



LANDSCAPE
CONSERVATION
COOPERATIVES



2015

LCC Network Conservation Science Plan

LCC Network Conservation Science Plan — *Natural and cultural resources are conserved at large landscape and seascape scales, guided by the collaborative application of science, experience, and cultural or traditional ecological knowledge and the generation of new conservation knowledge.*

ON THE COVER

Seascape. JANE PELLICCIOTTO

Fire management. BLAINE INGLIS/
USFWS

Bluebell meadow in Texas. TEXAS
PARKS AND WILDLIFE DEPT.

TABLE OF CONTENTS

Introduction	2	Theme 5. Socioeconomic and Cultural Values	34
Purpose of the Science Plan	3	Aspirational Statement	34
Collaborative Development	4	Scope of Issue	34
Implementation	5	Fundamental Question	37
Themes	6	Objectives	38
		Action Items	38
		Deliverables	39
Theme 1. Landscape Conservation Planning	8	Project Timeline	40
Aspirational Statement	8	Aspirational Statement	41
Scope of Issue	8	Scope of Issue	41
Fundamental Question	11		
Objectives	11	Theme 6. Science Communication and Delivery	41
Action Items	12	Fundamental Question	43
Deliverables	13	Objectives	43
Project Timeline	13	Action Items	44
		Deliverables	45
Theme 2. Landscape Conservation Design	14	Project Timeline	45
Aspirational Statement	14		
Scope of Issue	14	Theme 7. Monitoring and Assessment	46
Fundamental Question	17	Aspirational Statement	46
Objectives	17	Scope of Issue	46
Action Items	18	Fundamental Question	48
Deliverables	20	Objectives	48
Project Timeline	20	Action Items	48
		Deliverables	50
Theme 3. Climate Adaptation	21	Project Timeline	50
Aspirational Statement	21		
Scope of Issue	21	Appendix A: Glossary	51
Fundamental Question	23		
Objectives	23	Appendix B: Summary of Action Items	56
Action Items	24		
Deliverables	25	Appendix C: Acronyms	65
Project Timeline	26		
		Appendix D: Citations	66
Theme 4. Data Management, Integration, and Sharing	27		
Aspirational Statement	27		
Scope of Issue	27		
Fundamental Question	29		
Objectives	29		
Action Items	30		
Deliverables	32		
Project Timeline	33		



Aurora Borealis at Sherburne National Wildlife Refuge. BRYAN WORTH

Bunched Arrowhead. GARY PEEPLES/USFWS

Tundra swan footprint, Kigigak Island, Alaska. KRISTINE SOWL/USFWS

Introduction

Landscape Conservation Cooperatives (LCCs) are public-private partnerships composed of states, tribes, federal agencies, non-governmental organizations, universities, international jurisdictions, and others working together to address landscape and seascape scale conservation issues. Each of the 22 LCCs is a self-directed partnership that functions as part of the international LCC Network.

The Vision of the LCC Network—“Landscapes capable of sustaining natural and cultural resources for current and future generations”—was adopted by the 22 LCCs in coordination with their Steering Committees in 2012. To proactively pursue this Vision, the LCC Network is facilitating the identification, design, and delivery (through partners) of an ecologically connected network of landscapes and seascapes adaptable to global change with the ability to sustain ecological integrity and health to meet the needs of society at multiple scales.

Working collaboratively, LCCs contribute to this goal by tackling large scale conservation challenges through a variety of activities. LCCs develop and deliver integrated science-based information; develop shared, landscape-level conservation objectives and strategies; identify gaps; co-produce and share applied conservation science; design, monitor, and evaluate the effectiveness of conservation planning and strategies; communicate science outcomes, best practices, and implications; and develop linkages that connect multiple LCCs as needed. Working together at the scale of the LCC Network allows us to have a greater collective impact on conservation issues and goals than we could have as individual conservation organizations or single LCCs.



Native prairie monitoring. CAMI DIXON/USFWS

PURPOSE OF THE SCIENCE PLAN

Recognizing that many science and technical issues transcend individual LCC geographies, this LCC Network Conservation Science Plan (hereafter, Science Plan) uses a strategic conservation framework to identify and describe the common science and technical priorities and practices that support the LCC Network’s Vision and Mission. These Network-level themes are intended to add value to individual LCC efforts and to provide mechanisms for aligning these efforts across multiple spatial scales.

The [LCC Network Strategic Plan](#) identifies four strategic goal areas (conservation strategy, collaborative conservation, science, and communications) that support the Network’s Vision and Mission. The Science Plan and the Strategic Plan are related documents that have been developed in close coordination. The Science Plan supports the Strategic Plan by focusing on the scientific and technical challenges associated with each of the strategic goal areas, with an emphasis on Goal 3-Science.



The Science Plan also strives to create a framework for:

SHARED DIRECTION—providing a unifying framework and shared direction for LCC Network conservation science, allowing for the scaling and combination of individual LCC efforts;

EMERGING ISSUES—identifying and focusing attention on conservation science issues and processes that operate at scales larger than individual LCCs;

NETWORKED RELATIONSHIPS—identifying relationships (and gaps) among science efforts at multiple scales (individual LCC, multi-LCC, Network-wide) to facilitate collaboration among LCCs, Climate Science Centers, and others to develop and provide integrated science-based information about the implications of climate change and other drivers affecting the sustainability of natural and cultural resources;

CLEAR ARTICULATION—communicating the LCC Network’s shared science and technical priorities and practices;

PRIORITIZED ACTION—informing investments (funding, technical capacities) and actions by science funders, providers, and practitioners; and,

A FORUM FOR DIALOGUE—providing a baseline for subsequent discussions to revise future LCC Network science and technical priorities and practices in an adaptive management framework.

Supporting the LCC Network Strategic Plan

Goal 3.

Science

Natural and cultural resources are conserved at large landscape and seascape scales, guided by the collaborative application of science, experience, and cultural or traditional ecological knowledge and the generation of new conservation knowledge.

The Science Plan provides a broad description of the scope of science needs and approaches for the LCC Network and will provide the basis for developing annual work plans for the LCC Network Science Coordinators Team, starting in 2015. The Science Plan establishes priorities for action over the next five years and is a living document that will be revisited periodically to ensure that the content is relevant and consistent with emerging conservation science needs and the practice of landscape-scale conservation.

COLLABORATIVE DEVELOPMENT

The LCC Network Science Coordinators Team (LSCT or Science Team), composed of the Science Coordinators from the 22 LCCs and staff from the Network Coordination Office, was formally chartered in 2013 to “strengthen the scientific foundations of the LCCs and the LCC Network.” The Science Team identified one of their roles as providing the “the core capacity for identifying and collaborating on approaches to strategically address science and technical issues that are relevant to multiple LCCs or the LCC Network as a whole.” In its [Charter](#) the Science Team identified “developing a strategic science framework and an LCC Network Science [Plan] with an associated work plan” as a priority action. Completing the Science Plan was subsequently prioritized by the coordinating staff from each LCC and emphasized within the Strategic Plan, which was developed by over 50 representatives from within the Network, including members of the LCC Council and LCC Steering Committees.



Joshua Tree
National Park.
ANDREA GRAFFIS

The Science Plan was collaboratively developed by the Science Team with additional input and feedback from the LCC Coordinators Team, Steering Committees, technical committees and science partners, and the Council. The Science Plan development process included the initial framing and prioritization exercises by the Science Team; the drafting of chapters by writing teams; the refinement of content during a series of virtual and in-person workshops, including a 2014 workshop with over 30 representatives from LCC partner organizations; and revision based on over 500 substantive comments from more than 20 organizations across the Network.

IMPLEMENTATION

The primary audiences for the Science Plan include LCC Science Coordinators, Coordinators, Network staff, Technical Teams, Steering Committees, and Council, as well as science funders and other partners interested in the LCC Network Vision and Mission. The Science Plan reflects shared science priorities that transcend individual LCC geographies. Addressing these science priorities will benefit and add value to the work of individual LCCs (mission, goals, priorities, etc.) and the Network as a whole. As such, it is expected that the Science Team and each LCC will choose to play a role in helping to address elements of the Science Plan. However, it is important to note that *no elements of the Science Plan obligate individual LCC partner organizations to any actions*. Similarly, participation in addressing elements of the Science Plan is at the discretion of individual Steering Committees.

SHARED DIRECTION
EMERGING ISSUES
NETWORKED RELATIONSHIPS
PRIORITIZED ACTION

The Science Plan can be used to orient the funding and technical capacities of a variety of organizations with an interest in landscape conservation. For example, this plan can inform decisions by the 250+ organizations that actively participate in the LCC Network, including the U.S. Fish and Wildlife Service (USFWS) Science

Applications Program and other agencies that provide support for science, staffing, and technical needs at the individual, multi-LCC, and LCC Network scales, contingent upon the availability of resources.

Each LCC is a collaborative, self-directed conservation partnership that connects active members to a shared landscape vision. Many of the efforts within individual LCCs are focused strictly within individual LCC geographies. By undertaking these efforts in the scalable context of the priorities identified in the Science Plan, and by ensuring that each LCC's efforts are compatible with those of adjacent LCCs, the LCC Network Vision and Mission will be more efficiently and effectively achieved at all scales. The Science Plan provides a framework to organize and align LCC actions that build on and enhance ongoing coordination and collaboration with complementary partnership-driven regional science programs.

The Science Plan recognizes the value of traditional knowledges in large landscape conservation, management, and adaptation to climate change while also recognizing the proprietary and sometimes sensitive nature of traditional knowledges. Guidelines and protocols will be followed to provide safeguards, including free, prior, and informed consent.

The [DOI Climate Science Centers \(CSCs\)](#) provide much of the information and tools related to climate change, including physical and biological research, ecological forecasting, and multi-scale modeling in response to landscape-level priorities and cross-sector needs identified by the LCCs. Established by Secretarial Order No. 3289, the CSCs provide scientific information, tools, and techniques that land, water, wildlife, and cultural resource managers and other interested parties can use to anticipate, monitor, and adapt to climate change impacts. The managing entity for the eight CSCs is the U.S. Geological Survey's (USGS) National Climate Change and Wildlife Science Center (NCCWSC). Staff from the NCCWSC and the CSCs contributed to the development of the Science Plan through participation in workshops and the review process and will continue to engage in LCC conservation science planning, development, and delivery.

Other important networks that work closely with LCCs include the National Oceanic and Atmospheric Administration (NOAA) [Regional Integrated Sciences and Assessments \(RISA\)](#) program and the U.S. Department of Agriculture (USDA) [Climate Hubs](#). The RISA program supports research teams that help expand and build the U.S.'s capacity to prepare for and adapt to climate variability and change, supporting NOAA's [Climate Mission Goal](#). Climate Hubs capitalize on USDA Service Centers, U.S. Forest Service (USFS) Threat Centers and partnerships, such as Cooperative Extension and the Climate Change Response Frameworks, to enable farmers, ranchers, and forest landowners to adapt to the impacts of climate change and weather variability and to promote agriculture/forestry production sustainability and health.

THEMES

The Science Plan is organized by thematic area:

1. Landscape Conservation Planning
2. Landscape Conservation Design
3. Climate Adaptation
4. Data Management, Integration, and Sharing
5. Socioeconomic and Cultural Values
6. Science Communication and Delivery
7. Monitoring and Assessment

Each theme contains an aspirational statement that describes what the LCC Network is striving toward and/or the motivation behind the theme, followed by the scope of the issue, a fundamental question, specific objectives with associated action items and deliverables, and a general timeline, where appropriate.

The themes complement and build upon each other and fit broadly into an adaptive management framework (Figure 1). Landscape conservation planning (Theme 1) is informed by and incorporates climate adaptation (Theme 3) and socioeconomic and cultural values (Theme 5), which feeds into landscape conservation design (Theme 2). Key components throughout implementation are data management, integration, and sharing (Theme 4), science communication and delivery (Theme 6), and monitoring and assessment (Theme 7). Key terms are defined in Appendix A—Science Plan Glossary. All action items are listed by theme in Appendix B and acronyms are defined in Appendix C.

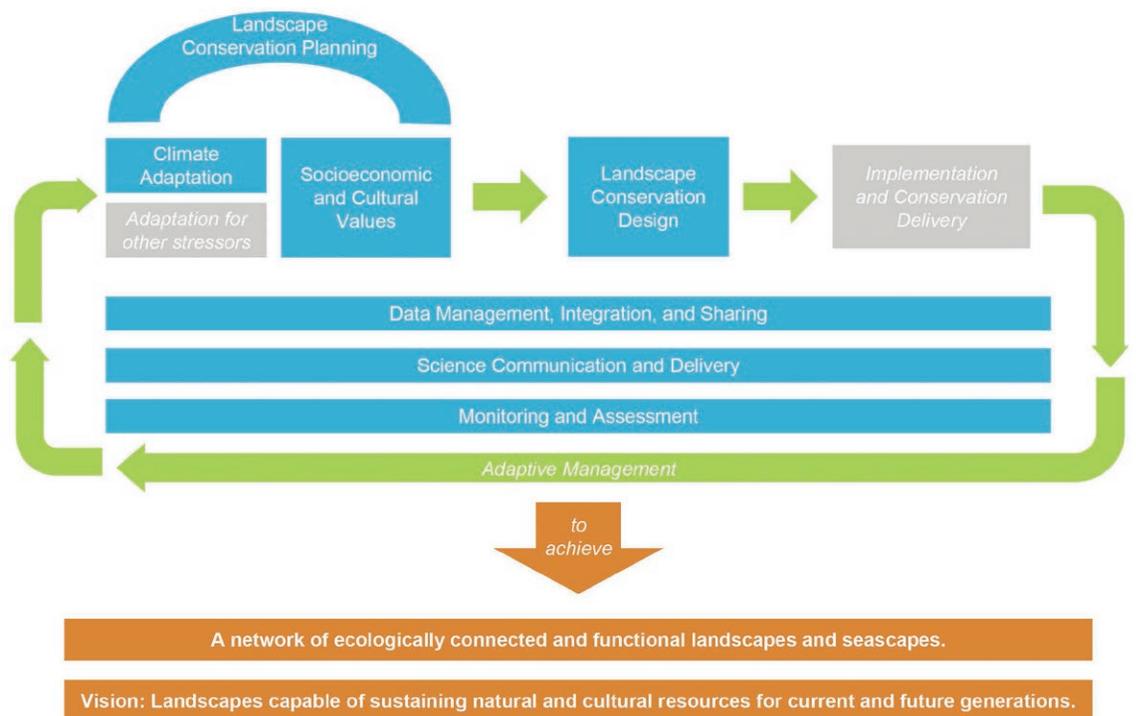


Figure 1. Conceptual schematic of relationships among the Science Plan themes.



Theme 1

Landscape Conservation Planning

California LCC workshop to engage Tribal and agency participants in how Traditional Ecological Knowledge can help ensure resilient and sustainable landscapes.
KELLY GROW/CALIFORNIA DEPT. OF WATER RESOURCES

ASPIRATIONAL STATEMENT

Science-based collaborative conservation planning that ensures conservation designs are compatible across the LCC Network and reflect goals for conservation targets in changing landscapes.

Scope of Issue

Achieving the LCC Network Vision of landscapes capable of sustaining natural and cultural resources for current and future generations requires informing decisions about current and future land use. This includes identifying shared conservation objectives, and determining where and how much conservation action is needed to achieve these conservation objectives. One approach for making such decisions is through an organized, collaborative process that results in spatial plans for conservation action. The phrase “Landscape Conservation Design” has recently been used to broadly describe an iterative, collaborative, and holistic process (and the resulting products) that provides information, analytical tools, spatially explicit data and maps, and best management practices to develop shared conservation strategies and to achieve jointly held conservation goals among partners. For the purposes of the Science Plan we are describing this complex process as two phases: landscape conservation planning (Theme 1; adapted from “Biological Planning” [NEAT 2006]) and landscape conservation design (Theme 2; adapted from “Conservation Design” [NEAT 2006]), which are consistent with elements of the USFWS’s and USGS’s Strategic Habitat Conservation framework (NEAT 2006), the BLM’s Landscape Approach for Managing Public Lands ([BLM](#)), the NPS’s Call to Action ([NPS](#)), the USFS’s National Forest System Land Management Planning ([USFS](#)), DOI’s Mitigation Policy (DOI), and similar adaptive management approaches of States, Tribes, non-governmental organizations, and others.



California tiger salamander. ADAM CLAUSE/USFWS

Supporting the LCC Network Strategic Plan

Goal 1. Conservation Strategy

Objective 1

Identify shared conservation objectives, challenges, and opportunities to inform landscape conservation at continental, LCC, island, and regional scales.

SHARED CONSERVATION TARGETS

Landscape conservation planning involves identifying goals and measurable objectives for shared natural and cultural resource conservation targets. In addition, the relationships between conservation targets and aspects of the environment are identified (aided by models) to establish management objectives that can be influenced by resource management agencies and organizations that influence conditions on the landscape. Landscape conservation design places the landscape conservation planning goals and objectives into a spatial context and provides maps and conservation strategies that can be used to inform resource management decisions. Landscape conservation planning and design processes are linked and rely on an iterative process that feeds back and forth between the two activities.

WHERE TO CONSERVE

Landscape conservation planning provides the foundation for identifying the locations, sizes, and characteristics of a network of ecologically functional and connected conservation areas/landscapes (which include open spaces and working lands), and for informing policy and resource management decisions that impact achieving conservation goals. Landscape conservation planning typically informs design at a spatial scale beyond most site-specific planning units (Groves et al. 2002) and has traditionally focused on creating reserves or a network of reserves to maximize the conservation of biodiversity. The science of landscape conservation planning has advanced to incorporate ecological processes, ecosystem services, cultural resources, and related societal needs from landscapes (e.g., food, fiber, water, energy, living space), and to include planning for dynamic landscapes in light of climate change (Groves et al. 2012, Cross et al. 2012) and other large-scale stressors.

CONSERVATION AT THE RIGHT SCALES

Landscape conservation planning is useful and desired at large landscape scales for many reasons. For example, partners that are interested in conserving a species, ecosystem, or cultural landscape across its entire range (e.g., including multiple life history phases, across a large area that crosses jurisdictional boundaries, etc.), necessarily benefit from identifying vulnerabilities and understanding stewardship responsibilities across that range. Similarly, strategic and proactive conservation requires consideration of factors such as future stressors, changing conditions, shifting species distributions, human dimensions, and other dynamic shifts that will occur outside and across individual management units.

LCC NETWORK ROLE

To effectively inform conservation delivery, landscape conservation planning must be a collaborative exercise that involves the agencies, organizations, and communities that influence current and future landscape conditions. A critical step is the identification of conservation targets of shared interest, as well as measurable objectives and limiting factors for those conservation targets, as these are essential for informing management and conservation actions and for measuring their success. The LCC Network has an opportunity to help foster and support this broader perspective on landscape conservation

planning and to encourage planning that is designed to lead to implementation. Individual LCCs and their partners benefit from landscape conservation planning, and these benefits multiply when planning efforts are built to be compatible within and across LCC geographies. The challenge is ensuring that LCC landscape conservation planning efforts are relevant and meaningful at the scale of individual LCCs, multiple LCCs, and across the entire Network.

The need for an individual LCC to focus on landscape conservation planning in order to achieve that LCC’s mission is well recognized. However, a strength of the Network is the ability to facilitate cohesive landscape conservation planning within and across LCCs that informs landscape conservation design and conservation delivery at multiple scales (e.g., continental, multi-LCC, etc.). One role of the LCC Network is to support landscape conservation planning within individual LCCs, and another is to synthesize and coordinate planning to facilitate and enable the identification and conservation of a network of ecologically functional and connected landscapes across the LCC Network’s entire geographic area.

PLANNING AND DESIGN FRAMEWORK

Landscape conservation planning encapsulates the initial steps in the process leading towards landscape conservation design. The fundamental steps of landscape conservation planning are listed below. These steps are firmly planted within the traditional view of landscape conservation planning (e.g., NEAT 2006, Groves et al. 2002); however, they need to inform and be informed by the components of landscape conservation design (Theme 2). Although the steps below are presented linearly, they may be revisited at any point in the planning process.

LANDSCAPE CONSERVATION PLANNING STEPS

1. Articulate the purpose for, and the spatial and temporal scope of, the landscape conservation planning effort. Understand how the planning effort relates to, aligns with, and builds upon other landscape conservation planning efforts.
2. Identify shared (i.e., mutually agreed upon by partners) conservation targets (i.e., the “things” we are focused on conserving, such as species, ecosystems, or ecological processes/services). May include:
 - a. Coarse filter targets (“conserving nature’s stage” including geodiversity/geological facets, ecosystem processes/services, species selected via an umbrella or keystone approach, cultural landscapes), and
 - b. Fine filter targets (“the actors”), including endangered, game, and other single species efforts; single recreational uses (e.g., hunting, hiking, ATV riding); historic and cultural sites.
3. Identify adaptation strategies & actions
4. Implement adaptation options



Landscape conservation planning is an iterative process. ADAPTED FROM GLICK ET AL. 2012



Sockeye Salmon schooling in Hidden Lake, Alaska.
KATRINA MUELLER/
USFWS

3. Identify existing or establish new conservation goals and measurable objectives for the selected conservation targets.
4. Collect a wide range of data and information, and identify information gaps to assess current status and recent trends of conservation targets.
5. Identify limiting factors affecting the status of conservation targets, including the consideration of scenarios of future change (e.g., climate, land use) and management constraints.
6. Assess potential responses of the conservation targets to those scenarios.
7. Revisit goals and objectives, making sure they are realistic under future scenarios (Stein et al. 2014).

Fundamental Question

How can the LCC Network facilitate and coordinate landscape conservation planning that explicitly accounts for future landscape conditions at regional scales and ensure that individual LCC planning can scale up to inform a network of ecologically connected and functional landscapes and seascapes?

Objectives

Supporting the LCC Network Strategic Plan

Goal 1. Conservation Strategy

Example Tactics

- » Establish conservation objectives at the LCC level and other applicable scales.
- » Roll-up LCC objectives to identify Network-scale objectives.
- » Identify priority areas where opportunities exist to improve resilience and/or apply adaptation strategies for priority resources, ecosystem services, and communities.

OBJECTIVE 1: Articulate LCC Network-wide or regional conservation targets (and their associated goals and objectives) that would adequately represent the Network-wide vision of achieving an ecologically connected network of functional landscapes capable of sustaining natural and cultural resources for current and future generations (*top down*). These targets would be flexible for the 22 self-directed LCCs to adopt and participate in as they deem appropriate.

OBJECTIVE 2: Identify conservation targets (and their associated goals and measurable objectives) from each LCC and regionally scaled initiatives that can potentially scale to the LCC Network-wide goal of achieving an ecologically connected network of functional landscapes (*bottom up*).

Examples of potential conservation targets that should be considered as either Network-wide or regional conservation targets include (but are not limited to):

- a. Connectivity of terrestrial and aquatic habitats
- b. Geodiversity (Conserving Nature’s Stage, Beier et. al 2015)
- c. Wide-ranging or migratory species
- d. Ecosystem services (e.g., recreation, water quality, etc.)
- e. Ecosystem processes and function
- f. Cultural landscapes

OBJECTIVE 3: Maximize compatibility between Network-wide conservation targets (and the goals and measurable objectives for them) and the conservation targets (and their associated goals and objectives) of individual LCCs. Evaluate the degree to which these conservation targets, collectively, reflect what we think we need to achieve an ecologically connected network of functional landscapes at a continental scale. Identify gaps and adjust as needed.

OBJECTIVE 4: Flesh out specific objectives for steps 4-8 in the Landscape Conservation Planning Framework based on results from Objectives 1-3 above.

Action Items

ACTION 1: Conduct a literature review of existing national and international plans to identify existing conservation targets. (Objective 1)

ACTION 2: LCC Science Coordinators and technical staff identify priority conservation targets that adequately capture the goal of an ecologically connected landscape. (Objective 1)

ACTION 3: Collate conservation targets identified by individual LCCs and regional-scale initiatives into a single product (document, database, map, etc.). (Objective 2)

ACTION 4: Develop criteria for sorting through LCC-specific targets to determine which are useful for rolling up into multi-LCC and LCC Network-wide vision (e.g., frequency/overlap across multiple LCCs, ecosystem type, geographic region, other factors to be determined). (Objective 2)

ACTION 5: Apply criteria to develop list of LCC conservation targets across multiple LCCs that inform LCC Network-wide vision. (Objective 2)

ACTION 6: Evaluate and combine conservation targets to identify a parsimonious list. (Objective 3)

ACTION 7: Assess regional, partner-focused conservation planning frameworks and paradigms in use. (Objective 3)

ACTION 8: Identify effective practices and develop minimum standards for compatibility of landscape conservation plans across LCC borders (e.g., common scenario/timeframe, common metrics/currency). (Objective 3)

ACTION 9: Hold a workshop to rapidly prototype the landscape conservation planning framework (steps 1-6), capture best practices for achieving an ecologically connected network of landscapes for the LCC Network to test, and identify gaps in tools and analyses. (Objective 4)

Deliverables

- DELIVERABLE 1:** An annotated literature search that compiles existing conservation targets from existing national and international plans. (Action 1)
- DELIVERABLE 2:** White paper discussing LCC Network priority conservation targets for an ecologically connected network of landscapes. (Action 2)
- DELIVERABLE 3:** White paper discussing regional LCC priority conservation targets for an ecologically connected network of landscapes. The white paper will include and apply criteria to prioritize the regional conservation targets. (Actions 3-5)
- DELIVERABLE 4:** Evaluate and combine Deliverables 2 and 3 into one annotated list of conservation targets. (Action 6)
- DELIVERABLE 5:** Peer reviewed paper and review by LCC Steering Committees on LCC Network minimum standards for compatibility of plans across LCC borders (e.g., common scenario/timeframe, common metrics/currency). (Actions 7-8)
- DELIVERABLE 6:** Develop a management document that summarizes deliverable 5. (Action 8)
- DELIVERABLE 7:** A summary of the workshop to rapidly prototype the landscape conservation planning framework with recommendations for the LCC Network on appropriate methodology for steps 1-7 in the framework. (Action 9)
- DELIVERABLE 8:** A white paper that will provide objectives, actions, and deliverables with a timeline and budget for the LCC Network to address landscape conservation planning steps 4-6. (Action 9)

Project Timeline

- » Objectives 1 and 2: Months 1–9
- » Objective 3: Months 6–18
- » Objective 4: Months 12–24



Theme 2

Landscape Conservation Design

Stakeholders come to the table to collaborate on the South Atlantic LCC's landscape conservation design. SOUTH ATLANTIC LCC

ASPIRATIONAL STATEMENT

Landscape conservation designs provide a foundation for collective impact in achieving individual and shared goals, meeting objectives for conservation targets, and developing a network of ecologically connected and functional landscapes and seascapes.

Scope of Issue

For the purposes of the Science Plan, “landscape conservation design” is the second phase (with “landscape conservation planning,” Theme 1) of a collaborative, holistic process that results in products including shared and spatially explicit conservation strategies among partners. The “landscape” portion of the term conveys the idea that the planning and design process encompasses a large spatial extent, typically at or beyond the scale of large watersheds or ecoregions. With an origin in landscape ecology, “landscape” also highlights the idea that a planning-design process encompasses more than the needs of a single species, but rather addresses multiple species, ecosystem processes or services, or similar conservation targets. The concept of large-scale collaborative ecosystem or multi-species planning has deep historical roots in public and non-governmental organizations under a variety of names. Examples of other efforts that include many or all of the elements of landscape conservation planning and design include: the *Northwest Forest Plan* (USDA and USDI 1994), BLM Rapid Ecological Assessments (Bureau of Land Management 2015), State Wildlife Action Plans (Association of Fish and Wildlife Agencies 2012), The Nature Conservancy’s Ecoregional Assessments (The Nature Conservancy and World Wildlife Fund 2006), and World Wildlife Fund Biodiversity Visions (Dinerstein et al. 2000). As used in this document, landscape conservation design is not confined to terrestrial settings; it can also address coastal and marine spatial planning.



Connect the Connecticut is a collaborative landscape conservation design for the Connecticut River Watershed to plan and design a landscape that provides habitat for fish, wildlife, and plants and provides jobs, food, clean water, storm protection, recreation, and other natural benefits that support people and communities. USFWS

SPATIALLY EXPLICIT

Landscape conservation design continues the collaborative process begun during the landscape conservation planning theme. Fundamentally, landscape conservation planning answers the questions of “what” to protect and restore (the conservation targets) and “how much” (conservation goals and measurable objectives for those conservation targets). Landscape conservation design addresses the questions of “where” and “how” to conduct conservation actions such as protection, restoration, and management to achieve the goals and objectives for conservation targets. The “design” portion of the term conveys the idea of a creative process to identify specific areas for priority action that collectively comprise an integrated, interrelated whole. Landscape conservation design recognizes that the spatial composition, configuration, and connectedness of habitats and ecosystems play an integral role

in sustaining resources and ecological functions over the long term. This spatial aspect distinguishes landscape conservation design from other planning efforts that may identify conservation targets and objectives but that do not specify where conservation actions should occur.

A FLEXIBLE APPROACH

Although a prominent application of landscape conservation design has been in the development of terrestrial and marine protected area networks, this is only one of many possible conservation approaches that can result from a design process. Landscape conservation designs can also reflect ecosystem values present in the built environment and other areas strongly modified by human activities, and can recognize areas that are important for resource extraction and management. As such, landscape conservation designs can be useful for implementing a landscape-scale approach to mitigation, and for informing decisions across sectors (conservation, energy, transportation, agriculture, etc.) that influence landscape condition.

NEED FOR COMPATIBILITY

Landscape conservation designs at various scales are increasingly being developed across the extent of the LCC Network with some, but by no means all, sponsored by LCCs. If successfully implemented, these designs have the potential to enhance large-scale conservation of wildlife and other natural and cultural resources. However, the independent development of separate, inconsistent designs raises the prospects of significant gaps or incompatibilities among adjacent landscape conservation designs that could inhibit the coordinated conservation action needed in the face of climate change and other regional or continental-wide stressors. Such coordinated action related to the design and delivery (by partners) of an ecologically connected network of functional landscapes has been recommended in recent programs and reports such as the *National Fish, Wildlife and Plants Climate Adaptation Strategy* (2012) and the Wildlife Habitat Policy Research Program (2010).

Supporting the LCC Network Strategic Plan

Goal 1.

Conservation Strategy

Objective 2

Develop then deliver (through partners) regional landscape conservation goals and designs that support resiliency and adaptation to both global change and regional landscape challenges, while ensuring the inclusion of all partners and stakeholders necessary for successful conservation.

Objective 3

Integrate regional or other scale-specific conservation designs to align and focus conservation action at the Network scale, within available authorities.

LCC NETWORK ROLE

LCCs and the LCC Network are ideally situated to play an international leadership role in the advancement of landscape conservation design. As a forum for conservation partners, they can facilitate or contribute to the collaborative planning and design process. As sources and integrators of landscape-scale information and tools for natural and cultural resources, they possess or can tap into the scientific expertise needed during the landscape conservation design process. The LCC Network in particular can play a role in enhancing consistency and compatibility among landscape conservation designs and in building an international community of practice.

COMMON DESIGN ELEMENTS

The conservation community has yet to come to consensus on standardized processes or frameworks for landscape conservation design. However, some common themes and elements have emerged from organizations that have performed and reviewed conservation design efforts. Recognizing that landscape conservation designs need to be flexible enough to accommodate the needs and priorities of participating partners, common design actions that build upon the steps described under Theme 1 include the following:

- » Translating the goals and objectives for conservation targets into a spatially explicit desired condition of the landscape, reflecting plausible scenarios of future change.
- » Selecting and designing a network of conservation areas (to include working lands, etc.) and any needed connections among them that can achieve the desired landscape conditions.
- » Identifying the protection, management, restoration, and monitoring strategies needed to ensure that the network of conservation areas will achieve the goals of the design.
- » Clearly communicating about the process and results of the design effort.
- » Revising and adapting the design as experience is gained during implementation and as ecosystems and human communities change over time.



Pine forest in
Appalachicola National
Forests: example of a
priority area in both
the South Atlantic LCC
Blueprint and Florida CLIP
in the portion of Northern
Florida that serves as an
integration area for both
conservation designs.
MATTHEW PAULSON

FACILITATING DESIGN COMPATIBILITY

Effective landscape conservation designs are built upon a foundation of sound conservation science, but as participatory processes they entail many value-based questions that cannot be answered solely through scientific analysis of physical structure and function. These include questions such as: What resources do we care most about? How should we balance trade-offs among competing objectives? What degree of conservation is desirable and achievable? Consequently, fully addressing the problem of inconsistent or incompatible landscape conservation designs is beyond the scope of the Science Plan. The purpose of this theme of the Science Plan is to focus on those technical and scientific aspects of landscape conservation design that facilitate design compatibility.

Fundamental Question

How can the LCCs address technical aspects to ensure that landscape conservation designs are compatible within and across LCC geographies so that they collectively contribute to an ecologically connected network of functional landscapes and seascapes?

This fundamental question recognizes that collaborative decisions and available technical tools will differ among individual conservation design efforts.

Objectives

The objectives presented here are aimed at relatively short term actions (1-2 year timeframe) that build toward a longer-term goal of expanded, integrated landscape conservation planning and design across the LCC Network. To be most effective, addressing the scientific and technical components of landscape conservation design as described here should be complemented by Network development of the broader collaborative aspects of the design process. The process of addressing these objectives is likely to identify gaps in data (e.g., availability of spatial data that adequately reflect the occurrence and quality of locations for conservation targets) and methods for landscape conservation design that cannot be addressed during the initial timeframe of activities under this version of the Science Plan. These gaps should be documented and prioritized to serve as the basis for future updates for this theme of the Science Plan.

OBJECTIVE 1: For single landscape conservation designs—improve technical approaches for integrating multiple products of landscape conservation planning within a collaborative process. For example, this could include integrating multiple species habitat models or integrating “coarse filter” targets (e.g., ecosystem processes, geophysical features, or wide-ranging or migratory species) and “fine filter” targets (e.g., endangered or game species).



The American oystercatcher and red-headed woodpecker are ecosystem integrity metrics for the South Atlantic LCC, part of the beach bird index and the forested wetland bird index, respectively.

OYSTERCATCHER: JAMES DIEDRICK. WOODPECKER: KENNETH COLE SCHNEIDER. (Right) The South Atlantic LCC's Conservation Blueprint 2.0 is an example of a landscape conservation design, a living spatial plan for shared conservation action. SOUTH ATLANTIC LCC

OBJECTIVE 2: For multiple (neighboring) landscape conservation designs—improve technical approaches for integrating adjacent landscape conservation designs to foster:

- » Compatibility and interoperability of the designs
- » An ecologically connected network of landscapes and seascapes adaptable to global change

These approaches should accommodate the integration of designs that were developed using different inputs and methodologies.

OBJECTIVE 3: Improve scientific and technical approaches for addressing and incorporating design elements that function at large geographic scales that are beyond the area typically considered in local or regional landscape conservation designs (e.g., wide-ranging or migratory species, broad scale process targets, etc.).

Action Items

ACTION 1: Review current technical methods for integrating conservation targets and other science inputs (such as species-habitat models and ecosystem integrity metrics, historic resource models) into a landscape conservation design, within a collaborative, participatory design environment. Note: the conservation targets considered should be informed by those LCC Network, regional, or LCC-specific targets evaluated as being most useful for conservation planning under Theme 1 of this Plan. (Objective 1)

ACTION 2: Review and evaluate best practices for achieving successful collaboration among partners to integrate science inputs. (Objective 1)

- ACTION 3:** Identify advantages, disadvantages, and appropriate applications of the methods identified in Actions 1-2 for integrating science inputs. (Objective 1)
- ACTION 4:** If appropriate and necessary, develop new methods for integration of science products into design. (Objective 1)
- ACTION 5:** Evaluate alternative technical approaches for reconciling and integrating landscape conservation designs from adjacent areas to make them compatible. (This evaluation should recognize that because goals, objectives, and collaborative processes differ among design efforts, comprehensive consistency among designs may be unrealistic.)
- ACTION 6:** Review and evaluate best practices for achieving successful collaboration among partners to integrate conservation designs from adjacent areas. (Objective 2)
- ACTION 7:** Identify advantages, disadvantages, and appropriate applications of the approaches identified in Actions 5-6 for integrating conservation designs. (Objective 2)
- ACTION 8:** If appropriate and necessary, develop new methods for integrating multiple conservation designs. (Objective 2)
- ACTION 9:** Demonstrate the application of methodologies that integrate two or more conservation designs so that they align and are compatible. (Objective 2)
- ACTION 10:** Review and evaluate the goals and objectives for conservation targets and identify the aspects that are most appropriately considered at spatial scales larger than what is typically encompassed by local or regional landscape conservation designs (e.g., larger than the scale of an individual LCC or large watershed). For example, this may include populations or metapopulations of species with wide distributions, full ranges utilized by individuals of migratory species, or the need for long-term shifts in range to accommodate changing climates. Note: the conservation targets considered should be informed by those LCC Network, regional, or LCC-specific targets that have been identified as being most useful for landscape conservation planning under Theme 1 of this Science Plan. (Objective 3)
- ACTION 11:** Evaluate alternative approaches for incorporating the considerations from Action 10 into landscape conservation design at multiple scales. (Objective 3)
- ACTION 12:** Where appropriate and necessary, develop new technical methods for addressing the considerations from Action 10 and incorporating them into landscape conservation design. (Objective 3)
- ACTION 13:** Using the results from Actions 10-12, demonstrate how these considerations can be integrated into multiple, compatible landscape conservation designs using the methods identified (both existing and newly developed). (Objective 3)

Deliverables

DELIVERABLE 1: A synthesis report that reviews existing methods, best practices, applications and (as necessary) new methods for effectively integrating landscape conservation targets and other science products within a collaborative design environment. (Actions 1-4)

DELIVERABLE 2: A synthesis report that reviews methods and approaches for compatible integration of adjacent landscape conservation designs. The focus would be on the scientific and technical aspects of integration but would also reflect the collaborative decision-making context of the landscape conservation planning and design process. (Actions 5-9)

DELIVERABLE 3: A synthesis report on conservation targets that need to be addressed at scales larger than the geographic extent typically addressed by local, state or regional landscape conservation designs, and how to incorporate these considerations into landscape conservation designs. (Actions 10-12)

DELIVERABLE 4: A demonstration of the integration of at least two or more landscape conservation designs (e.g., from at least two adjacent LCC geographies) into a compatible, consistent format using the methods reviewed in the two synthesis reports as well as any new technical methods. (Action 13)

Project Timeline

- » Objective 1: 6 to 12 months
- » Objective 2: 9 months to 2 years
- » Objective 3: 9 months to 2 years



Theme 3

Climate Adaptation

Measuring sea level rise
in a salt marsh. BILL
BUTCHER/USFWS

ASPIRATIONAL STATEMENT

The LCC Network aspires to facilitate the development of an ecologically connected network of landscapes and seascapes, and recognizes that climate adaptation is critical for success.

Scope of Issue

Many of the agencies, tribes, territories, and organizations that are partners in the LCCs have authorities, mandates, and missions that focus on the conservation of natural and cultural resources for current and future generations. Safeguarding these natural and cultural resources in a changing climate is a serious and urgent challenge, requiring an understanding of current impacts, future risks, and possible mechanisms for adaptation. Climate adaptation is an “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC WGII 2007).

CLIMATE ADAPTATION POLICIES

Climate adaptation is the focus of numerous policy directives relevant to partners within the LCC Network. For example, it is the central focus of DOI Secretarial Order 3289 that established the network of LCCs. Climate adaptation was one of the three major strategies in the USFWS’ *Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change*, in which “LCCs are envisioned as the centerpiece of the Service’s and the Department’s...informed management response to climate change impacts on natural resources.” It is the subject of Executive Order 13653, 1 November 2013, which included LCC-relevant task areas entitled “Managing Lands and Waters for Climate Preparedness and Resilience” and “Providing Information, Data, and Tools for Climate Change Preparedness and Resilience.”



The National Fish, Wildlife, and Plants Climate Adaptation Strategy is a call to action for solutions to address the impacts of a changing climate on the fish, wildlife, and plant resources of the United States.

PRIORITIZING RESILIENCE

The President’s *Priority Agenda for Enhancing the Climate Resilience of America’s Natural Resources*, prepared by the Council on Climate Preparedness and Resilience Climate and Natural Resources Working Group, was released in October 2014. It includes a roadmap for moving forward climate change adaptation actions and strategies for resilience. Resilience is “the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions” (Executive Order 13653) and is recognized as a complex endeavor (President’s *Priority Agenda*, 2014).

In 2009, Congress urged the Council on Environmental Quality and DOI to develop a national, government-wide climate adaptation strategy to assist fish, wildlife, plants, and related ecological processes in becoming more resilient to the impacts of climate change. By the spring of 2013, the USFWS, the Council on Environmental Quality, the NOAA, and federal, state, and tribal partners released the *National Fish, Wildlife, and Plants Climate Adaptation Strategy* (hereafter, *Climate Strategy*). The *Climate Strategy* provides a framework for natural and cultural resource managers to develop adaptation plans. It is a “joint effort at three levels of government (federal, state, and tribal) to identify what must be done to help living resources of the United States become more resilient, adapt to, and survive a warming climate.”

IMPLEMENTING THE CLIMATE STRATEGY

The *Climate Strategy* enumerated seven goals, each with multiple strategies and actions. It encourages LCCs to take a lead role in its implementation, and most LCCs are already using it to help inform their work and regional priorities. The *Climate Strategy* identifies a wide range of important climate adaptation activities, including developing vulnerability assessments, communication tools, research, and conservation plans. In many cases of high uncertainty, scenario planning may also be an appropriate tool. Many of these recommended activities directly align with and help achieve shared LCC goals and are thus appropriate and beneficial for LCCs and partners to undertake. Sharing information across LCCs, CSCs, and other partners to ensure best available information and practices is particularly important. However, priorities, climate-related decisions, the state of science, and the collective capacity of scientific and conservation organizations vary regionally. Each LCC addresses these tasks differently, as appropriate for their region. The challenge is to support and connect these different efforts across the continent and to provide the information, tools, and actions in a cohesive manner consistent with the framework presented by the *Climate Strategy*.

In addition to the *Climate Strategy*, other interagency efforts have produced the *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate*, released October 28, 2011; the *National Ocean Policy Implementation Plan*, released April 16, 2013; and the *Priority Agenda for Enhancing the Climate Resilience of American’s Natural Resources*, released October 8, 2014.

Supporting the LCC Network Strategic Plan

Goal 1. Conservation Strategy

An ecologically connected network of landscapes and seascapes adaptable to global change—such as climate change—with the ability to sustain ecological integrity and health to meet the needs of society at multiple scales.

Supporting the LCC Network Strategic Plan

Goal 1. Conservation Strategy Objective 2

Develop then deliver (through partners) regional landscape conservation goals and designs that support resiliency and adaptation to both global change and regional landscape challenges, while ensuring the inclusion of all partners and stakeholders necessary for successful conservation.



Climate change threatens many migratory species, such as the red knot, which was listed as a threatened species in 2014. GREGORY BREESE/USFWS

LCC NETWORK ROLE

Climate adaptation is a process, not a product or an endpoint. A coordinated process is needed across the LCC Network to facilitate the development of research, information, and decision support tools that address scientific needs and bridge the gap between research and operations. This will help meet the needs for adaptation planning and implementation. LCCs are uniquely positioned to bring partners together to develop shared and coordinated responses to climate change and its impacts across the continent and to facilitate climate adaptation that is undertaken with a range of resources and at a range of scales (both temporal and spatial). LCCs need to coordinate across the LCC Network to build on our work and the work of our partners. LCCs can learn from each other about current planning, on-the-ground adaptation, and how science is being used.

INITIAL FOCUS

This theme is initially focused on implementation of the *Climate Strategy's Goal 1, Strategy 1.1: Identify areas for an ecologically-connected network of terrestrial, freshwater, coastal, and marine conservation areas that are likely to be resilient to climate change and to support a broad range of fish, wildlife, and plants under changed conditions.* This is the first step towards climate adaptation; additional work will need to be done in subsequent years to implement additional components of the *Climate Strategy*. In addition, the LCC Network will remain engaged with other partners as they develop their own approaches to climate adaptation and implementation of the *Climate Strategy*.

Fundamental Question

How can the LCC Network facilitate and contribute to the development and integration, at a continental scale, of the landscape-scale strategies and approaches identified by the *Climate Strategy* that will increase natural and cultural resource adaptation or resilience to climate change?

Objectives

- OBJECTIVE 1:** Identify and develop critical spatial and natural and cultural resource data across the Network necessary to implement the *Climate Strategy*, with an initial emphasis on *Goal 1, Strategy 1.1*.
- OBJECTIVE 2:** Assess the efforts of individual LCCs to determine the degree to which they reflect the climate adaptation needs of conservation targets across the landscape and seascape and determine how to improve incorporation of climate adaptation activities.
- OBJECTIVE 3:** Develop a process that allows LCCs to track and communicate collective achievement of actions that support Goal 1 of the *Climate Strategy* (with an initial emphasis on *Goal 1, Strategy 1.1*).
- OBJECTIVE 4:** Coordinate funding and activities of LCCs with climate science partners (including NCCWSC, CSCs, USDA Hubs, RISAs, international partners, etc.) to achieve effective and efficient conservation at broader scales as they relate to implementation of the *Climate Strategy* and other connected strategies.

Goal 1.
Conservation Strategy

Example Tactics

Identify priority areas where opportunities exist to improve resilience or adaptation strategies for priority resources, ecosystem services, and communities.

Identify, prioritize, and support implementation of cross-LCC actions where coordinated action across several LCCs could have a multiplying effect.

Action Items

- ACTION 1:** Work with LCCs and partners to identify and prioritize the critical spatial and natural and cultural resource data necessary for implementing the *Climate Strategy*, with a focus on data that are needed by multiple LCCs or at broader scales. Then, based on this prioritized list, implement processes for ensuring these data are developed, acquired, and made available to the LCCs and partners. (Objective 1)
- ACTION 2:** Work in conjunction with the Joint Implementation Working Group for the *Climate Strategy* to develop an LCC self-assessment template regarding LCC efforts towards meeting *Goal 1, Strategy 1.1*. (Objective 1)
- ACTION 3:** As each LCC deems appropriate, conduct a self-assessment (using a template to be developed) regarding their efforts towards meeting *Goal 1, Strategy 1.1*. The individual assessments will include a description of the methodology and tools by which LCCs develop information such as models of projected change in priority natural and cultural resources (e.g., species distributions, habitats, ecosystems) including rates of change. (Objective 2)
- ACTION 3A:** The self-assessments will be compiled across the Network into a single evaluation (potentially led by a management or science fellow¹) that will describe the extent to which individual LCCs are incorporating climate information into their adaptive management framework (as it relates to *Goal 1, Strategy 1.1*), and that will identify gaps in knowledge and actions taken across the Network.
- ACTION 3B:** Host an LCC workshop following the compilation of the climate adaptation self-assessments and evaluation of efforts to share lessons learned, including both progress and obstacles in applying climate change information to conservation planning and across social boundaries. One focus will be the effectiveness of proposed ecologically connected networks to meet their conservation goals under plausible scenarios of climate change.
- ACTION 4:** After the workshop, a needs assessment report would contain the compilation of the self-assessments, workshop results, and identify opportunities and impediments towards aligning the efforts of individual LCCs across the LCC Network. LCCs will evaluate how implementing *Climate Strategy 1.1* can best be incorporated with their conservation targets, conservation priorities, and strategic plans, working with partners and integrating their work with existing management plans such as the State Wildlife Action Plans, National Fish Habitat Partnerships, Joint Ventures, State Climate Change Vulnerability Assessments, State Historic Preservation Plans, Cultural Heritage Corridors, etc. The individual action items identified by each LCC will be collated into a single Network action plan. (Objective 2)
- ACTION 5:** Issue a network RFP in 2017 to solicit project proposals that address the priorities and needs identified in the completed assessment report. The RFP will support the goal of climate adaptation at system scales (i.e., the scale of species' ranges, cultural landscapes, ecosystem processes, etc.). (Objective 4)

¹ Potential fellowship programs to consider include the [Presidential Management Fellowship \(PMF\) Program](#), the [Science and Technology Policy Fellowship](#) from AAAS, the Knauss Fellowship, or other identified programs.



Sea level rise workshop in Tijuana, Mexico. REBECCA FRIS/USFWS

ACTION 6: Develop a mechanism to track actions across the LCC Network that are focused on the development of a network of ecologically connected and functional landscapes. (Objective 3)

ACTION 7: Coordinate and integrate these efforts with the Joint Implementation Working Group for the *Climate Strategy* so that the CSCs and other partners can share lessons learned and adaptive approaches undertaken, communicate progress being made, and build LCC capacity for implementing the *Climate Strategy*. (Objective 4)

ACTION 8: Support the implementation of the President’s Priority Agenda as it relates to moving forward climate change adaptation and strategies for resilience in landscapes/regions chosen as “flagships” if involvement by LCCs is requested and they can play a leadership or supporting role. (Objective 4)

ACTION 9: After three years, revisit the Science Plan’s objectives that narrow the focus to implementing *Climate Strategy Goal 1, Strategy 1.1*. Individual LCCs are currently at different stages in implementation. Based on success across the LCC Network in implementation of the *Climate Strategy*, consider expanding the focus to include additional strategies in *Goal 1* or actions from additional climate strategies such as the *National Ocean Policy Implementation Plan* and the *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate*. (Objective 4)

Deliverables

DELIVERABLE 1: A prioritized list of the critical spatial and natural and cultural resource data necessary for implementing the *Climate Strategy*, with a focus on data that are needed by multiple LCCs or at broader scales. (Action 1)

DELIVERABLE 2: A completed Assessment Report regarding how the LCCs are addressing the *Climate Strategy Goal 1, Strategy 1.1*, that contains LCC self-assessment information, results from the LCC Network workshop to share lessons learned regarding the application of climate change knowledge to conservation planning, and a synthesis from across the Network. (Actions 2-3)

DELIVERABLE 3: LCC Network climate action plan that collates the individual LCC action items focused on implementing the *Climate Strategy Goal 1, Strategy 1.1* that can be shared. (Actions 4, 7, 8)

DELIVERABLE 4: Nationally funded LCC projects, leveraged with partners, during Year 2 that advance the goal of applying climate-informed conservation planning applicable beyond an individual LCC’s boundaries. (Actions 5 and 8)

DELIVERABLE 5: A tracking mechanism/methodology to measure progress toward meeting the goals of developing and integrating landscape and seascape-based strategies and approaches identified in the *Climate Strategy* across the LCC Network (with an initial focus on *Goal 1, Strategy 1.1*) using metrics and a system agreed upon in Action 6 above. (Actions 6-8)



Climate change and sea level rise can damage coasts, leading to impacts similar to when Hurricane Irene hit the Outer Banks of North Carolina in 2011. TOM MCKENZIE/USFWS

Project Timeline

YEAR 1

- » Development and completion of self-assessments by all LCCs to report on current actions as well as identify gaps in knowledge, tools, actions, and capacity related to *Climate Strategy Goal 1, Strategy 1.1*. (Deliverable 1)
- » Per the President's *Priority Agenda* and in support of *Climate Strategy Goal 1, Strategy 1.1*, if requested, LCCs will assist Federal agencies and other partners working to address ecosystem management issues to “select flagship geographic regions for which they will identify priority areas for conservation, restoration, or other investments to build resilience in vulnerable regions, enhance carbon storage capacity, and support management needs.” (Deliverables 2 and 3)

YEAR 2

- » Host a workshop to discuss progress and next steps. (Deliverable 1)
- » Complete the Adaptation Needs Assessment Report. (Deliverable 1)
- » Per the President's *Priority Agenda*, LCCs (if requested and appropriate for participation) and other partners with selected flagship areas “will have identified and mapped the initial list of priority areas within each of the selected geographic landscapes or regions”. (Deliverable 1 and 2)
- » Incorporate the Adaptation Needs Assessment Report and LCC Network climate action plan into the LCC Network website with a link to the *Climate Strategy* website.
- » Develop RFP for projects to address science needs identified in the Adaptation Needs Assessment Report. (Deliverable 3)
- » Track progress with the Joint Implementation Working Group. (Deliverable 4)

YEAR 3

- » LCCs implement additional priority actions that build on efforts to address *Climate Strategy Goal 1, Strategy 1.1* across the LCC Network. (Deliverables 2 and 3)
- » Track progress with the Joint Implementation Working Group. (Deliverable 4)



Theme 4

Data Management, Integration, and Sharing

A sea otter researcher tracks a radio-tagged sea otter near Morro Bay. LILLIAN CARSWELL/USFWS

ASPIRATIONAL STATEMENT

Strategic and effective conservation investments that support a network of ecologically connected and functional landscapes and seascapes are made possible by discoverable, accessible, and usable data.

Supporting the LCC Network Strategic Plan

Goal 3. Science

Example Tactic

Support efficiency among LCCs and other appropriate broad-scale monitoring programs in generating status and trend information on priority resources and landscapes by facilitating sharing, cooperative synthesizing, communications, and evaluation of data.

Scope of Issue

Conservation is most effective when decisions are based on scientific information and informed by monitoring. The need to provide for exchange of data among the scientific, resource management, and conservation communities is at the core of the LCC Network Mission, and this relationship is one that the LCC Network seeks to strengthen and make more efficient. However, data management within the scientific community has been less than optimal; recent research indicates that 80% of data used for peer-reviewed science publications becomes irretrievably lost within 20 years (Gibney and Van Noorden 2013, Vines et al. 2013). Appropriately documenting and archiving important datasets and providing opportunities for review and use by others is paramount if these resources are to benefit the conservation discipline. This is especially important given the cross-cultural nature of data exchange and the need to put high-integrity information into credible, repeatable, transparent, and practical use.

DATA SHARING

Many agencies recognize the need for long-term data management and access and are already dedicating increased attention and resources to this as well as more consistent use of available tools, workflows, and processes (Office of Science and Technology Policy 2013, Office of Management and Budget 2013, Executive Order 13642). The LCC Network, as a conglomeration of partnerships, is well positioned to both benefit from and contribute to these efforts by raising awareness of the issues and integrating effective solutions at the junction of the research, resource management, and conservation communities. LCCs and CSCs are expected to develop integrated data management networks to facilitate effective and meaningful sharing of data and information. LCC investments from federal DOI partners in these systems are expected to maintain consistency with DOI-wide information standards (e.g., shared data management standards, databases, Geographic Information Systems (GIS) protocols) to enable coordination and information sharing (CSC/LCC 2011).

DEVELOPING BEST PRACTICES

The data management efforts of the LCCs and the Network are informed by fundamental guidance documents (CSC/LCC 2011, Finn et al. 2013). The LCC Data Management Working Group (DMWG) provides a forum for communicating about these topics and is helping to develop and maintain a community of practice among LCC data managers and technical staff. Similarly, the Integrated Data Management Network project worked to establish a common framework for LCC-level informatics described in the Team Report (IDMN Team 2015). However, much work is needed to ensure that best practices are adopted by the LCC Network and that data resources are made available to all who may benefit from them. We envision a well-functioning data management, integration, and sharing process that integrates, at minimum, the products of Network-funded projects with those from individual LCC-funded projects, and that supports the data lifecycle in a coordinated manner (Figure 2). Although some data generated by LCC Network partners are sensitive and not appropriate for distribution (e.g., Traditional Ecological Knowledge; NCCWSC 2014), most data are expected to be widely shared.

DATA MANAGEMENT NEEDS

In this Science Plan theme, we identify the key informatics needs of the LCC Network and the steps to address them. Implementation of data management best practices at the LCC level is the responsibility of the LCCs as self-directed partnerships. Conservation partners and interests at all scales will benefit from appropriate data alignment, integration, and interoperability.



(Left) Data that informs conservation action for Monarch butterflies depends on tagging data from citizen scientists. (Middle) Data points from Monarch Watch. (Right) Planting milkweed for Monarchs. USFWS

Fundamental Question

How can the LCC Network support the management, integration, and delivery of high-integrity science data that are generated through LCC funding or activities, including:

- » How to develop a durable Network-level data infrastructure?
- » How to communicate the need and opportunities for data management to LCC Steering Committees and staff, project principal investigators, and science delivery partners?
- » How to enable and ensure wide adoption across the LCC Network of data management guidance and best practices?

Objectives

The LCC Network should endeavor to meet the following objectives for all data, documents, and software funded by the LCC Network Coordination Office or by LCCs:

- OBJECTIVE 1:** Make data, documents, and software freely available for conservation use or research; when size permits, the data should be available online, with visual presentation when appropriate (e.g., maps for geodata).
- OBJECTIVE 2:** Collect complete, high quality metadata for each dataset from the principal investigators.
- OBJECTIVE 3:** Aggregate searchable metadata for easier discovery at the Network level, linked to the online or offline sources.
- OBJECTIVE 4:** Deliver high-integrity data in useful and documented formats, using standard vocabularies for usability and compatibility.

OBJECTIVE 5: Securely archive data for appropriate periods into the future.

OBJECTIVE 6: Include valuable existing and legacy data in the curation process whenever appropriate.

OBJECTIVE 7: Provide for coordinated development, discovery and use of specialized systems by LCCs and the LCC Network for accomplishing all of the above.

Action Items

This theme touches on all aspects of data science, including data management, data analysis, and data collection design. Therefore, it is appropriate to use a Data Management Lifecycle approach to define actions for LCC Network data management and methods (Figure 2). Initial activities will broadly focus on the data resource itself (maintain, document, quality assurance, archive). Once adequate progress has been achieved across the LCC Network, focus will expand to include analysis tools that use and manipulate

data resources. Lastly, focus will expand again to include data collection design (plan, acquire). The first action is to understand what resources are in place and which are in development. The following action items will be much more efficiently achieved if they build off existing, well-vetted resources that are identified and cataloged during a discovery phase.

ACTION 1: Establish standards for LCC Network funded science projects (i.e., all projects funded by or through the LCCs) that align with best practices employed by LCCs, CSCs, and partners.

ACTION 1A: Initiate an accountability process for LCC Network-funded projects. Draft or adopt standards (including a Data Management Plan requirement) guiding documentation, distribution, and curation of deliverables that are clear and consistent with existing standards (e.g., NCCWSC 2014). Review and evaluate the products of LCC Network-funded projects, see that best practices are followed, including Data Management Plans and distribution of deliverables.



FIGURE 2. The Data Lifecycle (adapted from BLM 2006). All major stages of the lifecycle involve quality assurance and control activities (QA/QC). Data stewardship is usually the responsibility of those who collect the data. Data curation addresses the demands of long-term preservation and access, likely by staff that did not design or collected the data. Metadata are the information accompanying a dataset that document and describe the data so that others can use and interpret the data (definitions adapted from NRC 2007).

- ACTION 1B:** Encourage formal data publication (e.g., [Ecological Archives Data Papers](#), Nature Publishing Group’s Scientific Data; Avian Knowledge Network) of LCC Network-funded science and encourage LCCs and their principal investigators to publish data; ensure unpublished data are appropriately documented and archived.
- ACTION 1C:** Maintain an online repository (e.g., [GitHub](#)) for distributing and maintaining the source code for tools developed by the LCC Network and LCCs.
- ACTION 2:** Communicate the importance and value of these objectives to LCCs.
- ACTION 2A:** Develop and maintain a single online location with standards and best practices documents aligned with the Data Lifecycle (Figure 2).
- ACTION 2B:** Collaborate and coordinate tool development and use, as needed.
- ACTION 3:** Develop or adopt training for all aspects of data management for LCC staff and partners responsible for science delivery and data management.
- ACTION 3A:** Select and promote specific metadata editing tools and associated training courses.
- ACTION 3B:** Maintain training materials aligned with the Data Lifecycle (Figure 2) for data management, including examples and case studies.
- ACTION 4:** Develop a tracking mechanism and performance metrics for use of data assets, modeling tools, etc. specific to the LCC Network.
- ACTION 4A:** Develop project and data tracking database.
- ACTION 4B:** Develop sophisticated analytics schema that estimate impact of LCC Network and LCC science.
- ACTION 5:** Fund or encourage LCCs to fund projects that seek to discover and curate important existing legacy datasets that might otherwise be lost.
- ACTION 6:** Communicate value and implement use:
- ACTION 6A:** Focus on [data.gov](#), [ScienceBase](#), and other established discovery portals, catalogs, or curation sites in accordance with Federal Open Data policies and encourage LCCs to do likewise.
- ACTION 6B:** Define a direct path for the LCC Network to Data.gov (e.g., a stand-alone [CKAN](#) instance).
- ACTION 7:** Conduct a systematic cross-LCC assessment of best practices, data and metadata completeness and quality, storage and distribution capacities and architectures, archiving practices, etc. When found lacking, discover the key sticking points (e.g., do they need more training materials, or do they know how to do it but just need more staff funding) so the LCC Network doesn’t spend money “fixing” the wrong problems.
- ACTION 7A:** Cross-reference results of available needs assessments.
- ACTION 8:** Direct the DMWG to participate in discussions with related working groups in relevant agencies (e.g., USGS Community for Data Integration, USFWS Data Subcommittee).

Deliverables

Action Item	Product	Suggested Lead	Currently Available (A), In Progress (P), or Needed (N)
1A & 1B	Data Management Standard for LCC Network	LCC Science Coordinators & DMWG	N, P
1B	Annotated list of opportunities for data publications	DMWG	N
1C	Identify and maintain an online repository for distributing and maintaining the source code	IDMN / DMWG	P
2A & 2B	Data Management Communication Strategy	Communication Working Group & DMWG representative	N
3A & 3B	Web resources—a hub for training and guidance based on the Data Life Cycle (Fig. 2)	DMWG led crowd-sourcing and partnerships (e.g., IDMN; USGS Center for Data Integration; ServCat)	N
4A	Project and data tracking database	IDMN	P
4B	Analytics schema and web reports	Contractor	N
5	Encourage legacy data archiving	Science Coordinators through funding processes	N
6A	Implement ScienceBase and other established discovery portals for LCC Network	DMWG & IDMN collaboration; individual LCCs	A, P
6B	Pathway to Data.gov	Coordination with data and IT specialists from Federal agencies and bureaus such as DOI, USFWS, USGS, BLM, Bureau of Reclamation, USDA, and/or NOAA	N
7	Systematic cross-LCC assessment of best practices, data and metadata completeness and quality, distribution architectures, archiving practices	Research	N
8	Community of Practice	DMWG	P
9	Prioritize data management tasks	USFWS Science Applications Staff, LCC Coordinators, Science Coordinators	N

Project Timeline

- » Items 1c, 4a: Completed within 6 months of Science Plan approval
- » Items 1a, 1b, 6a: Completed within 1 calendar year of Science Plan approval
- » Items 2a, 2b, 3a, 3b, 4a, 6b, 7, 7a: Completed within 2 calendar years of Science Plan approval
- » Items 5, 8, 9: Ongoing



Theme 5

Socioeconomic and Cultural Values

Young angler at the Upper Mississippi River National Wildlife Refuge. BOB DRIESLEIN/USFWS

ASPIRATIONAL STATEMENT

Landscape conservation efforts that incorporate socioeconomic and cultural values will more effectively engage people and are more likely to result in support for a network of ecologically connected and functional landscapes and seascapes.

Supporting the LCC Network Strategic Plan

Goal 3. Science

Objective 2

Promote collaborative production of science and research, including human dimensions, as well as the use of experience and indigenous and traditional ecological knowledge among LCCs, Climate Science Centers, and other interested parties. Use these to inform resource management decisions, educate local communities, and address shared needs.

Scope of Issue

The LCC Network Vision explicitly identifies cultural resources as a critical element of future conservation landscapes. The [LCC Network Mission statement](#) guides LCCs to collectively “develop and provide science-based information for the sustainability of natural and cultural resources.” Further, [Secretarial Order 3289](#) that established the network of LCCs implies that partner-driven, broad-scale conservation action is critical to maintaining functioning economies (energy production and delivery, inland and coastline water management, etc.) as well as ecosystems. This guidance clearly defines economic and cultural considerations as important elements of a holistic Science Plan.

CONNECTING NATURAL, CULTURAL, AND ECONOMIC VALUES

Understanding the connections between natural, cultural, and economic values is particularly important since the vast majority of many landscapes are dedicated to deriving benefits for society or ecosystem services (National Millennium Ecosystem Assessment 2005). These include goods and services with direct economic links like food, fuel and fiber; socio-cultural values like aesthetics, human health, and recreation; and cultural identity, gained through the preservation of cultural sites and the historical record. They



Local tribes gather at Grand Canyon National Park to discuss importance of the area's natural and cultural resources. Arizona Congressman Raul Grijalva seated, center. ERIN WHITTAKER/NPS

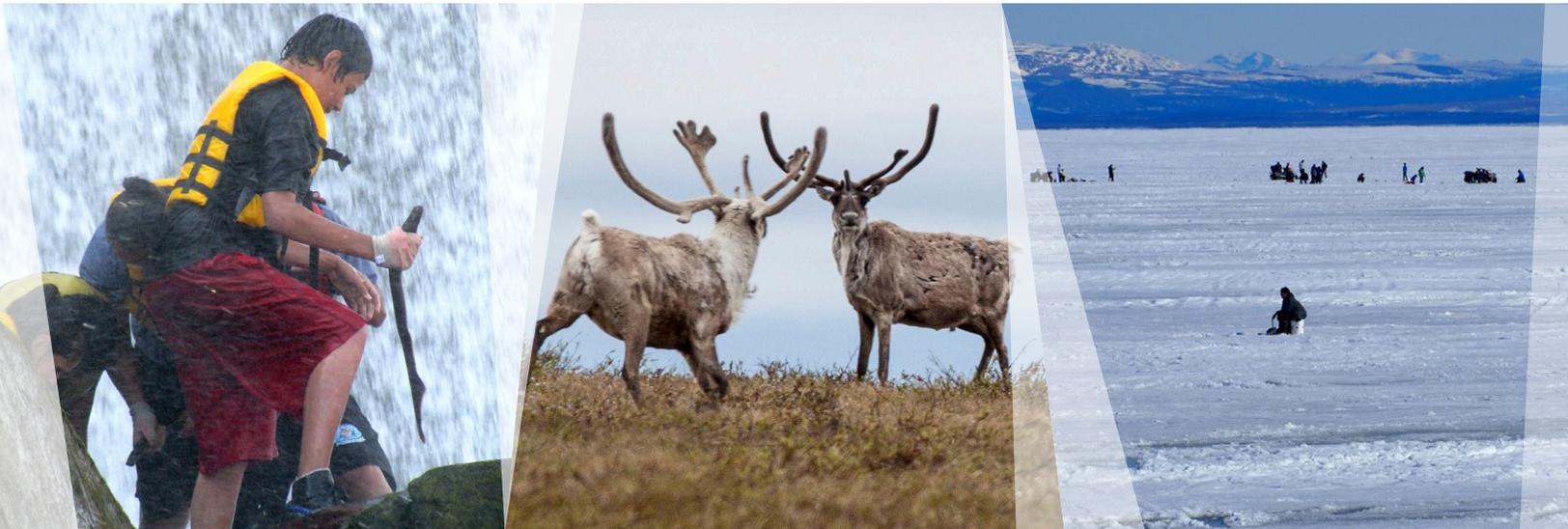
also include ecosystem functions that result in clean water, carbon storage, soil stability, etc. The provisioning of these goods and services while simultaneously promoting other ecological values is increasingly being pursued by both the public and private sectors and there is a need for coordination and better science to support these efforts. For example, conservation action on the ground is often driven primarily by economic decisions, especially for private landowners and managers. Unfortunately many of the industries dependent on natural resources (timber, ranching, fisheries, recreation, mining, agriculture, etc.) are underrepresented in LCC Network efforts. For LCC efforts to be truly reflective of multiple stakeholders and to promote the societal value of functional landscapes, the LCC Network must find better ways to incorporate broad economic, social, and cultural perspectives into our planning and design efforts.

NEED FOR A COMMON FRAMEWORK

Because ecosystem goods and services differ across LCC geographies, we need a common framework for describing and spatially inventorying them (e.g., the [Natural Capital Project](#)) and for exploring strategies to highlight their value to promote conservation. Looking across the international landscape, LCCs should be cognizant of the diverse activities and objectives that affect important landscape-level natural and cultural resource conservation efforts. The diverse state, provincial, regional, tribal, and national institutions that oversee defense, energy, water delivery, historic preservation, outdoor recreation, and transportation regularly make decisions about land use based on the benefits it offers to society. The LCC Network would benefit by effectively partnering with these institutions to integrate conservation of LCC conservation targets with their efforts. For example, a multi-LCC project focused on Gulf of Mexico hypoxia aims to make explicit links to improved water quality and increased agricultural productivity generated by fish and wildlife habitat conservation actions.

CULTURAL VALUES

Preservation and persistence of our diverse heritage and culture is an important element of conservation. Many tribal governments and indigenous organizations understand the need to adapt as they are already experiencing the impacts of climate change on species, habitats, and ecosystems that are vital to their cultures and economies (*National Fish, Wildlife and Plants Climate Adaptation Strategy* 2012, Maldonado et al. 2013). For example, consideration of how historic landscapes and sites support cultural identity, which in turn promotes community resilience, has direct implications for conservation. Individual LCCs have taken a variety of approaches toward incorporating socioeconomic and cultural values into their science and planning efforts. Many LCCs have already engaged with tribal and community stakeholders to better understand the role of landscapes and how they are valued by communities. Some specific efforts have also been made to draw upon Traditional Ecological Knowledge (TEK), which is sometimes referred to as Traditional



Tribal youth gathering Pacific lamprey at Willamette Falls in Oregon. MEGHAN KEARNEY/USFWS

Caribou, an important resource for subsistence economies. BOB WICK/BLM

Subsistence fishing in the Arctic. WESTERN ARCTIC NATIONAL PARKLANDS

and Local Knowledge, to better approach science questions and prioritize investments. Still other LCCs have made a more explicit focus on cultural sites and historically significant landscapes in their science and planning investments. The range of approaches to addressing cultural resources and values within the Network can be further leveraged and expanded to complement the LCC Network's other conservation efforts. However, in order for this to be done effectively, there is a need for improving the consistency in language and methods used, as well the expertise of individuals and entities involved.

SOCIAL VALUES

As LCCs make strides to promote landscape-scale conservation we must recognize that investments in integrating societal values (cultural, social, and economic) associated with landscapes promote the overall relevance of the LCC Network. Investments in understanding and incorporating ecosystem services and cultural values are also a benefit as they bring in a wider array of researchers and stakeholders. Key to such collaboration is establishing consistent approaches to how data describing ecosystem services and cultural values are collected and integrated into LCC endeavors. The need for consistent approaches and data integration exists across many areas of the Network's activity from identifying conservation priorities and conducting vulnerability assessments, to landscape conservation design and monitoring progress on conservation delivery. Similarly, investments in social science that help LCCs learn the most effective ways to bring stakeholders into our landscape conservation efforts are also needed.



First Nations Blessing of
Baynes Sound, Vancouver,
British Columbia. VIU
DEEP BAY

KEY CONSIDERATIONS

- » The LCC Network needs a common vocabulary for describing socioeconomic and cultural services/needs as well as compatible methodologies for collecting and synthesizing the value of these services/needs to inform planning and design work.
- » For socioeconomic and cultural perspectives to be included in landscape-level assessments and analyses, it will be vital that these data are collected and analyzed with a spatial component.
- » It is important to recognize the proprietary rights of TEK to indigenous peoples as a special consideration when incorporating local knowledge or community input.
- » Individual LCCs and the LCC Network must recognize that there is a need to synthesize and fill gaps in understanding how people value landscapes and that our current efforts can be improved.
- » LCC Network efforts must strive to understand and subsequently integrate the economic drivers behind land and resource use decisions—from private land managers to businesses concerned about their level of corporate social responsibility.

UNDERSTANDING ORGANIZATIONAL BARRIERS

Finally, international, national, and regional policies on major ecological and cultural issues are a significant influence and major consideration in all aspects of the LCC Network's operations. The ways in which individual agencies and organizations create rules and guidelines, identify priorities, and conduct business are a reflection of their own innate organizational cultures. Parallel, yet vital to the success of our efforts to understand societal and cultural values for landscapes, is the need for focused reflection and evaluation of institutional, policy, and financial barriers that inhibit increased collaboration among partners. Given that LCCs are designed to work as cooperatives composed of multiple agencies, tribes, and organizations that serve an array of stakeholders, understanding organizational barriers is also key information needed for institutional development of the LCCs.

Fundamental Question

How can LCCs incorporate socioeconomic and cultural values to ensure that landscape conservation planning, design, and outcome-based monitoring efforts reflect the broader context of societal demands on landscapes now and into the future?

Objectives

- OBJECTIVE 1:** Help the LCC Network understand how society values functional landscapes (e.g., sense of place) and understand what motivates society and decision-makers to take action toward or away from sustainable natural and cultural resource management.
- OBJECTIVE 2:** Increase understanding of social, economic, and cultural values and how they affect and can be incorporated into LCC landscape-scale efforts.
- OBJECTIVE 3:** Establish clear definitions and common approaches among the LCCs that promote the integration of social, economic, and cultural values into LCC efforts.
- OBJECTIVE 4:** Help the LCC Network understand the cultural, policy, or financial impediments that result in institutional barriers that negatively affect our ability to collaborate on conservation outcomes.
- OBJECTIVE 5:** Encourage inclusion of industries dependent on natural resources in collaborative conservation planning efforts.

Action Items

- ACTION 1:** Develop workshops specifically for the LCC community to learn about ways to collect and quantify socioeconomic and cultural values at the landscape level (e.g., ecosystem services and sense of place mapping) and how to incorporate these values into LCC efforts, including approaches to stakeholder and partner engagement. (Objectives 1, 2 and 4)
- ACTION 2:** Synthesize research and information about how people value landscapes, including TEK and local knowledge (when voluntarily offered by knowledge holders) and share it with LCC staff and Steering Committees so they can better incorporate that information into conservation planning and design efforts to make those efforts more comprehensive and more broadly supported by land use decision-makers and other stakeholders that influence the success of landscape-scale conservation. (Objectives 2 and 4)
- ACTION 3:** Synthesize existing efforts to integrate and scale up elements of key ecosystem services and cultural values into landscape scale conservation planning and design. (Objectives 2 and 4)
- ACTION 4:** Research public-private partnerships that have resulted in the successful incorporation of industry and other resource-dependent sectors into collaborative conservation planning efforts, including a targeted effort to solicit interest in LCC Network planning efforts. (Objective 3)
- ACTION 5:** Undertake a synthesis of literature and conduct an organizational assessment to evaluate internal impediments to collaboration among LCC partners resulting from organizational culture, policy mandates, as well as staff and financial constraints. (Objective 4)

ACTION 6: Encourage inclusion of individuals with economic, social, and cultural expertise and perspectives to share information and participate in the LCC Network to improve and broaden our conservation efforts through formal engagement on science teams or working groups composed of anthropologists, social scientists, or economists at all levels within the LCC Network. (Objective 5)

Deliverables

DELIVERABLE 1: A training/workshop(s) drawing on case studies from current efforts of other entities delivered specifically to the LCC community (LCC staff and key participants) on techniques for incorporating socioeconomic and cultural values into LCC efforts. (Actions 1-2)

DELIVERABLE 2: Common frameworks, tools, and techniques that have been successfully piloted by LCCs or other landscape-scale conservation partnerships for describing and incorporating the values of socioeconomic and cultural services into LCC efforts. (Actions 2-4)

DELIVERABLE 3: A report and/or workshop sharing best practices of landscape planning and design efforts that integrate ecosystem services and cultural values. (Actions 3-4)

DELIVERABLE 4: A pilot project demonstrating that ecosystem services and cultural values can be integrated into individual LCC and/or LCC Network-wide conservation planning and design efforts. (Actions 3-4)

DELIVERABLE 5: A report and/or workshop focused on the LCCs to share case studies of public-private partnerships with industry and other partners that promote collaborative conservation at landscape scales. (Action 5)

DELIVERABLE 6: A report synthesizing the institutional/organizational barriers germane to LCCs that negatively impact effective and efficient collaborative conservation efforts at landscape scales and an LCC Network workshop and/or invited panel aimed at developing techniques/practices for overcoming those barriers. (Action 5)

DELIVERABLE 7: Improved participation in LCC community by individuals and organizations with economic, social, and cultural expertise and perspectives. (Action 6)

Project Timeline

YEAR 1

- » Conduct an internal inventory of current and prior LCC efforts working on incorporating socioeconomic and cultural values (< 6 months)
- » Develop and deliver a training workshop specifically for LCC community (1 year)
- » Launch an effort to evaluate institutional barriers for efficient collaboration within LCC community (< 2 years)
- » Launch/leverage one or more pilot efforts within LCCs that explore methods for incorporating socioeconomic and cultural values (< 2 years)
- » Launch/leverage an effort to synthesize LCC Network perspectives on how landscapes are valued in socioeconomic and cultural terms and explore societal motivations for landscape-level conservation (< 2 years)

YEAR 2

- » Launch/leverage at least one pilot effort to quantify 2-3 ecosystem services or cultural values at the LCC Network scale (1 year)
- » Launch/leverage an effort to identify key ecosystem services and cultural values most closely linked to landscape function for a majority of LCCs (1 year)

YEAR 3

- » Host an LCC-sponsored summit built around the results of work conducted in Years 1 and 2 and to revisit science priorities under this theme



Theme 6

Science Communication and Delivery

Explaining the acquisition and co-operative management practices among partners at Sandstone Ranch in Alberta, Canada. IAN DYSON

ASPIRATIONAL STATEMENT

The expertise, innovation and successes of those who communicate LCC science become critical assets in the LCC Network's transformation of the practice of large-scale conservation.

Supporting the LCC Network Strategic Plan

Goal 4. Communications

Objective 1

Communicate the existence and application of LCC Network science, products, and tools to partners and stakeholders in a form that is understandable, publicly accessible, engaging, and relates to what matters to end users and society.

Scope of Issue

The ability to effectively communicate scientific information is critical to achieving the conservation mission of the LCCs. Science communication occurs within each LCC as it collaboratively develops and shares new tools, techniques, ideas, and data with conservation partners and regional science providers, and in turn communication from partners provides the LCC with conservation results and science needs that guide research and development of decision support options. This within-LCC communication must target a variety of audiences, and use appropriate channels and formats to ensure uptake and action. Translation of science to inform decision-makers and resource managers is key to overcoming barriers to action. In many geographies, private landowners and other non-technical conservation actors are important audiences.

COMMUNICATION NETWORKS

At the inter-LCC level, science communication is needed to support collaborative efforts, develop and share best practices, and coordinate efforts at larger landscape scales, thus fostering partners' experience of the LCC Network as seamlessly delivering relevant and complementary information. The Network has developed a number of multi-LCC and LCC Network-wide peer-to-peer networks that are continuously evolving to improve coordination and communication of activities. Such networks provide venues for developing and sharing best practices in science communication and delivery, and are active at multi-LCC and LCC Network-wide scales. Examples include monthly coordination meetings among the communities-of-practice of the LCC Coordinators, Science Coordinators, Data Managers, and Communications Specialists.

COMMUNICATING SCIENCE TO INFORM MANAGEMENT

The objectives and actions outlined below seek to improve the ability of the LCCs to successfully communicate scientific information to inform management activities and achieve conservation success by increasing the skills, capacity, and tools to deliver this information within individual LCCs. We anticipate that successful messages developed at the intra- and inter-LCC levels will also be useful in Network-level communications. Actions that must be taken at the Network level to communicate the activities, achievements, and value of the LCC enterprise are the purview of the LCC Network Communications Team and will be detailed in a separate national communications plan.

Communicating scientific information to inform management activities is an essential component of successful science delivery. The wide recognition of this is illustrated by the fact that approximately half of the LCCs have communications specialists on staff or as long-term contractors. This provides a substantial resource of expertise for the Network, but also shows a disparity in communications capacity—and likely effectiveness—between individual LCCs. This Theme describes steps to be taken in order to maximize the practice and application of science communications within the LCC Network in the short term using existing communications capacity. Future resources may allow more (or all) LCCs to support dedicated communications staff or contractors; future iterations of the Science Plan will be modified to reflect LCC Network capacity as it evolves.

APPROACH

Two linked efforts would build on the current level of communications capacity within the LCC Network. The first is focused on using the existing LCC communications professionals to assemble, evaluate, and disseminate effective communications approaches. The second is aimed at assisting key LCC staff, including those without dedicated communications capacity, in improving science communications and delivery.



Conservation must keep pace with changing communication technologies like social media. DJ CASE & ASSOCIATES

SCIENCE DELIVERY EFFORTS

Currently, a Science Delivery Working Group within the LCC Network Communications Team is focused on improving all phases of science delivery. The Science Delivery Working Group is identifying ways to enhance the transfer of best practices and new approaches among all LCCs, and will help guide both the assessment and product development phases of science delivery.

CHALLENGES AND OPPORTUNITIES

The communications arena is evolving rapidly, with new methods (e.g., human and social dimensions of conservation, participatory approaches), channels (e.g., new and social media), technologies (e.g., cloud-based data viewers), and analysis tools (e.g., social network analysis and website analysis) arising, sometimes with more familiar modalities being left behind. Knowing the key audiences, the most effective channels to reach them, and the most relevant narratives to inform decision-makers requires expertise, time, and human capacity. It is clear that the LCCs must fully engage with the challenge of science communication to effectively deliver conservation science now and into the future.

Training in communications could provide LCC Coordinators and Science Coordinators with the tools needed to work more effectively with their communications staff (if present), and to guide contractors and grantees in improving the science delivery components of funded projects. Ultimately science translation will need to be built into the LCCs' science development and delivery efforts from the beginning. To achieve this, resources of partners and research teams will need to be harnessed, critical barriers and communication gaps understood by LCC staff, and effective solutions developed and shared.

Fundamental Question

How can LCCs effectively target science communications to deliver the information necessary to stimulate action across partners and the LCC Network, and increase the conservation impact of the LCCs?

Objectives

OBJECTIVE 1: Information gaps and barriers that prevent the effective use of conservation science by resource managers and decision-makers will be targeted, identified, and addressed by specific investments on the part of the LCC Network and individual LCCs. LCC staff, especially the communications specialists, and when absent the Science Coordinators, will have the tools and skills to identify, develop, and manage effective communications that are focused on key audience identification, translation, and science delivery.



The North Pacific Steering Committee discusses top priorities for climate change science within their organizations. JOHN MANKOWSKI/NPLCC

OBJECTIVE 2: Science products of LCCs will be supported with effective communications to enhance their use by, and utility to, resource managers and decision-makers.

Action Items

ACTION 1: The Science Delivery Working Group will complete an initial review of current science delivery approaches (gap identification and delivery techniques) by the LCC Network as well as current best practices in this field based on literature, techniques, tools, and leading institutions. (Objective 1)

ACTION 2: Through consultation with leading experts and the LCC community, the Science Delivery Working Group will identify and implement an assessment process that will draw on methods of relevant social science disciplines and information technology to identify improvements that can be made in science delivery efforts of the LCCs. (Objective 1)

ACTION 3: Based on the results of Actions 1 and 2 above (Objective 2):

ACTION 3A: Develop focused training for communication specialists, Science Coordinators, and other LCC staff and partners to increase their ability to guide science translation and delivery to key audiences. Possible topics include: how to identify and understand audiences, how to tailor information that is appropriate for various audiences, what makes a good communication strategy, how to take advantage of various tools and technologies, how to assess if communication is effective, and how to tell better stories.

ACTION 3B: Develop and circulate communication templates for various product types. Templates will be based on successful LCC science communications and best practices compiled from multiple LCC and partner communications efforts to date. Templates will also include new, innovative, and creative methods for approaching science communication to better reach and inform diverse audiences.

ACTION 3C: Develop guidelines to ensure that the process of producing science products includes articulation and execution of effective communication efforts to reach target audiences, frame key messages, and effectively solicit input of end users throughout the product development process.

ACTION 4: Based on the assessment and products from Actions 1-3 above, disseminate tools and techniques to objectively identify and address communication gaps and barriers that inhibit science delivery within the LCCs and other conservation partnerships. (Objective 1)

ACTION 5: Support social science research projects to identify and address science communication gaps and barriers specific to the work of the LCCs during the course of completing items Actions 1-4. (Objective 1)



Talking to local partners about planting pollinator gardens in Asheville, NC.
GARY PEEPLES/USFWS

Deliverables

DELIVERABLE 1: An analysis of appropriate techniques and tools for use in identifying barriers and gaps to effective science delivery. (Action 1)

DELIVERABLE 2: A description of an assessment process to identify improvements that can be made in science delivery efforts. (Action 2)

DELIVERABLE 3: A new or existing science communications training course and associated curriculum materials. (Action 3)

DELIVERABLE 4: Communication plan templates for various types of science products. (Action 3)

DELIVERABLE 5: Guidelines for developing science communication strategies as integral components of science product development. (Action 3)

DELIVERABLE 6: Research results that inform the field of science delivery by conservation partnerships. (Actions 4-5)

Project Timeline

YEAR 1

- » Science Delivery Working Group completes their initial assessment with recommendations for a science delivery assessment (Deliverables 1-2)
- » An assessment process is launched for a subset of the LCCs (Deliverable 2)

YEAR 2

- » Completion of the science delivery assessment (Deliverable 2)
- » Develop and hold pilot course on science communications for Science Coordinators and other LCC staff (Deliverable 3)
- » Finish development of communications strategy guidelines that enhance the effectiveness of science delivery (Deliverables 4-5)



Theme 7

Monitoring and Assessment

Tennessee Wildlife Resources Agency biologists David Sims and Will Painter (intern) conducting a mussel inventory on the East Fork of the Stones River. Inventories can be used to assess both the status of wildlife populations as well as the effectiveness of conservation delivery in achieving goals for priority conservation targets. PANDY ENGLISH/TWRA

ASPIRATIONAL STATEMENT

Monitoring and assessment activities are essential for designing and maintaining a network of ecologically connected and functional landscapes and seascapes, both in order to inform the landscape conservation planning and design efforts that guide the actions taken toward this Vision and for evaluating progress.

Scope of Issue

Achieving the LCC Network Vision of sustaining natural and cultural resources for current and future generations requires informing decisions about future resource use. This requires attention to improving the collection and delivery of two distinct types of monitoring and assessment information.

MONITORING LCC NETWORK EFFORTS

First, the LCC Network must *monitor the effects* of its individual and collective efforts regarding the conservation of shared conservation targets and the development of an ecologically connected network in order both to evaluate progress and performance (outputs, outcomes, and impacts *sensu* Koopman et al. 2013) and to improve future landscape and seascape conservation planning, design, and delivery (Figure 1). While this includes evaluating performance on each of the proposed actions in all themes of the Science Plan, a primary focus is monitoring impacts of LCC Network-guided conservation delivery on the priority conservation targets (both social and ecological) identified by the actions under Theme 1.

Supporting the LCC Network Strategic Plan

Goal 2. Collaborative Conservation

Objective 3

Demonstrate, monitor, and evaluate the value and effectiveness of the LCC Network.

MONITORING STATUS AND TRENDS OF CONSERVATION TARGETS

Second, landscape conservation planning, design, and delivery activities require access to historic and current landscape-scale (or larger) monitoring-derived information on *status and trends and/or thresholds* for the identified conservation targets and associated drivers of change. Such monitoring is a main source of information for landscape conservation design and includes monitoring to better characterize sources of system variation and their magnitudes so as to reduce uncertainty in planning. Here we primarily focus on monitoring to inform selection of LCC Network-level conservation targets and their objectives (Theme 1) and design activities (Theme 2).

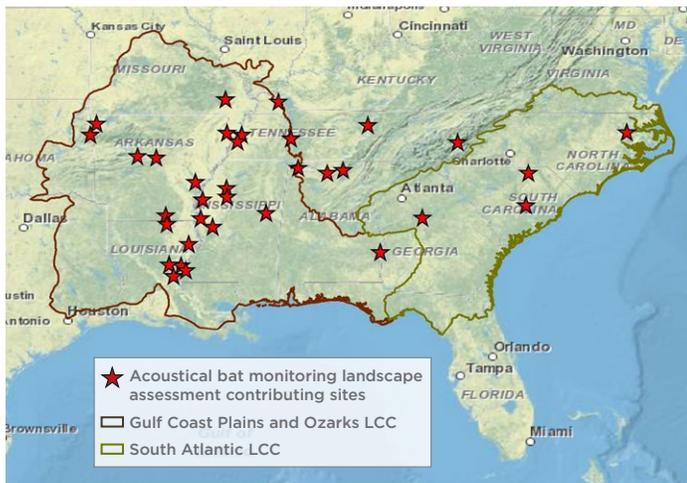
The need for both types of monitoring arises at the regional, individual LCC, multi-LCC, and Network scales.

LCC NETWORK ROLE

The LCC Network's efforts in providing cohesive conservation planning and design at broader scales (e.g., LCC, multi-LCC, LCC Network-wide) requires equal attention and effort to the monitoring activities necessary both to inform and to assess those conservation planning, design, and delivery activities. For example, a critical step in identifying conservation targets of shared interest, as well as measurable objectives and limiting factors for those conservation targets, are considerations of feasibility, strategies, and costs for the associated monitoring, including monitoring design, implementation, data management, and reporting.

BUILDING ON PARTNER EFFORTS

The LCC Network has an opportunity to help inform, promote, design, and implement monitoring to address these needs at each relevant scale, especially through collaborations with partners. In doing so the LCC Network will incorporate and collaboratively build from the guidance, best practices, protocols, templates, and other products already developed by the relevant landscape or larger scale monitoring programs of our partners, including BLM's Assessment, Inventory, and Monitoring Strategy; Environmental Protection Agency's National Aquatic Resources Survey; USFWS' National Wildlife Refuge System Inventory and Monitoring Program; USFS' Forest Inventory and Assessment program, National



With initial logistical support from the GCPO LCC, the USFWS Inventory & Monitoring Network is coordinating acoustical surveys of bats across National Wildlife Refuges in the Southeast as part of a larger effort to monitor trends in abundance and distribution of bats.

Forest Health Monitoring program, and Inventory, Monitoring, and Assessment Strategy; USGS's National Water Quality Assessment; NPS' Vital Signs monitoring program; Natural Resources Conservation Service's monitoring programs; and the efforts of our State partners. The LCC Network will also incorporate and collaboratively build from the effectiveness monitoring efforts for conservation delivery efforts (AFWA 2011, Conservation Measurement Partnership 2013) and for monitoring in the context of adaptive management (Williams et al. 2009; Williams et al. 2012), where appropriate.



Five Midwest/Southern LCCs with federal and nonprofit partners have developed a standardized range-wide monitoring protocol for the federally endangered Interior Least Tern, one of three requirements for delisting. Developing and testing the protocol also developed a network of partner organizations potentially able to monitor specific colony sites. JANE LEDWIN/USFWS

OPPORTUNITIES

LCCs should especially focus on opportunities to work with partners to advance comparability of monitoring data on conservation targets and limiting factors to support synthesis and integration at landscape and larger scales through promotion of minimum standards for data collection and data management, common protocols, data sharing and access (see Theme 4), etc. Similar attention should be given to opportunities to promote compatibility of survey methods, work flow tools (design, analysis, data management, reporting) across monitoring efforts. Such actions will improve scalability of monitoring information.

Fundamental Question

How can the LCC Network inform, design, promote, and implement the monitoring necessary to guide and to evaluate the Network's efforts in providing cohesive landscape and seascape conservation planning, design and delivery at broader scales (e.g., LCC, multi-LCC, LCC Network-wide)?

Objectives

- OBJECTIVE 1:** Ensure that the selection of LCC Network-level conservation targets (and their goals and objectives) incorporates consideration of the availability, or feasibility, of meeting each target's associated information needs.
- OBJECTIVE 2:** Ensure that the information needs associated with the monitoring and assessment of LCC Network-level conservation targets is met.
- OBJECTIVE 3:** Ensure regular assessment of effectiveness of actions directed at achieving LCC Network Vision.

Action Items

- ACTION 1:** Compile and provide guidance to LCCs on setting feasible monitoring objectives, including necessary precision, intended types of changes of interest, and intended analyses for assessing change. Ensure these are included among the criteria for selecting the LCC Network-scale conservation targets (Theme 1, Objective 2, Action 2). (Objective 1)
- ACTION 2:** In conjunction with Theme 1, Objective 1, Action 2, develop inventory of existing landscape, regional, national, or LCC Network-scale monitoring programs of relevance to the LCC Network priority conservation targets and their limiting factors. Inventory will include summary of program objectives, spatial domain, temporal revisitation frequency, types of attributes measured, data sharing and access, and points of contact. (Objective 1)

- ACTION 3:** For partner monitoring programs preliminarily identified as potential information sources for each conservation target (and goals and objectives), assess the adequacy of the existing monitoring information, precision, spatial and temporal resolution, etc., to ensure it meets the information needs associated with that conservation target. (Objective 1)
- ACTION 4:** Identify gaps in existing sources of monitoring information for informing selection of conservation targets (and later, assessment of effectiveness of conservation delivery). (Objective 1)
- ACTION 5:** Identify information needs that are not currently met by existing partner monitoring programs but where the necessary data exists and is being collected. Identify and resolve barriers to achieving the necessary data integration, synthesis, and reporting at landscape or larger spatial scales. (Objective 2)
- ACTION 6:** Develop guidance for assisting LCCs in partnering with industry to address information needs not currently met by existing partner monitoring programs. (Objective 2)
- ACTION 7:** Identify opportunities to advance comparability of monitoring data from multiple partners at landscape or larger scales and develop and implement strategies to achieve that. For example, agreement on minimum data collection standards and minimum data management standards, promotion of common protocols and templates, etc. (Objective 2)
- ACTION 8:** Identify opportunities to help partner monitoring programs that inform conservation targets improve their efficiency through development of a checklist for assessing monitoring program elements, improved data collection methods and metrics, streamlined workflow processes, etc. (Objective 2)
- ACTION 9:** Apply the Open Standards for Conservation framework (Conservation Measurement Partnership 2013) to develop processes for compiling and assessing progress towards achieving the LCC Network Vision. (Objective 3)
- ACTION 10:** Identify information needs (precision, frequency, spatial resolution, etc.) required by key funders and stakeholders in the LCC Network in order to assure adequate progress is being made toward the Network Vision. (Objective 3)
- ACTION 11:** Identify those conservation delivery actions whose underlying guidance meets the formal technical requirements for adaptive management (Williams et al. 2009); identify resources required to implement formal adaptive management. (Objective 3)
- ACTION 12:** Determine the baseline status (circa 2020) of the LCC Network in achieving the LCC Network Vision. (Objective 3)

Deliverables

- DELIVERABLE 1:** White paper synthesizing guidance on setting monitoring objectives in context of setting landscape scale, regional, LCC, multi-LCC or LCC Network-scale monitoring objectives. (Action 1)
- DELIVERABLE 2:** Inventory of existing partner monitoring programs (e.g., online interface to updateable geospatial database). (Action 2)
- DELIVERABLE 3:** Summary identifying potential information sources for each LCC Network-scale conservation target and unfulfilled gaps. (Actions 3-4)
- DELIVERABLE 4:** White paper summarizing prioritized actions for addressing information gaps of LCC Network-scale conservation targets through existing partner monitoring programs and associated strategic initiatives to promote and implement the actions. (Actions 5-6)
- DELIVERABLE 5:** White paper on successful partnering with industry regarding data sharing. (Action 6)
- DELIVERABLE 6:** White paper strategy document summarizing successful strategies in advancing comparability of monitoring data based on LCC-driven or other examples. Accompanying peer-reviewed publication. (Actions 7-8)
- DELIVERABLE 7:** White paper on application of the Open Standards for Conservation to monitoring progress toward the LCC Network Vision, including details on the indicators and metrics chosen. (Action 9)
- DELIVERABLE 8:** White paper identifying necessary data processing and information production steps required to evaluate progress and strategies for automating, as much possible, these steps to streamline LCC Network-scale reporting. (Actions 9-10)
- DELIVERABLE 9:** A joint initiative with the Climate Science Centers targeting formal implementation of formal adaptive management of conservation delivery. (Action 11)
- DELIVERABLE 10:** White paper reporting current (circa 2020) baseline status with respect to achieving the LCC Network Vision. (Action 11)

Project Timeline

- » Action 1: Months 1-3
- » Action 2: 5 months after draft list from Theme 1, Objective 2, Action 2 available
- » Actions 3-5: 9 months after Action 2 ends.
- » Action 6: Months 1-3
- » Action 7: ongoing following Actions 3 and 4
- » Action 8: Months 13-16
- » Action 9: 12 months following completion of Theme 1, Objective 3, Action 1
- » Action 10: 6 months following completion of Action 9

Appendix A: Glossary

CLIMATE ADAPTATION—Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities ([IPCC WGII 2007](#)). A category of activities to help species, systems, and communities respond to climate change.

CLIMATE SCIENCE CENTER (CSC)—DOI entities managed by the U.S. Geological Survey and hosted by consortiums of universities that provide scientific information, tools, and techniques that land, water, wildlife, and cultural resource managers and other interested parties can use to anticipate, monitor, and adapt to climate change impacts ([About the Climate Science Centers](#)).

CONSERVATION DELIVERY—Implementation of actions, decisions, and on-the-ground activities undertaken for the conservation of natural or cultural resources.

CONSERVATION DESIGN (AS COMPONENT OF SHC)—Applying models to spatial data that culminates in the designation of priority management areas and coarse estimates of the amount of habitat that will be needed to attain a suite of population objectives. ([USFWS 2008](#)). [Conservation design](#) involves combining geospatial data with biological information and models to create tools such as maps that evaluate the potential of every acre of habitat to support a species' population. Using these tools, we can determine what the current habitat-acre capability is—and what it needs to be—to achieve our specific biological objectives or outcomes. We can then make decisions collaboratively about the kind, quantity, and configuration of habitat needed, and what activities to undertake and where.

CONSERVATION GOAL—A description of shared broad-scale desired and/or negative states or conditions of a landscape that span political, jurisdictional, and ecological boundaries ([Landscape America—Identify Conservation Goals and Objectives](#); [LCC Network Strategic Plan 2014](#)).

CONSERVATION OBJECTIVE—A specific description of a measurable outcome pursued in support of a conservation goal. All conservation objectives should ideally be SMART (specific, measurable, attainable, relevant, and time-bound).

CONSERVATION PRIORITY—Knowledge, actions, or activities needed to address goals and objectives for conservation targets (modified from [USFWS Science Investment and Accountability Schedule—SIAS](#)).

CONSERVATION TARGET—The biological, ecological, cultural, and/or physical entities or processes that a project is trying to conserve (Modified from [Salafsky et al. 2008](#)).

CORPORATE SOCIAL RESPONSIBILITY—A company's sense of responsibility towards the community and environment (both ecological and social) in which it operates. Companies express this citizenship (1) through their waste and pollution reduction processes, (2) by contributing educational and social programs, and (3) by earning adequate returns on the employed resources ([Business Dictionary](#)).

CULTURAL LANDSCAPE—*A geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with an historic event, activity, or person, or exhibiting other cultural or aesthetic values* ([NPS, 2012a](#)). Cultural landscapes are also defined as “*cultural properties [that] represent the combined works of nature and of man*” ([UNESCO, 2012](#)).

CULTURAL RESOURCES—The tangible items of historic or cultural significance, including cultural landscapes, buildings, structures, and objects, but also the intangible items, such as traditional knowledge, practices, and life-ways ([NPS 2012b](#)).

DATA—Textual information, numeric information, instrumental readouts, equations, statistics, images (whether fixed or moving), diagrams, and audio recordings. Includes data that are raw, processed, derived, published, or archived, and includes physical samples. Data may be generated by experiments, models and simulations, or observations of natural phenomena at specific times and locations (National Academies Press 2009). Data also includes any custom code or applications that were developed to aid in data analysis or transformation. Code and applications must include adequate documentation and/or within-code comments to understand its function.

DATA MANAGEMENT—Development and execution of architectures, policies, practices, and procedures that properly manage the full data lifecycle needs of an enterprise including access to partners in the scales and formats they need ([Data Management Association](#)).

DATA SCIENCE—Study of the generalizable extraction of knowledge from data. Incorporates varying elements and builds on techniques and theories from many fields, including signal processing, mathematics, probability models, machine learning, statistical learning, computer programming, data engineering, pattern recognition and learning, visualization, uncertainty modeling, data warehousing, and high performance computing with the goal of extracting meaning from data and creating data products.

ECOSYSTEM SERVICES—Benefits people obtain from ecosystems, including *provisioning services* such as food and water; *regulating services* such as flood and disease control; *cultural services* such as spiritual, recreational, and cultural benefits; and *supporting services* such as nutrient cycling that maintains the conditions for life on Earth ([Millennium Ecosystem Assessment](#)).

ECOSYSTEM INTEGRITY—A measure of how characteristic a site is for its natural region, including the composition and abundance of native species and biological communities, rates of change and supporting processes ([Panel on the Ecological Integrity of Canada's National Parks](#)).

FUNCTIONAL LANDSCAPES—Landscapes and seascapes that are resilient or adaptable to system-level changes (such as climate change) and that contain lands and waters with the abiotic, biotic, and ecological conditions required to support priority natural and cultural resources at desired levels (such as self-sustaining populations of plants, fish, and wildlife) while also providing human societal needs such as ecosystem services, food, fiber, water, energy, and living space.

GEODIVERSITY—The variability of Earth's surface materials, landforms, and physical processes. Examples include materials such as rocks, soils, and water; landforms such as mountains, glaciers, and lakes; and processes such as soil formation, coastal erosion, and sediment transport ([Hjort et al 2015](#)).

HUMAN DIMENSION OF NATURAL RESOURCES MANAGEMENT—The social attitudes, processes, and behaviors related to how we maintain, protect, enhance, and use our natural resources.

JOINT IMPLEMENTATION WORKING GROUP (JIWG)—Is composed of Federal, State, and Tribal agencies and is currently leading implementation of the [National Fish, Wildlife, and Plants Climate Adaptation Strategy](#). The purpose of the JIWG is to help facilitate and promote implementation across multiple agencies, as well as to share information about adaptation among participants.

JOINT VENTURES—A network of collaborative, regional partnerships comprised of government agencies, non-profit organizations, corporations, tribes, and individuals that conserve habitat for priority species (e.g., birds, monarchs, fish), other wildlife, and people ([Migratory Bird Joint Ventures](#)).

LANDSCAPE—An area that is spatially heterogeneous in at least one factor of interest (Turner et al. 2001). A subjective spatial area of interest considered a single unit for conservation planning, design, and delivery. The term “landscape,” as used in this document, may encompass waterscapes and seascapes.

LANDSCAPE COMPOSITION—Types of elements (such as different habitat types) and the amounts of those elements (e.g., area, number, or biomass) in a landscape.

LANDSCAPE CONFIGURATION—Spatial arrangement of elements in the landscape.

LANDSCAPE CONSERVATION COOPERATIVE (LCC)—A public-private partnership comprised of states, tribes, federal agencies, non-governmental organizations, universities, international jurisdictions, and others working together to address landscape and seascape scale conservation issues ([Landscape Conservation Cooperatives](#)).

LCC NETWORK VISION—An aspirational statement that sets direction by describing why the LCC Network exists and what it is seeking to achieve into the future. The Vision of the LCC Network is: *Landscapes capable of sustaining natural and cultural resources for current and future generations.*

LCC NETWORK MISSION—A written declaration of the LCC Network’s core purpose and focus. The Mission of the LCC Network is:

A network of cooperatives depends on LCCs to:

- » Develop and provide integrated science-based information about the implications of climate change and other stressors for the sustainability of natural and cultural resources;
- » Develop shared, landscape-level, conservation objectives and inform conservation strategies that are based on a shared scientific understanding about the landscape, including the implications of current and future environmental stressors;
- » Facilitate the exchange of applied science in the implementation of conservation strategies and products developed by the Cooperative or their partners;
- » Monitor and evaluate the effectiveness of LCC conservation strategies in meeting shared objectives;
- » Develop appropriate linkages that connect LCCs to ensure an effective network.

LANDSCAPE CONSERVATION DESIGNS (LCDS)—Describe shared, cross-jurisdictional visions for meeting conservation objectives. LCDs evaluate drivers that have created the current patterns on the landscape and that affect potential future landscape patterns. LCDs use a partnership-driven, science-based planning process that (1) assesses the current and projected landscape condition; (2) identifies desired landscape characteristics through the integration of quantifiable biological, cultural, social, and physical resource objectives; (3) analyzes the landscape’s ability to achieve desired resource objectives under a variety of scenarios and/or limiting factors; and (4) provides landscape-scale management, mitigation, and monitoring strategies to achieve resource objectives. This information will inform a description of a desired future condition for identified landscape features, processes, or resources and a suite of management strategies developed with partners to achieve the desired future condition. Understanding historic and current environmental drivers will inform and guide management plans to achieve conservation goals for targeted features or resources or for a specific area under a bureau’s (or organization’s) jurisdiction. LCDs inform the development of each partner’s site-specific management plans (and National Environmental Policy Act documents) and actions within the landscape of the LCD to deliver conservation activities, attain desired resource objectives, sustain ecosystem function/processes, and achieve the missions, mandates, and goals of partner agencies/organizations ([DOI 2014](#)).

LCC NETWORK—The 22 individual LCCs and their Steering Committees, staff, partners, and others associated with the LCCs.

LCC NETWORK COORDINATION OFFICE—The office of the National LCC Coordinator and related staff focused on coordinating, maintaining, and developing connections among the international network of 22 LCCs.

LCC PARTNERS—Organizations, entities, and individuals that actively participate in one or more LCCs.

LCC STEERING COMMITTEE—Each LCC is governed by a voluntary Steering Committee, typically with representatives from conservation and resource management entities (natural and cultural). These entities include a wide variety of federal, state, territorial, and international agencies; tribal and other indigenous peoples; universities; non-governmental organizations; and others located or operating within the LCC geographic region. Steering Committees provide leadership to guide direction and set priorities of the partnership and contribute technical expertise and resources to achieve the goals and objectives of the LCC. Steering Committees accept ultimate responsibility for the performance and success of the partnership.

LEGACY DATA—Valuable historic data, documents, and technical drawings that are often stored in an old or obsolete format or computer system and are, therefore, difficult to access or process.

LIMITING FACTORS—A primary factor constraining the growth of a population toward objective levels. These factors are often resources or environmental conditions that affect the growth, abundance, or distribution of a natural or cultural resource, such as a species or habitat type.

MANAGEMENT DECISIONS—Decisions regarding the execution of program responsibilities, including, but not limited to, establishment of priorities, allocation of resources, assignment of roles and responsibilities, workload management, and such other decisions as are necessary to perform the functions of a program. Land management decisions can be the specific action taking place on some type of protected property and can include such things as fire, planting native plants, removing exotic flora and fauna, etc. Characterized by specific actions in specific places for specific purposes.

MONITORING AND RESEARCH (AS COMPONENT OF SHC)—Are a prominent and fundamental element of SHC, and without this step, we lose the iterative process whereby managers learn and increase their efficiency. Monitoring and Research, which consists of three sub-elements, helps evaluate: assumptions made in population-habitat models and decision support tools, habitat responses to conservation actions, population responses to conservation actions, and progress toward habitat and population objectives (USFWS 2006).

NATIONAL FISH HABITAT PARTNERSHIPS—Government agencies, non-profit organizations, corporations, tribes, and individuals that protect, restore, and enhance the nation's fish and aquatic communities through a network of collaborative, regional partnerships that foster fish habitat conservation and improve the quality of life for the American people (National Fish Habitat Partnership).

NETWORK SCALE—Refers to the largest spatial extent encompassed by all 22 LCCs in contrast to regional and local scales. The LCC Network spans much of the North American continent and significant portions of the Pacific basin and Caribbean Islands (“Find an LCC” map available [online](#)).

RAPID ECOREGIONAL ASSESSMENT (REA)—Evaluations by the Bureau of Land Management (BLM) that examine ecological values, conditions, and trends within, which are large, connected areas that have similar environmental characteristics. Called “rapid” assessments because they synthesize existing information, rather than conduct research or collect new data, and are generally completed within 18 months.

REGIONAL INTEGRATED SCIENCES AND ASSESSMENTS (RISA)—An interdisciplinary NOAA science program that support research teams that provide information to help communities prepare for and adapt to climate variability and change.

RESILIENCE, COMMUNITY—Community resilience is the capability to anticipate risk, limit impact, and bounce back rapidly through survival, adaptability, evolution, and growth in the face of turbulent change (CARRI 2013).

RESILIENCE, ECOLOGICAL—Current Ecological Usage: the capacity of an ecosystem to return to its original state following a perturbation, including maintaining its essential characteristics of taxonomic composition, structure, ecosystem functions, and process rates. Emerging Climate Change Usage: in the emerging context of climate change, resilience might best be thought of as the ability of an ecosystem to recover from or adjust easily to change, measured more in terms of overall ecosystem structure, function, and rates and less in terms of taxonomic composition. (NFWPCAS 2012)

SCENARIOS—Depicts plausible futures of a system under different conditions. A hypothetical sequence of events constructed for the purpose of focusing attention on causal processes and decision points (Kahn and Wiener, 1967, page 6). Evaluation of decisions under multiple scenarios provides insight into how robust decisions are under different assumptions about the future state of the system.

STATE WILDLIFE ACTION PLANS (SWAPS)—Congressionally mandated plans that were created by all 50 states and five U.S. territories in 2005. These proactive plans assess the health of each state’s wildlife and habitats, identify the problems they face, and outline the actions that are needed to conserve them over the long term.

STRATEGIC HABITAT CONSERVATION (SHC)—An iterative framework for setting and achieving conservation objectives based on the best available information, data, and ecological models. Full implementation requires four elements that occur in an adaptive management loop: 1) biological planning, 2) conservation design, 3) conservation delivery, and 4) monitoring and research (USFWS 2006).

TRADITIONAL ECOLOGICAL KNOWLEDGE—A cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment (Berkes 2012).

Appendix B: Summary of Action Items

THEME 1: LANDSCAPE CONSERVATION PLANNING

- ACTION 1:** Conduct a literature review of existing national and international plans to identify existing conservation targets. (Objective 1)
- ACTION 2:** LCC Science Coordinators and technical staff identify priority conservation targets that adequately capture the goal of an ecologically connected landscape. (Objective 1)
- ACTION 3:** Collate conservation targets identified by individual LCCs and regional-scale initiatives into a single product (document, database, map, etc.). (Objective 2)
- ACTION 4:** Develop criteria for sorting through LCC-specific targets to determine which are useful for rolling up into multi-LCC and LCC Network-wide vision (e.g., frequency/overlap across multiple LCCs, ecosystem type, geographic region, other factors to be determined). (Objective 2)
- ACTION 5:** Apply criteria to develop list of LCC conservation targets across multiple LCCs that inform LCC Network-wide vision. (Objective 2)
- ACTION 6:** Evaluate and combine conservation targets to identify a parsimonious list. (Objective 3)
- ACTION 7:** Assess regional, partner-focused conservation planning frameworks and paradigms in use. (Objective 3)
- ACTION 8:** Identify effective practices and develop minimum standards for compatibility of landscape conservation plans across LCC borders (e.g., common scenario/timeframe, common metrics/currency). (Objective 3)
- ACTION 9:** Hold a workshop to rapidly prototype the landscape conservation planning framework (steps 1-6), capture best practices for achieving an ecologically connected network of landscapes for the LCC Network to test, and identify gaps in tools and analyses. (Objective 4)

THEME 2: LANDSCAPE CONSERVATION DESIGN

- ACTION 1:** Review current technical methods for integrating conservation targets and other science inputs (such as species-habitat models and ecosystem integrity metrics, historic resource models) into a landscape conservation design, within a collaborative, participatory design environment. Note: the conservation targets considered should be informed by those LCC Network, regional, or LCC-specific targets evaluated as being most useful for conservation planning under Theme 1 of this Plan. (Objective 1)
- ACTION 2:** Review and evaluate best practices for achieving successful collaboration among partners to integrate science inputs. (Objective 1)
- ACTION 3:** Identify advantages, disadvantages, and appropriate applications of the methods identified in Actions 1-2 for integrating science inputs. (Objective 1)
- ACTION 4:** If appropriate and necessary, develop new methods for integration of science products into design. (Objective 1)
- ACTION 5:** Evaluate alternative technical approaches for reconciling and integrating landscape conservation designs from adjacent areas to make them compatible. (This evaluation should recognize that because goals, objectives, and collaborative processes differ among design efforts, comprehensive consistency among designs may be unrealistic.)
- ACTION 6:** Review and evaluate best practices for achieving successful collaboration among partners to integrate conservation designs from adjacent areas. (Objective 2)
- ACTION 7:** Identify advantages, disadvantages, and appropriate applications of the approaches identified in Actions 5-6 for integrating conservation designs. (Objective 2)
- ACTION 8:** If appropriate and necessary, develop new methods for integrating multiple conservation designs. (Objective 2)
- ACTION 9:** Demonstrate the application of methodologies that integrate two or more conservation designs so that they align and are compatible. (Objective 2)
- ACTION 10:** Review and evaluate the goals and objectives for conservation targets and identify the aspects that are most appropriately considered at spatial scales larger than what is typically encompassed by local or regional landscape conservation designs (e.g., larger than the scale of an individual LCC or large watershed). For example, this may include populations or metapopulations of species with wide distributions, full ranges utilized by individuals of migratory species, or the need for long-term shifts in range to accommodate changing climates. Note: the conservation targets considered should be informed by those LCC Network, regional, or LCC-specific targets that have been identified as being most useful for landscape conservation planning under Theme 1 of this Science Plan. (Objective 3)
- ACTION 11:** Evaluate alternative approaches for incorporating the considerations from Action 10 into landscape conservation design at multiple scales. (Objective 3)

ACTION 12: Where appropriate and necessary, develop new technical methods for addressing the considerations from Action 10 and incorporating them into landscape conservation design. (Objective 3)

ACTION 13: Using the results from Actions 10-12, demonstrate how these considerations can be integrated into multiple, compatible landscape conservation designs using the methods identified (both existing and newly developed). (Objective 3)

THEME 3: CLIMATE ADAPTATION

ACTION 1: Work with LCCs and partners to identify and prioritize the critical spatial and natural and cultural resource data necessary for implementing the *Climate Strategy*, with a focus on data that are needed by multiple LCCs or at broader scales. Then, based on this prioritized list, implement processes for ensuring these data are developed, acquired, and made available to the LCCs and partners. (Objective 1)

ACTION 2: Work in conjunction with the Joint Implementation Working Group for the *Climate Strategy* to develop an LCC self-assessment template regarding LCC efforts towards meeting *Goal 1, Strategy 1.1*. (Objective 1)

ACTION 3: As each LCC deems appropriate, conduct a self-assessment (using a template to be developed) regarding their efforts towards meeting *Goal 1, Strategy 1.1*. The individual assessments will include a description of the methodology and tools by which LCCs develop information such as models of projected change in priority natural and cultural resources (e.g., species distributions, habitats, ecosystems) including rates of change. (Objective 2)

ACTION 3A: The self-assessments will be compiled across the Network into a single evaluation (potentially led by a management or science fellow) that will describe the extent to which individual LCCs are incorporating climate information into their adaptive management framework (as it relates to *Goal 1, Strategy 1.1*), and that will identify gaps in knowledge and actions taken across the Network.

ACTION 3B: Host an LCC workshop following the compilation of the climate adaptation self-assessments and evaluation of efforts to share lessons learned, including both progress and obstacles in applying climate change information to conservation planning and across social boundaries. One focus will be the effectiveness of proposed ecologically connected networks to meet their conservation goals under plausible scenarios of climate change.

- ACTION 4:** After the workshop, a needs assessment report would contain the compilation of the self-assessments, workshop results, and identify opportunities and impediments towards aligning the efforts of individual LCCs across the LCC Network. LCCs will evaluate how implementing *Climate Strategy 1.1* can best be incorporated with their conservation targets, conservation priorities, and strategic plans, working with partners and integrating their work with existing management plans such as the State Wildlife Action Plans, National Fish Habitat Partnerships, Joint Ventures, State Climate Change Vulnerability Assessments, State Historic Preservation Plans, Cultural Heritage Corridors, etc. The individual action items identified by each LCC will be collated into a single Network action plan. (Objective 2)
- ACTION 5:** Issue a network RFP in 2017 to solicit project proposals that address the priorities and needs identified in the completed assessment report. The RFP will support the goal of climate adaptation at system scales (i.e., the scale of species' ranges, cultural landscapes, ecosystem processes, etc.). (Objective 4)
- ACTION 6:** Develop a mechanism to track actions across the LCC Network that are focused on the development of a network of ecologically connected and functional landscapes. (Objective 3)
- ACTION 7:** Coordinate and integrate these efforts with the Joint Implementation Working Group for the *Climate Strategy* so that the CSCs and other partners can share lessons learned and adaptive approaches undertaken, communicate progress being made, and build LCC capacity for implementing the *Climate Strategy*. (Objective 4)
- ACTION 8:** Support the implementation of the President's *Priority Agenda* as it relates to moving forward climate change adaptation and strategies for resilience in landscapes/regions chosen as "flagships" if involvement by LCCs is requested and they can play a leadership or supporting role. (Objective 4)
- ACTION 9:** After three years, revisit the Science Plan's objectives that narrow the focus to implementing *Climate Strategy Goal 1, Strategy 1.1*. Individual LCCs are currently at different stages in implementation. Based on success across the LCC Network implementation of the *Climate Strategy*, consider expanding the focus to include additional strategies in *Goal 1* or actions from additional climate strategies such as the *National Ocean Policy Implementation Plan* and the *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate*. (Objective 4)

THEME 4: DATA MANAGEMENT, INTEGRATION, AND SHARING

ACTION 1: Establish standards for LCC Network funded science projects (i.e., all projects funded by or through the LCCs) that align with best practices employed by LCCs, CSCs, and partners.

ACTION 1A: Initiate an accountability process for LCC Network-funded projects.

Draft or adopt standards (including a Data Management Plan requirement) guiding documentation, distribution, and curation of deliverables that are clear and consistent with existing standards (e.g., NCCWSC 2014). Review and evaluate the products of Network funded projects, see that best practices are followed, including Data Management Plans and distribution of deliverables.

ACTION 1B: Encourage formal data publication (e.g., [Ecological Archives Data Papers](#), [Nature Publishing Group's Scientific Data](#); Avian Knowledge Network) of LCC Network funded science and encourage LCCs and their principal investigators to publish data; ensure unpublished data are appropriately documented and archived.

ACTION 1C: Maintain an online repository (e.g., [GitHub](#)) for distributing and maintaining the source code for tools developed by the LCC Network and LCCs.

ACTION 2: Communicate the importance and value of these objectives to LCCs.

ACTION 2A: Develop and maintain a single online location with standards and best practices documents aligned with the Data Lifecycle (Figure 2).

ACTION 2B: Collaborate and coordinate tool development and use, as needed.

ACTION 3: Develop or adopt training for all aspects of data management for LCC staff and partners responsible for science delivery and data management.

ACTION 3A: Select and promote specific metadata editing tools and associated training courses.

ACTION 3B: Maintain training materials aligned with the Data Lifecycle (Figure 2) for data management, including examples and case studies.

ACTION 4: Develop a tracking mechanism and performance metrics for use of data assets, modeling tools, etc. specific to the LCC Network.

ACTION 4A: Develop project and data tracking database.

ACTION 4B: Develop sophisticated analytics schema that estimate impact of LCC Network and LCC science.

ACTION 5: Fund or encourage LCCs to fund projects that seek to discover and curate important existing legacy datasets that might otherwise be lost.

ACTION 6: Communicate value and implement use:

ACTION 6A: Focus on [data.gov](#), [ScienceBase](#), and other established discovery portals, catalogs, or curation sites in accordance with Federal Open Data policies and encourage LCCs to do likewise.

ACTION 6B: Define a direct path for the LCC Network to Data.gov (e.g., a stand-alone [CKAN](#) instance).

ACTION 7: Conduct a systematic cross-LCC assessment of best practices, data and metadata completeness and quality, storage and distribution capacities and architectures, archiving practices, etc. When found lacking, discover the key sticking points (e.g., do they need more training materials, or do they know how to do it but just need more staff funding) so the LCC Network doesn't spend money "fixing" the wrong problems.

ACTION 7A: Cross-reference results of available needs assessments.

ACTION 8: Direct the DMWG to participate in discussions with related working groups in relevant agencies (e.g., USGS Community for Data Integration, USFWS Data Subcommittee).

THEME 5: SOCIOECONOMIC AND CULTURAL VALUES

ACTION 1: Develop workshops specifically for the LCC community to learn about ways to collect and quantify socioeconomic and cultural values at the landscape level (e.g., ecosystem services and sense of place mapping) and how to incorporate these values into LCC efforts, including approaches to stakeholder and partner engagement. (Objectives 1, 2 and 4)

ACTION 2: Synthesize research and information about how people value landscapes, including TEK and local knowledge (when voluntarily offered by knowledge holders) and share it with LCC staff and Steering Committees so they can better incorporate that information into conservation planning and design efforts to make those efforts more comprehensive and more broadly supported by land use decision-makers and other stakeholders that influence the success of landscape-scale conservation. (Objectives 2 and 4)

ACTION 3: Synthesize existing efforts to integrate and scale up elements of key ecosystem services and cultural values into landscape scale conservation planning and design. (Objectives 2 and 4)

ACTION 4: Research public-private partnerships that have resulted in the successful incorporation of industry and other resource-dependent sectors into collaborative conservation planning efforts, including a targeted effort to solicit interest in LCC Network planning efforts. (Objective 3)

ACTION 5: Undertake a synthesis of literature and conduct an organizational assessment to evaluate internal impediments to collaboration among LCC partners resulting from organizational culture, policy mandates, as well as staff and financial constraints. (Objective 4)

ACTION 6: Encourage inclusion of individuals with economic, social, and cultural expertise and perspectives to share information and participate in the LCC Network to improve and broaden our conservation efforts through formal engagement on science teams or working groups composed of anthropologists, social scientists, or economists at all levels within the LCC Network. (Objective 5)

THEME 6: SCIENCE COMMUNICATION AND DELIVERY

ACTION 1: The Science Delivery Working Group will complete an initial review of current science delivery approaches (gap identification and delivery techniques) by the LCC Network as well as current best practices in this field based on literature, techniques, tools, and leading institutions. (Objective 1)

ACTION 2: Through consultation with leading experts and the LCC community, the Science Delivery Working Group will identify and implement an assessment process that will draw on methods of relevant social science disciplines and information technology to identify improvements that can be made in science delivery efforts of the LCCs. (Objective 1)

ACTION 3: Based on the results of Actions 1 and 2 above (Objective 2):

ACTION 3A: Develop focused training for communication specialists, Science Coordinators, and other LCC staff and partners to increase their ability to guide science translation and delivery to key audiences. Possible topics include: how to identify and understand audiences, how to tailor information that is appropriate for various audiences, what makes a good communication strategy, how to take advantage of various tools and technologies, how to assess if communication is effective, and how to tell better stories.

ACTION 3B: Develop and circulate communication templates for various product types. Templates will be based on successful LCC science communications and best practices compiled from multiple LCC and partner communications efforts to date. Templates will also include new, innovative, and creative methods for approaching science communication to better reach and inform diverse audiences.

ACTION 3C: Develop guidelines to ensure that the process of producing science products includes articulation and execution of effective communication efforts to reach target audiences, frame key messages, and effectively solicit input of end users throughout the product development process.

ACTION 4: Based on the assessment and products from Actions 1-3 above, disseminate tools and techniques to objectively identify and address communication gaps and barriers that inhibit science delivery within the LCCs and other conservation partnerships. (Objective 1)

ACTION 5: Support social science research projects to identify and address science communication gaps and barriers specific to the work of the LCCs during the course of completing items Actions 1-4. (Objective 1)

THEME 7: MONITORING AND ASSESSMENT

- ACTION 1:** Compile and provide guidance to LCCs on setting feasible monitoring objectives, including necessary precision, intended types of changes of interest, and intended analyses for assessing change. Ensure these are included among the criteria for selecting the LCC Network-scale conservation targets (Theme 1, Objective 2, Action 2). (Objective 1)
- ACTION 2:** In conjunction with Theme 1, Objective 1, Action 2, develop inventory of existing landscape, regional, national, or LCC Network-scale monitoring programs of relevance to the LCC Network priority conservation targets and their limiting factors. Inventory will include summary of program objectives, spatial domain, temporal revisitation frequency, types of attributes measured, data sharing and access, and points of contact. (Objective 1)
- ACTION 3:** For partner monitoring programs preliminarily identified as potential information sources for each conservation target (and goals and objectives), assess the adequacy of the existing monitoring information, precision, spatial and temporal resolution, etc., to ensure it meets the information needs associated with that conservation target. (Objective 1)
- ACTION 4:** Identify gaps in existing sources of monitoring information for informing selection of conservation targets (and later, assessment of effectiveness of conservation delivery). (Objective 1)
- ACTION 5:** Identify information needs that are not currently met by existing partner monitoring programs but where the necessary data exists and is being collected. Identify and resolve barriers to achieving the necessary data integration, synthesis, and reporting at landscape or larger spatial scales. (Objective 2)
- ACTION 6:** Develop guidance for assisting LCCs in partnering with industry to address information needs not currently met by existing partner monitoring programs. (Objective 2)
- ACTION 7:** Identify opportunities to advance comparability of monitoring data from multiple partners at landscape or larger scales and develop and implement strategies to achieve that. For example, agreement on minimum data collection standards and minimum data management standards, promotion of common protocols and templates, etc. (Objective 2)
- ACTION 8:** Identify opportunities to help partner monitoring programs that inform conservation targets improve their efficiency through development of a checklist for assessing monitoring program elements, improved data collection methods and metrics, streamlined workflow processes, etc. (Objective 2)
- ACTION 9:** Apply the Open Standards for Conservation framework (Conservation Measurement Partnership 2013) to develop processes for compiling and assessing progress towards achieving the LCC Network Vision. (Objective 3)

- ACTION 10:** Identify information needs (precision, frequency, spatial resolution, etc.) required by key funders and stakeholders in the LCC Network in order to assure adequate progress is being made toward the Network Vision. (Objective 3)
- ACTION 11:** Identify those conservation delivery actions whose underlying guidance meets the formal technical requirements for adaptive management (Williams et al. 2009); identify resources required to implement formal adaptive management. (Objective 3)
- ACTION 12:** Determine the baseline status (circa 2020) of the LCC Network in achieving the LCC Network Vision. (Objective 3)

Appendix C: Acronyms

ACRONYM	DEFINITION
AFWA	Association of Fish and Wildlife Agencies
BLM	Bureau of Land Management
CSC	Climate Science Center (USGS)
DMWG	LCC Network Data Management Working Group
DOI	U.S. Department of the Interior
IDMN	LCC Network Integrated Data Management Network
IPCC	Intergovernmental Panel on Climate Change
LCC	Landscape Conservation Cooperative
LCT	LCC Coordinators Team
LSCT	LCC Science Coordinators Team
MOU	Memorandum of Understanding
NCCWSC	National Climate Change and Wildlife Science Center (USGS)
NEAT	National Ecological Assessment Team (USFWS and USGS)
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRC	National Research Council
RFP	Request for proposals
RISA	Regional Integrated Sciences and Assessments (NOAA)
SDWG	LCC Network Science Delivery Working Group
SWAP	State Wildlife Action Plan
TEK	Traditional Ecological Knowledge
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
QA/QC	Quality Assurance/Quality Control

Appendix D: Citations

Association of Fish and Wildlife Agencies, Teaming with Wildlife Committee, State Wildlife Action Plan (SWAP) Best Practices Working Group. 2012. Best Practices for State Wildlife Action Plans-Voluntary Guidance to States when Revising and Implementing SWAPS. Washington (DC): Association of Fish and Wildlife Agencies. 80 pages. [Available online.](#)

Association of Fish and Wildlife Agencies, Effectiveness Measures Working Group. 2011. Measuring the Effectiveness of State Wildlife Grants. [Available online.](#)

Beier, P., M.L. Hunter, and M. Anderson. 2015. Special Section: Conserving Nature's Stage. *Conservation Biology* 29: 613-617. [Available online.](#)

Bureau of Land Management. 2015. Rapid Ecoregional Assessments. June 18, 2015. [Available online.](#)

Bureau of Land Management. 2006. Data Administration and Management Handbook, H-1238. Bureau of Land Management handbook to accompany manual section 1238. [Available online.](#)

Chester, C.C., J.A. Hilty, S.C. Trombulak. 2012. Climate Change Science, Impacts, and Opportunities. In *Climate and Conservation: Landscape and Seascape Science, Planning, and Action*. J.A. Hilty, C.C. Chester, M.S. Cross (eds.). Island Press. pp 4.

Conservation Measures Partnership. 2013. Open Standards for the Practice of Conservation: Version 3.0, published April 2013. [Available online.](#)

Cross, M.S, E.S. Zavaleta, D. Bachelet, M.L. Brooks, C.A.F. Enquist, E. Fleischman, L.J. Graumlisch, C.R. Groves, L. Hannah, L. Hansen, G. Hayward, M. Koopman, J.J. Lawler, J. Malcolm, J. Nordgren, B. Petersen, E.L. Rowland, D. Scott, S.L. Shafer, M.R. Shaw, G.M. Tabor. 2012. The Adaptation for Conservation Targets (ACT) Framework: A tool for incorporating climate change in natural resource management. *Environmental Management* 50(3):341-351. doi:10.1007/s00267-012-9893-7. 50:341-351. [Available online.](#)

CSC/LCC. 2011. Landscape Conservation Cooperatives and Climate Science Centers Implementation Guidance. [Available online.](#)

Dinerstein, E., G. Powell, D. Olson, E. Wikramanayake, R. Abell, C. Loucks, E. Underwood, T. Allnutt, W. Wettengel, T. Ricketts, H. Strand, S. O'Connor, and N. Burgess. 2000. A workbook for conducting biological assessments and developing biodiversity visions for ecoregion-based conservation. Conservation Science Program, World Wildlife Fund-US, Washington, DC, USA.

DOI Secretarial Order 3289. 2009. Addressing the impacts of climate change on America's water, land and other natural and cultural resources. 14 September 2009. Washington, DC. [Available online.](#)

Executive Order 13642. Making Open and Machine Readable the New Default for Government Information. The White House. 9 May 2013. [Available online.](#)

Executive Order 13653. 2013. Preparing the United States for the Impacts of Climate Change. November 1, 2013. [Available online.](#)

Finn, S.P., J. Bradley, E. Fort, J. Jenkins, P. Lineback, B.J. Richardson, R. Riester, and J. Reynolds. 2013. Data Management Best Practices for Landscape Conservation Cooperatives Part 1: LCC Funded Science. LCC Network unpublished document. 5 pages.

Fiscal Year 2010 Department of the Interior, Environment and Related Agencies Appropriations Act Conference Report. [Available online.](#)

Gibney, E., Van Noorden, R. 2013. Scientists losing data at a rapid rate. *Nature*, 19 Dec 2013, doi:10.1038/nature.2013.14416.

Groves, C.R., D.B. Jensen, L.L. Valutis, K. H. Redford, M.L. Shaffer, J.M. Scott, J.V. Baumgartner, J.V. Higgins, M.W. Beck, and M.G. Anderson. 2002. Planning for Biodiversity Conservation: Putting Conservation Science into Practice. *BioScience* 52:499–512. [Available online.](#)

Groves, C.R., E.T. Game, M.G. Anderson, M. Cross, C. Enquist, Z. Ferdana, E. Girvetz, A. Gondor, K.R. Hall, J. Higgins, R. Marshall, K. Popper, S. Schill, and S.L. Shafer. 2012. Incorporating climate change into systematic conservation planning. *Biodiversity and Conservation* 21:1651–1671.

IDMN Team. 2015. Landscape Conservation Cooperative Integrated Data Management Network. [Available online.](#)

IPCC, Working Group II (WGII). 2007. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 2007 (II). M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Koopman, M., B. Petersen, J. Montambault. 2013. Final Report: LCC performance measures framework development, 30 Aug 2013.

Maldonado, J.E., R.E. Pandya, B.J. Colombi. 2013. Special Issue Editors. Climate change and indigenous people of the United States: Impacts, experiences, and actions. *Climatic Change*: 120(3).

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC. [Available online.](#)

National Academies of Science, Engineering, and Medicine. 2009. Ensuring the Integrity, Accessibility, and Stewardship of Research Data in the Digital Age. National Academies Press, Washington DC. [Available online.](#)

National Climate Change and Wildlife Science Center. 2014. National Climate Change and Wildlife Science Center & Climate Science Centers Data Sharing Policy, Version 3.0. NCCWSC/CSC Data Management Working Group. U.S. Geological Survey. [Available online.](#)

National Fish, Wildlife, and Plants Climate Adaptation Partnership. 2012. National Fish, Wildlife and Plants Climate Adaptation Strategy. Association of Fish and Wildlife Agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. Washington, D.C. [Available online.](#)

National Research Council (NRC). 2007. Environmental Data Management at NOAA: Archiving, Stewardship, and Access. Committee on Archiving and Accessing Environmental and Geospatial Data at NOAA, National Research Council. [Available online.](#)

National Research Council (NRC). 2009. Informing decisions in a changing climate. National Research Council Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change, Division of Behavioral and Social Sciences and Education. 200 pp. ISBN 978-0-309-13737-9.

NEAT. 2006. Final Report of the National Ecological Assessment Team. [Available online.](#)

Office of Management and Budget. 2013. Open Data Policy-Managing Information as an Asset. Executive Office of the President. 9 May 2013. [Available online.](#)

Office of Science and Technology Policy (OSTP). 2013. Increasing Access to the Results of Federally Funded Scientific Research. Executive Office of the President. 22 February 2013. [Available online.](#)

Science Policy Assessment and Research on Climate (SPARC). 2010. Usable Science: A Handbook for Science Policy Decision Makers. [Available online.](#)

Stein, B.A., P. Glick, N. Edelson, and A. Staudt (eds.). 2014. Climate-Smart Conservation: Putting Adaptation Principles into Practice. National Wildlife Federation, Washington, D.C. [Available online.](#)

The Nature Conservancy and World Wildlife Fund. 2006. Standards for Ecoregional Assessments and Biodiversity Visions. January 26, 2006. The Nature Conservancy, Arlington, VA. [Available online.](#)

U.S. Council on Climate Preparedness and Resilience, Climate and Natural Resources Working Group, 2014. *Priority Agenda: Enhancing the Climate Resilience of America's Natural Resources.* [Available online.](#)

U.S. Department of Agriculture and U.S. Department of the Interior. 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl: standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. U.S. Forest Service and U.S. Bureau of Land Management, Portland, Oregon. [Available online.](#)

U.S. Fish and Wildlife Service. 2010. *Rising to the Urgent Challenge: USFWS Strategic Plan for Responding to Accelerating Climate Change.* [Available online.](#)

Vines, T.H., A.Y.K. Albert, R.L. Andrew, F. Debarre, D.G. Bock, M.T. Franklin, K.J. Gilbert, J-S Moore, S. Renaut, D.J. Rennison. 2013. The Availability of Research Data Declines Rapidly with Article Age. *Current Biology* 24:94-97. [Available online.](#)

Wildlife Habitat Policy Research Program. 2010. Completing a Wildlife Habitat System for the Nation. [Available online.](#)

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of Interior, Washington, D.C. [Available online.](#)

Williams, B.K., and E.D. Brown. 2012. Adaptive Management: The U.S. Department of the Interior Applications Guide. Adaptive Management Working Group, U.S. Department of Interior, Washington, D.C. [Available online.](#)

AUTHORS & CONTRIBUTORS

CORE WRITING TEAM

LCC Science Coordinators Team and LCC Network Coordination Office

James Broska, Jeff Burgett, Megan Cook, Cynthia Edwards, Sean Finn, Rebecca Fris, Elsa Haubold, Todd Hopkins, Mary Mahaffy, Philip Martin, Rua Mordecai, Brent Murry, Mike Olson, Aaron Poe, Brad Potter, Joel Reynolds, John Rice, Aimee Roberson, Amanda Robertson, Scott Schwenk, Ben Thatcher, John Tirpak, Steve Traxler, Gwen White

OTHER MAJOR CONTRIBUTORS

- » General: Dennis Hodges and Diane Elam (LCC Network Coordination Office), Kasey Jacobs (Caribbean LCC)
- » Landscape Conservation Planning: Molly Cross (Wildlife Conservation Society)
- » Landscape Conservation Design: Rob Campellone (USFWS)
- » Climate Adaptation: Arpita Choudhury (AFWA), Mark Shaffer (USFWS)
- » Data Management, Integration, and Sharing: Deanne DiPietro (California LCC), Zhahai Stewart (California LCC), Matthew Heller (Great Northern LCC), Josh Bradley (Arctic LCC)
- » Socioeconomic and Cultural Values: Dale Blahna (U.S. Forest Service), Megan Cross (University of Minnesota), William Gascoigne (USGS), Daniel Odess (NPS), Natalie Sexton (U.S. Fish and Wildlife Service), Joe Watkins (NPS)
- » Science Communications and Delivery: Ashley Spratt (USFWS)

ADDITIONAL CONTRIBUTORS

Donna Brewer (USFWS), Karen Blakney (BLM), Shawn Carter (NCCWSC), Stanton Enomoto (Pacific Islands CCC), Preston Hardison (Tulalip Tribes), Michelle Haynes (USACE), Cat Hawkins Hoffman (NPS), Sally Holl (Desert LCC), Paul Leonard (Appalachian LCC), Kathy Lynn (Pacific Northwest Tribal Network), Laurie McGilvray (NOAA), Jerry McMahon (Southeast CSC), Paul Pajak (USFWS), Chad Rittenhouse (University of Connecticut), Frank Thompson (USFS), Max Post van der Burg (Plains and Prairie Potholes LCC)

PLAN DESIGN TEAM

Gregg Elliott, Michael Gale, Andrea Graffis, Meghan Kearney, Laura MacLean, Hilary Morris, Jane Pellicciotto

SUGGESTED CITATION

Landscape Conservation Cooperative Network, LCC Science Coordinators Team. 2015. LCC Network Conservation Science Plan Version 1.0. Falls Church, VA.