through the CSC for projects was not enough to make those projects worthwhile:

> You've got the level of funding.... We don't get enough direct research dollars out of it to make it worthwhile. And while it's a good idea, we can't only do the climate science which applies to stakeholder-driven. Because even though it's appreciated, that's not what give us tenure.... We can only do one thing, 'cause otherwise the science will suck. (SC Producer FG)

One participant argued that for social scientists, it was difficult to engage with the CSC on their research:

> There's been a great deal of enthusiasm in the CSC itself for integrating social scientific work into a lot of their other more traditional climate-focused work. But what's been interesting is to see ... what their priority is at the CSC level. I know sometimes run up against that their own reviewers and their own culture ... did not value sort of social science work. And so there's been a little bit of a tension there.... So there was kind of a culture that went beyond I think the people at our CSC

> that made it difficult for some of the social science initiatives to get kicked off and I think it's much improved now. (SC Producer 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 two-thirds of respondents (65%; n = 81) agreed or strongly agreed that climate adaptation science in the South Central region is available to decision makers (Figure SC-4), and about half thought that water managers (52%; n = 64) and fish and wildlife managers (51%; n = 62) used this science to inform management. Only about one-quarter (23%; n = 29) believed that policy makers used this science to inform policies. A majority (59%; n = 72) maintained that what is known about climate adaptation does not necessarily influence actions taken by decision makers in the region. Nearly half (46%; n = 56), 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.

One participant in the focus groups argued that the CSC helped to reduce this disconnect by filling gaps in the type of science produced:

> A connection that our partnership saw in ... what really the Climate Science Centers would bring to the table [was] looking at these issues at a much larger scale than normally.... Most agencies, state agen-

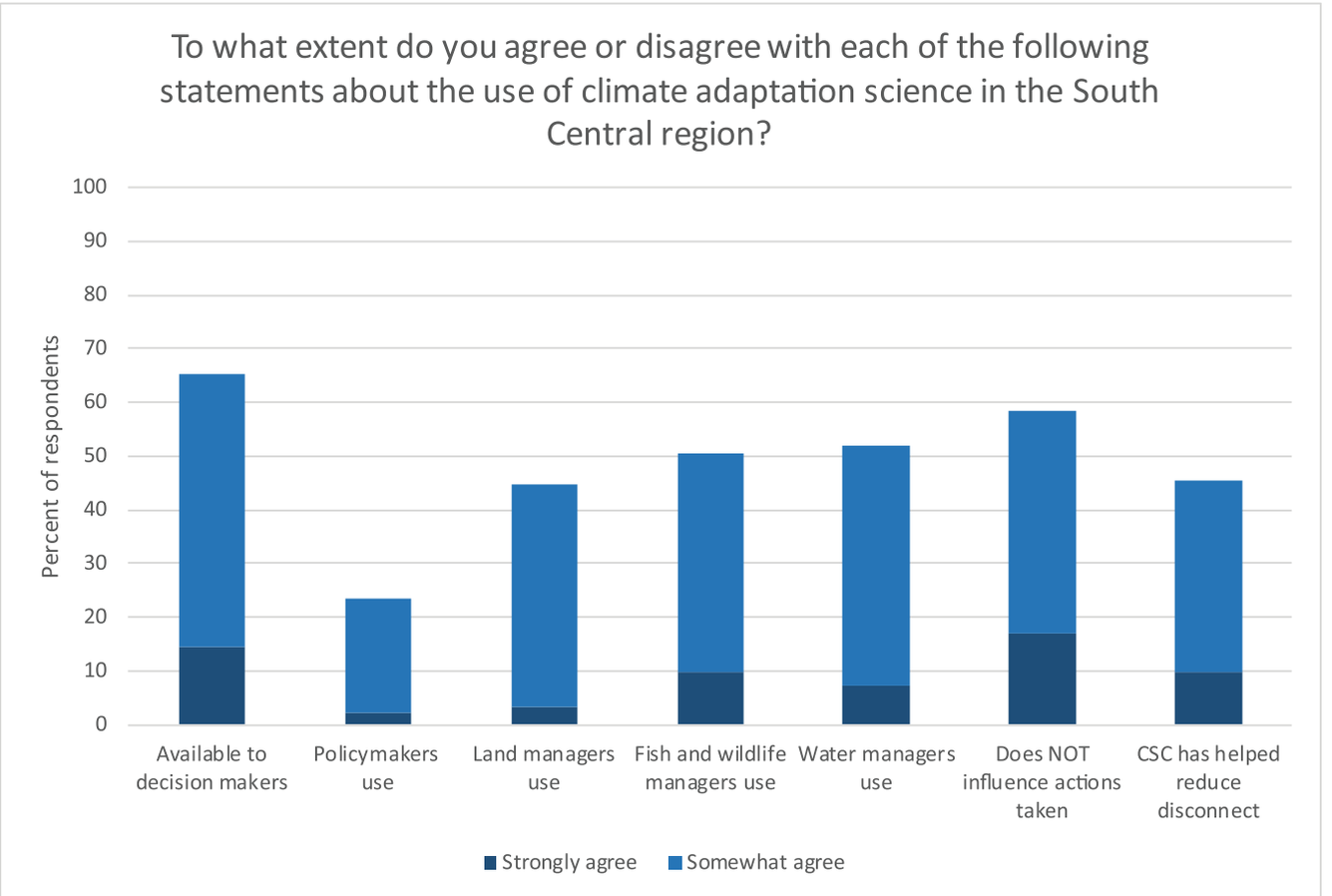

Figure SC-4. Based on survey question 11. Text in items shortened for presentation in graph.

> cies, federal agencies, or organizations have very specific geographic footprint, and they don't look to connect those dots on a larger landscape.... You've got to realize there's five states and multiple entities including tribes that have authority and responsibility in that watershed and never had there been an entire watershed-based evaluation from a conservation standpoint to develop consistency among all those efforts.... We were able to use climate data from the Climate Science Center customized for Oklahoma, Texas, Louisiana, and adjacent states to be consistent in how those action plans were put together. So very specific deliverables that were developed based on a larger-scale insight into conservation needs. (SC User FG)

In terms of the South Central CSC science specifically, three-quarters of respondents (74%; n = 93) strongly or somewhat agreed the CSC science can contribute to policy or management (Figure SC-5). Respondents were also positive about other characteristics of the CSC science, with large majorities finding it high quality (65%; n = 81) and appropriate to inform the types of decisions being made (69%; n = 86). A majority also thought that it integrated well with other information (55%; n = 68). Only a minority thought that the South Central CSC's science was irrelevant to management (14%; n = 17) or biased (4%; n = 5).

Similar themes were discussed during the focus groups. Participants generally agreed that the science the CSC produced was of high quality and that quality was an important consideration in their use of it:

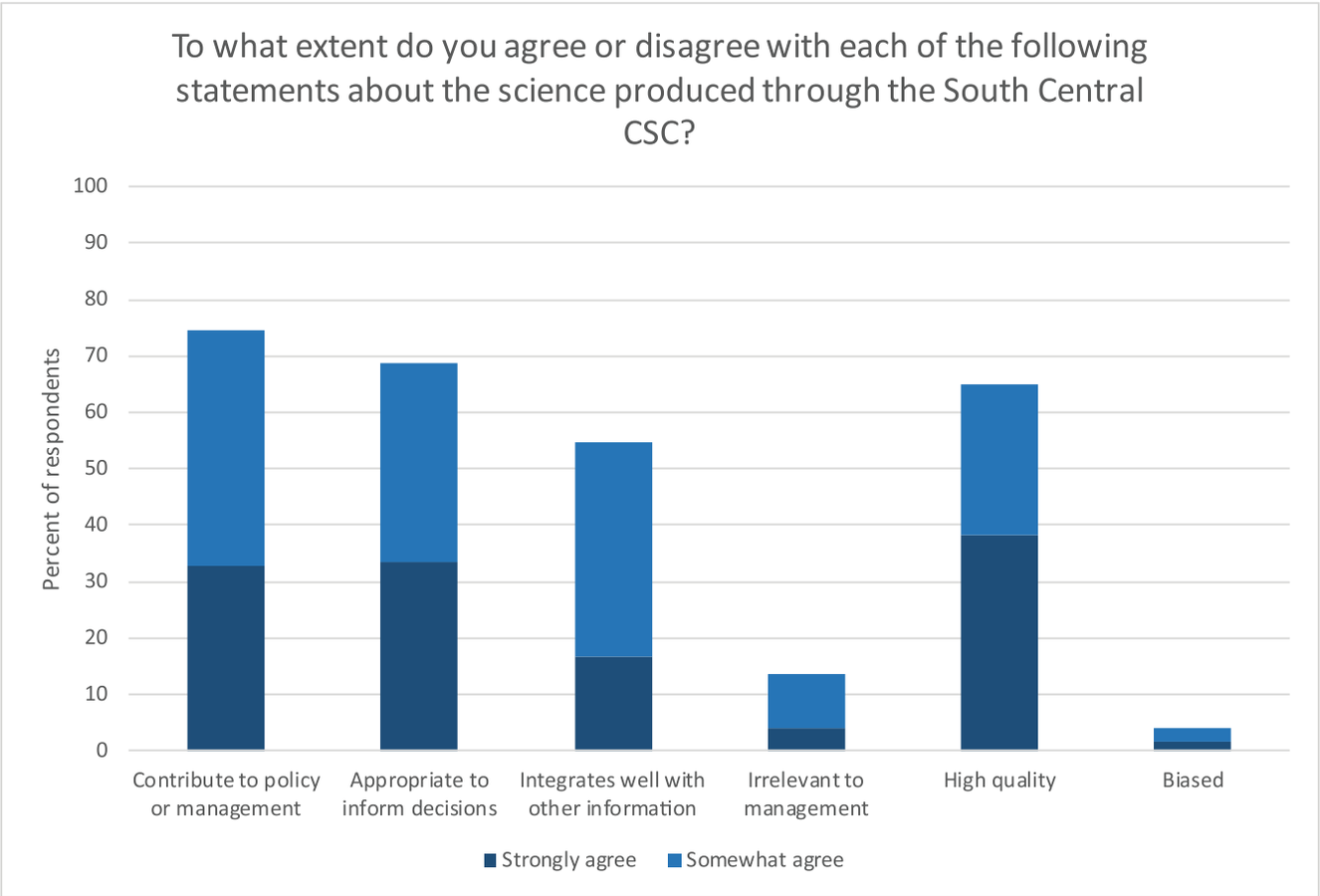

Figure SC-5. Based on survey question 12. Text in items shortened for presentation in graph, and only "strongly agree" and "somewhat agree" responses are shown.

> The vetting process is crucial. We went with the USGS instead of these company private firms, they were pounding to get in the door. And we went with USGS and their ties to the Science Center because we knew it would be a much deeper and much richer and more honest analysis of the actual science. (SC User FG)

They noted several challenges, however, that sometimes could whether it was appropriate to inform decisions. One participant pointed out that some scientists were not interested in doing actionable science:

> We also learned a lot, and there's value just getting experiences about what the challenges are in going through the translation and transfer of science, trying to maintain the high quality science along the way. And quite frankly the vast majority of people here ... have no interest in being and trained ... because they don't see it as helping their career.... It's not just limited to the South Central or the CSCs in general, but I think the organizations in the climate field in general have this bit of a no-man's land where some of the work that you need to do in order to really get that high quality science all the way to the stakeholders, there's aspects that ... may be too applied to be a top priority. (SC Producer FG)

Even those scientists who were interested did not always understand what type of science was relevant to stakeholders:

> When we had an early career workshop ... one of the places that we went to visit was one of the largest vineyards around. And of course the modelers are talking about ... projections, you know 20, 30, 40 years. And one of the producers ... turned and said, "I don't care. Right, I don't care. I want to know what's going to happen three months from now. Right, so why don't you provide me with that...." We don't understand how the rest of the world has to use some of the information. (SC Producer FG)

Conversely, potential users of the science were perceived to sometimes have difficulty recognizing the usefulness of science that was relevant to meeting their needs:

> I think we could get a strong Park Service response ... if I could find a way to get a project that's directly linked to one of the parks.... I think we have so many on-the-ground folks that just feel like they're overloaded, and they can't take on one more thing.... If you could show them a pilot or a benefit for participating ... the next thing you know you've got everybody wanting to jump onboard (SC User FG)

Science Users' and Producers' Use of Climate Adaptation Science

Among respondents who reported that they were science users, 40% (n = 20) reported that they or someone in their organization used climate adaptation science from sources affiliated with the South Central CSC. (Twenty-eight percent did not know whether they had.) More than two-thirds (68%; n = 34) reported that they or someone in their organization used climate adaptation science from sources not affiliated with the CSC.

The most common ways science users reported using the South Central CSC science (Figure SC-6) were to inform management plans (39%; n = 22) and inform management actions (32%; n = 18). One-quarter (25%; n = 14) used it to inform training of conservation professionals and about one-fifth (19%; n = 11) used it to inform the public about climate change and its impacts. It was less frequently used to inform policy (9%; n = 5) or inform land acquisition priorities (9%; n = 5).

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

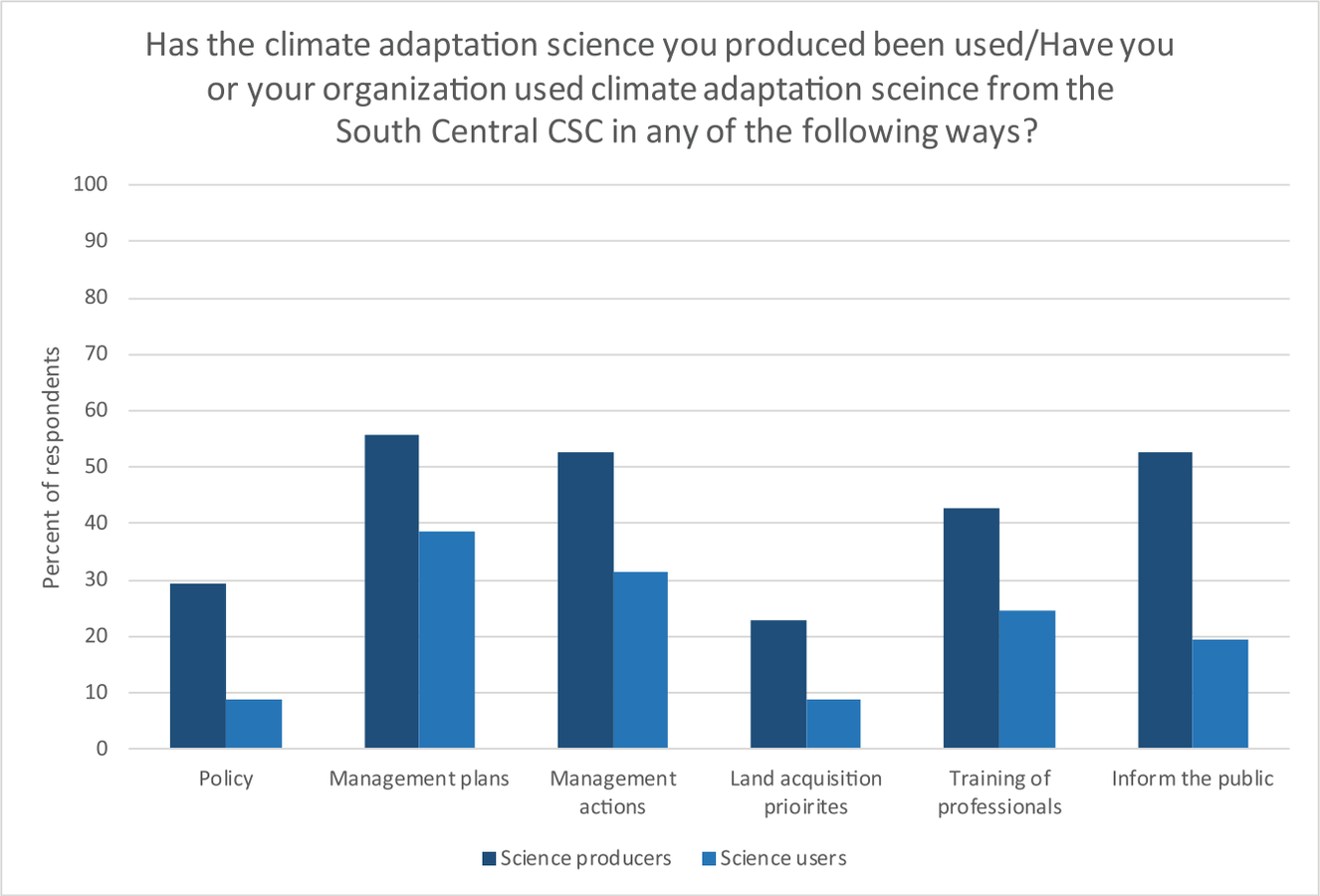

Figure SC-6. Survey questions 15 & 21. Text in items shortened for presentation in graph. Full text in table in appendix.

greater. More than half said their science had been used to inform management plans (56%; $n = 34$), inform the public about climate change and its impacts (53%; $n = 32$), or inform management actions (53%; $n = 32$). The differences between science users' and science producers' responses could reflect differences in perceptions about how frequently CSC science is used. It could also reflect that the use of CSC science is concentrated in a subset of potential CSC science users.

Nevertheless, CSC partners recognized factors that limited the use of CSC science. Science users and producers differed in their perceptions of what these factors were (Figure SC-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 (85%), scientists not working closely enough with decision makers (76%), the science not being communicated understandably (75%), decision makers lacking the skills and training to use the science (63%), and the management issues not being clearly defined (61%).

The only factor that more than 40% of science users thought limited the use of CSC science was scientists not working closely enough with decision makers (44%). Neither group considered a lack of quality of the science to be a problem (science users – 2%; science producers – 11%).

During the focus groups, discussions of the factors that could facilitate or limit the use of CSC science focused primarily on relationships and communication between scientists and decision makers. Several science users commented on how relationships could contribute to the use of science:

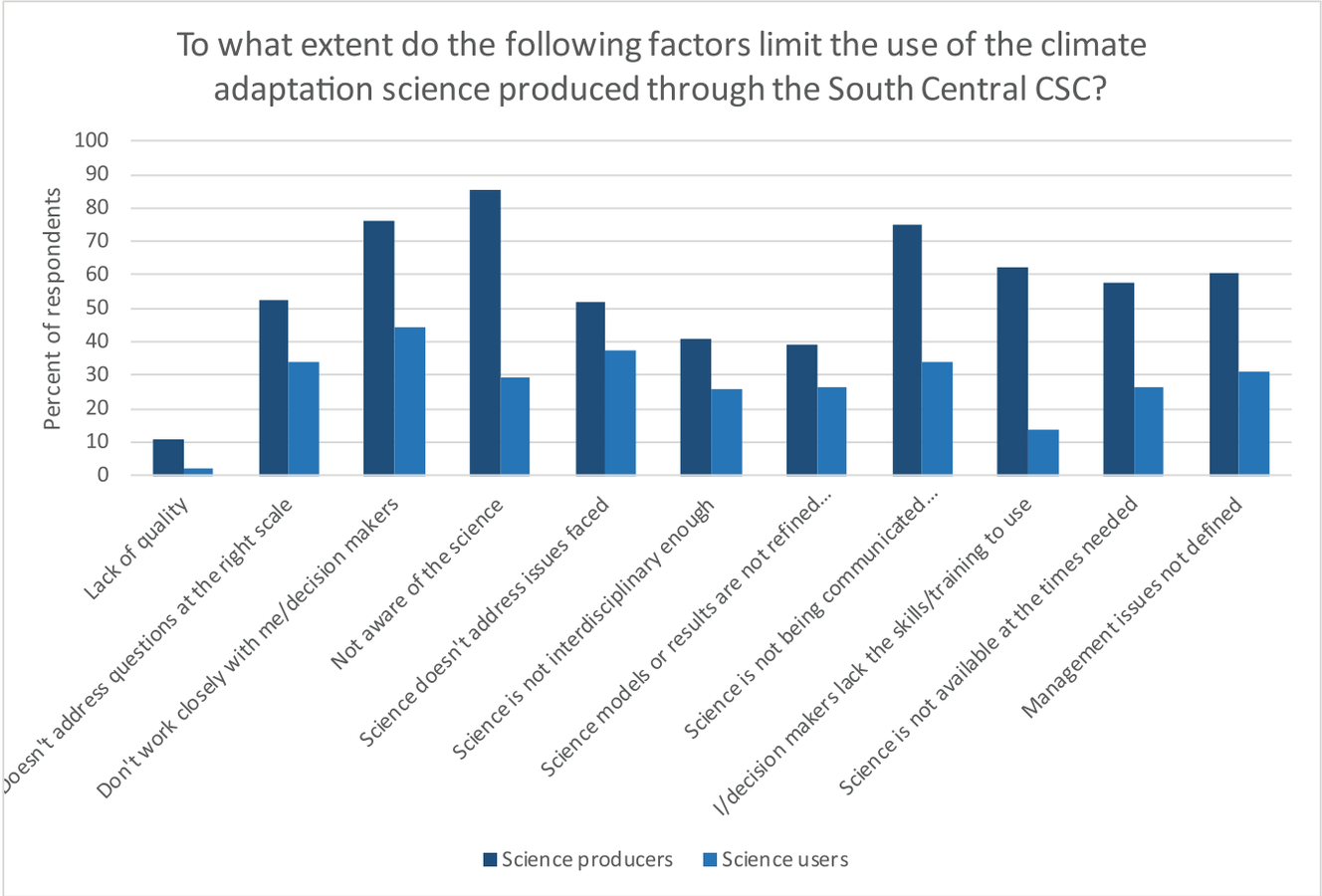

Figure SC-7. Survey questions 16 & 22. Text in items shortened for presentation in graph, and only "to a moderate extent," "to a large extent," or "to a very large extent" responses are shown. Also, text varied slightly for science producers and users.

> As more of a user directly of the science ... when I had questions about specific data that I needed ... to integrate into my overall analysis for the project that we talked about ... I can just contact the scientists directly here at the CSC. And then they can put me in contact with the appropriate person so if I needed some information, some idea of how to deal with something.... So having contacts with those scientists who ... were in it, producing the products that the Center was then sending out to other people.... They just directed me directly to those products for our purposes, and said that any time I had questions, if they couldn't ... do it here then they sent me to someone else. (SC User FG)

> You know, the science is terribly useful (chuckle). It's just making the connections of the on-the-ground resource manager so that they'll pick it up and run with it or use it to define further questions. (SC User FG)

The science producers recognized that in their interactions with science users, they needed to translate the science into terms that the users could understand:

> It's like stop talking, listen to what they're telling you ... as you're trying to translate your science to your audience.... That's something I never would have done on my own as an academic, but now that I've done it I... like it. (SC Producer FG)

The science users described how the science could be made understandable to them:

> For us I think it's when you think about science you think about white papers that are very scientific and academic, almost in a ... non-English language. How do we begin to understand and how do we be able to communicate with scientists you know as tribal leaders, as tribal community members? ... Then vice versa, the scientists... For some tribes, not all, but for some tribes, we start talking about fire and flood, you can't even really discuss it because you're calling that incident to happen... How do you even broach that subject culturally with science to a community who's almost culturally prohibited from maybe discussing that? ... I think it's really important, and I think the way to do that is to take that science and to be able to make it understandable for laypeople. And I think the Center has been really good ... Being there as a teacher not just as a scientist with data ... You have to be able to take that information, that data and translate it into Indian and translate it into layman and translate it into community so we can understand it and then so we can have that conversation, so you can understand where it is we're coming from as well.... I think we're starting to get there. I don't, I wouldn't say with a big flag, "Hey, this is a great success." I think we're getting there. (SC User FG)

> Developing a conservation vision, a common vision, requires the ability to surround something like a map that we can all share. And it's a communication that you can't put into words.... The science that's been developed through the Climate Science Center here ... when you see water ... that's projected in 50 years to be in somebody's front bedroom, that catches their attention.... The maps are a special way to communicate that people can gather around. (SC User FG)

One of the challenges that scientists faced when communicating the science was that potential users did not always have the capacity to understand the limitations of some of the science, particularly with regard to uncertainty:

> Sometimes stakeholders are looking for certain types of answers with certain ... levels of certainty.... Sometimes I use a meta-analogy that a lot of what is produced is of a certain quality and certainty, that it should be out on the server. It's kind of the over-the-counter type medicine.... But other things that are produced are more experimental, the levels of certainty aren't that high and really take the more sophisticated user to make sense of. And in that case I'd say that's where the datasets ... should be by prescription.... There needs to be some interactions where they are used wisely and not misused or abused.... One of the challenges that ... I know we've gone through here is trying to see if that distinction is acknowledged and recognized. (SC Producer FG)

In some cases, they faced the challenge of audiences that did not even believe that climate change was taking place:

> I appreciate this conversation about your audience and tailoring the information that you present to your audience, but I find it very, very difficult to uh to know in advance exactly the level of education, level of understanding and receptiveness of your audience on the topic that you're presenting ... and I guess just knowing how to present that material.... Last month doing that ... presentation ... it turns out [my audience was] very, very, very up to speed on climate change aspects ... not very many climate deniers in my audience, which was interesting. Here in the U.S., very often I'll get folks ... I'll get the eye roll.... It's really hard to stay upbeat in a presentation when guys are ... snickering.... Then obviously you've missed that target or missed the delivery to that person. You're not connecting with that person in that presentation and in that situation. (SC Producer FG)

Science Users' and Producers' Engagement in Co-production of Knowledge

Respondents reported on their beliefs about co-production of knowledge in general. A large majority of both science users (72%; $n = 34$) and producers (91%; $n = 52$) expressed support for co-production,

indicating it was important or very important for climate adaptation scientists and natural resources decision makers to work together to produce science research. One of the science users participating in the focus group argued why co-production was important:

> If we're being studied, if the Indian tribal communities are being studied, and the environment and the landscape, the air is being studied around tribes, then why aren't the tribes participating in that budgetary standpoint? And really as opposed to just being a subject that is being studied as opposed to being a partner and partner in the study. And let us help ask questions. And what I told some anthropologists that came through, they're wanting to do an anthropological study, is ... let us be part of the study.... We may not be the scientists, I might not have a Ph.D. at the end of my business card, but I've got questions I want to know about myself. (SC User FG)

Participants in the focus groups also spoke to the steps that the Southwest CSC took to ensure that at least some level of co-production occurred:

> I was able to participate in both the Southwest and South Central proposal review process.... Part of the ... scoring of the proposals was collaboration, and specifically collaboration with the LCCs.... Essentially the proposals were given extra points if they had a clear framework for collaboration laid out in advance. And because that was laid out in RFP, several of the science producers reached out to me and ... my coordinator directly to talk about forum for getting partner input on the products. (SC User FG)

Many science producers indicated experience in co-production in various phases of research projects, much more so than did science users[1] (Figure SC-8). For all phases of research projects, at least 40% of the science producers had experience collaborating with decision makers to a moderate, large, or very large extent. The only phases that fewer than half of science producers had experience collaborating with decision makers were designing the methods, determining the data sets to be used, and analyzing the data. (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 4 phases of research with which at least 30% of science users had experience: communicating results of a research project (38%), applying research results (38%), identifying research questions (34%), and determining research priorities for the CSC as a whole (33%).

The factors that science users thought were most likely to limit their involvement in research projects were scientists not reaching out to them (56% agreed or strongly agreed; $n = 27$), followed by different perspectives on what science is needed (40%; $n = 19$), and different perspectives on how research projects should be conducted (28%; $n = 13$). Other factors were perceived to limit the involvement of smaller numbers of respondents included funders not supportive of collaboration between scientists and science users (20%; $n = 9$), the science users not having enough time (17%; $n = 8$), and scientists not interested in listening to them (15%; $n = 7$).

Perceptions of the Role of the CSC

The South Central CSC has helped facilitate various connections (Figure SC-9). Approximately half of respondents reported connections with climate adaptation science (55%; $n = 61$), climate adaptation sci-

[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.

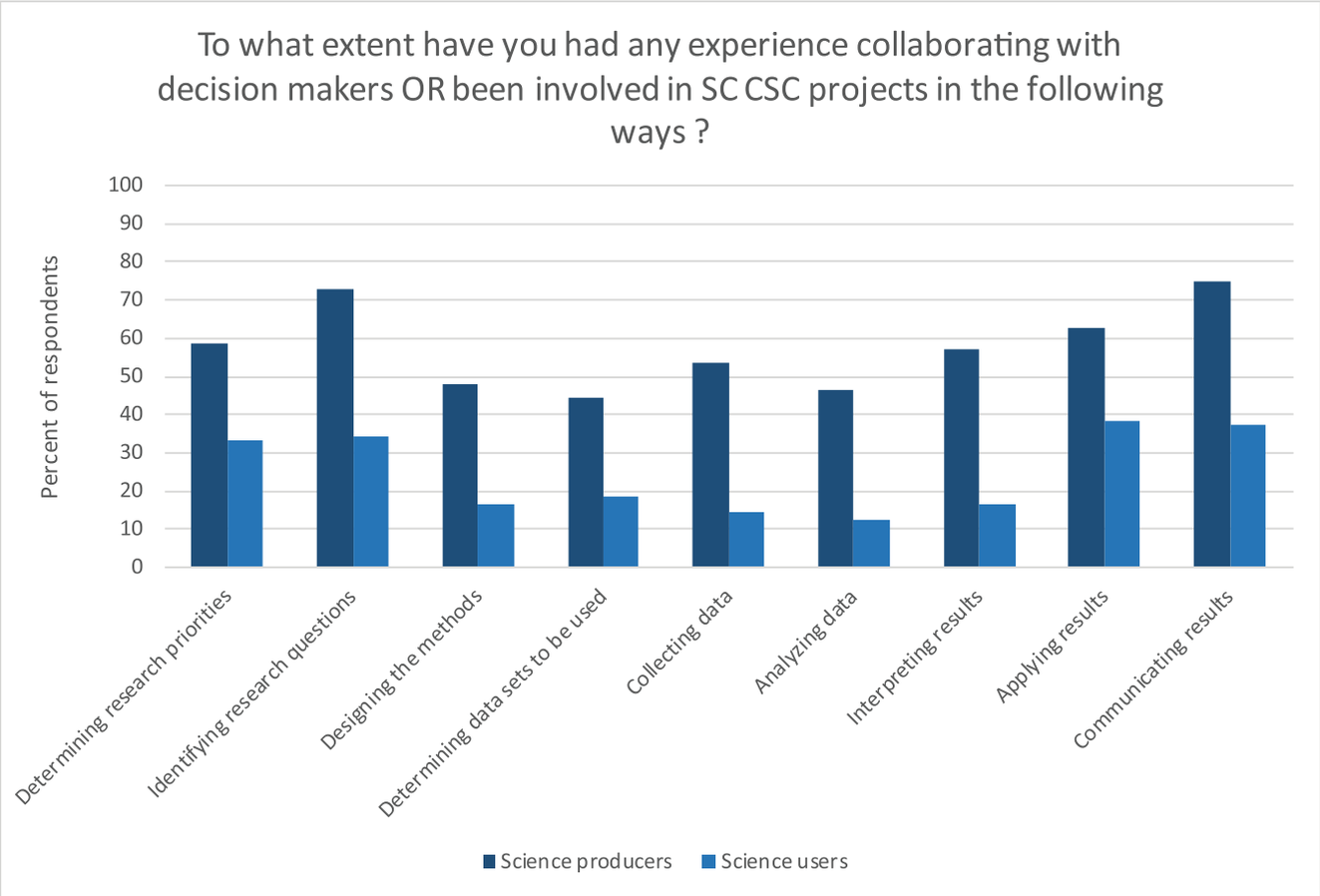

Figure SC-8. Survey questions 18 & 24. Text in items shortened for presentation in graph, and only "to a moderate extent," "to a large extent," or "to a very large extent" responses are shown. Additionally, the text of the question varied slightly for science producers and users (e.g., the users' version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

entists (55%; $n = 61$), professionals who might communicate science (50%; $n = 55$), and resources needed to conduct science (49%; $n = 54$).

Most than half of respondents agreed that the South Central CSC made a variety of contributions to the region (Figure SC-10). The contributions that were most widely perceived were communication between scientists and those who might use the science (68%; $n = 73$), awareness of available science (66%; $n = 71$), interdisciplinary science (64%; $n = 69$), and collaboration between scientists (62%; $n = 67$).

Summary of South Central Results

Survey respondents were comprised of almost one-half science users, slightly 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 slightly more involved than users. All were aware of the South Central CSC to at least some extent, but producers were more likely to be involved with it. 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 South Central CSC in a variety of ways, but the most common was as participants in CSC trainings, webinars, workshops, or conferences. One-quarter were CSC grant

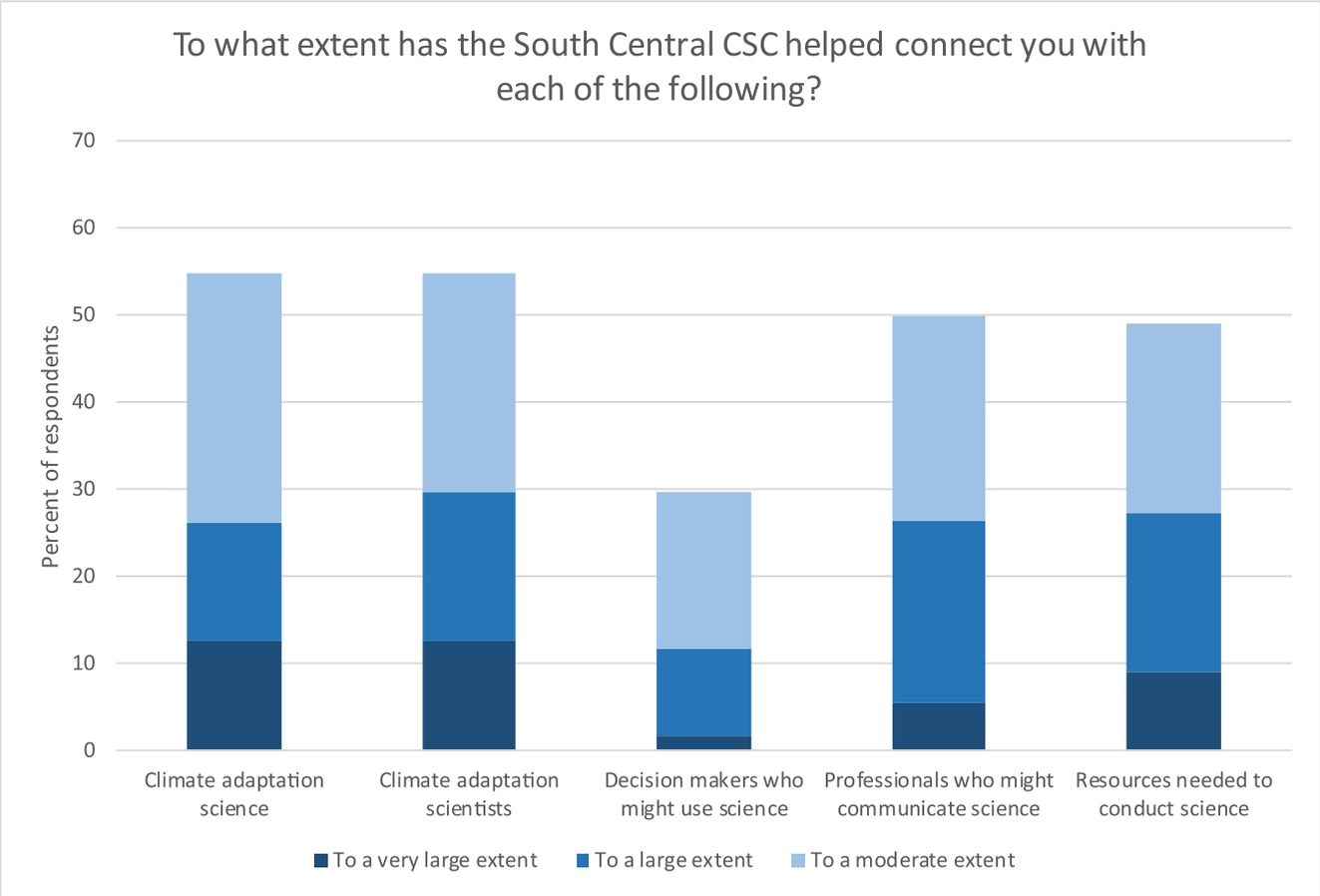

Figure SC-9. Note: text in items shortened for presentation in graph, and only "to a moderate extent," "to a large extent," or "to a very large extent" responses are shown.

recipients, applicants, or partners on a grant. Only 14% were resource managers or decision makers who had used the science produced by the CSC.

The CSC provided many important benefits to partners with the top ones identified by survey participants being providing access to climate adaptation science and providing access to a network of people interested in climate adaptation science. Focus group participants spoke about both of these benefits as well as the opportunities the CSC provided to students to learn about science and the needs that CSC funding could fill. Survey respondents reported they were limited in their involvement with the CSC by a variety of factors with the most common one being limits on their time.

About two-thirds of the survey respondents felt that climate adaptation science in the South Central region[2] was available to decision makers, and many also believed that decision makers (particularly water managers and fish and wildlife managers) use the climate adaptation science to inform management. Nevertheless, more than half believed that climate adaptation science did not influence *necessarily* management actions taken, although nearly half also believed that the South Central CSC had reduced the disconnect between scientists and decision makers. When asked specifically about the science produced through the South Central CSC, about three-quarters of the survey respondents agreed it can contribute to policy or management. Respondents were also generally positive about other characteristics of the CSC

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

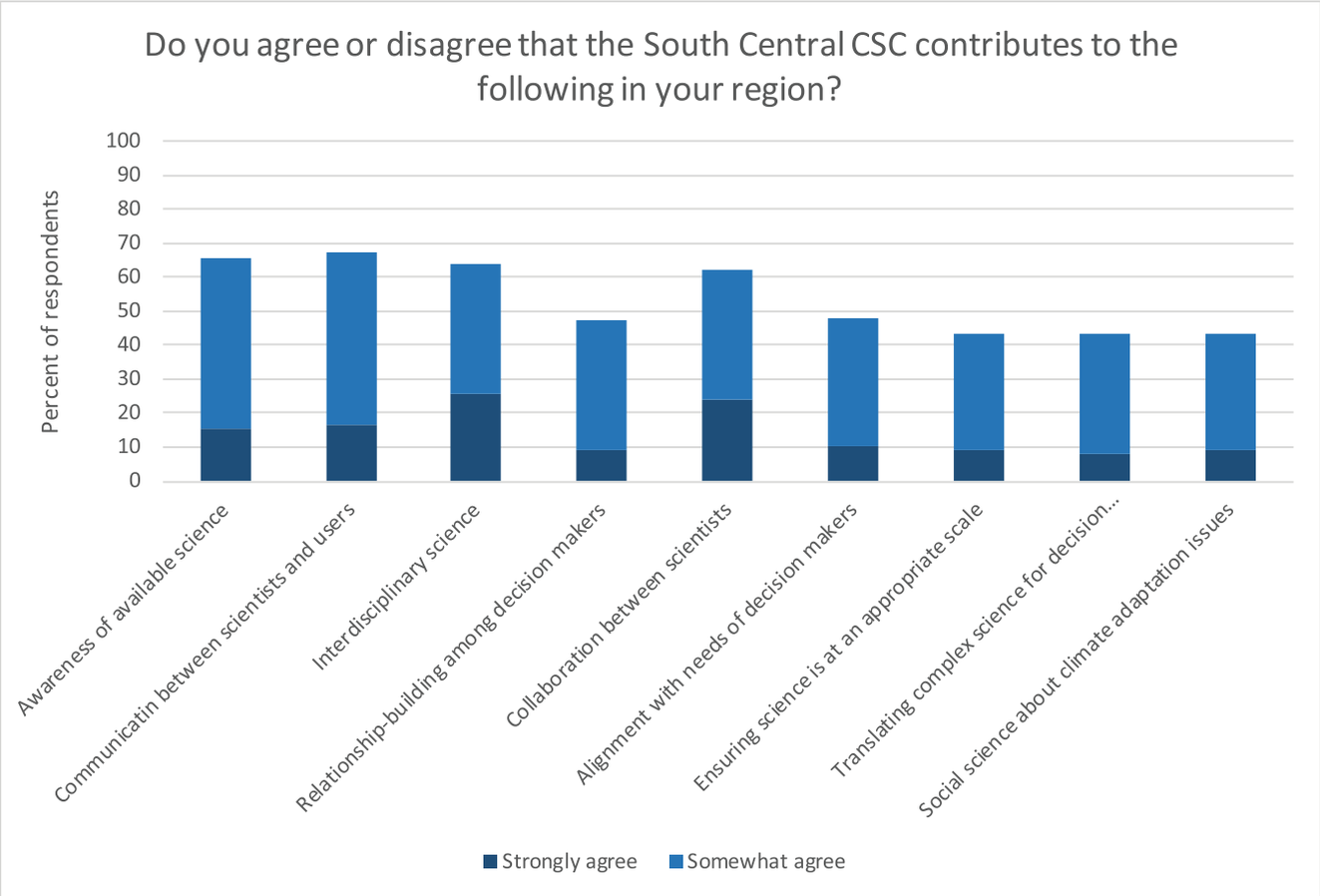

Figure SC-10. Note: text in items shortened for presentation in graph, and only "strongly agree" or "somewhat agree" responses are shown.

science, and the majority found it appropriate to the decisions being made, high quality, and able to integrate well with other information.

The most common ways science users and producers reported that the South Central CSC science was used were to inform management plans and inform management actions. Most science producers also thought it was used to inform the public. Focus participants thought that relationships between scientists and decision makers and efforts to translate science into forms that decision makers could use played important roles in promoting the use of climate adaptation science.

Science users and producers differed in their perceptions of what limits the use of CSC science. Science producers were more likely than science users to perceive a variety of factors as limiting the use of science. Focus group participants maintained that one of the limits on the use of the science was that science users did not always have the capacity to understand some of the limitations of the science

A large majority of both science users and producers expressed support for coproduction of knowledge, with producers more likely to support it. 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 (setting priorities and identifying research questions) and late stages (applying 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 scien-

tists not reaching out to them to collaborate, having different perspectives from scientists on what science is needed, and having different perspectives from scientists on how research projects should be conducted.

The majority of survey respondents noted a variety of contributions of the South Central CSC, including contributions to communication between scientists and science users, awareness of available science, interdisciplinary science, and collaboration between scientists.