



Great Northern

Landscape Conservation
Cooperative
Implementation Plan



Great Northern Landscape Conservation Cooperative FY2010 Implementation Plan

Purpose

On behalf of the Department of the Interior (DOI), the U.S. Fish and Wildlife Service (FWS) and the DOI agencies are rising to the challenges of landscape conservation in a changing climate. We are initiating a new enterprise, comprising agencies and organizations working together across landscapes and through science-management partnerships called Landscape Conservation Cooperatives (LCCs). The Mountain-Prairie Region (6) and Pacific Region (1) of the FWS have joined together in initiating the Great Northern LCC (GNLCC) and are seeking early involvement from conservation science and management partners. This document provides a development plan for initiating the GNLCC.

Geographic Area Description

The GNLCC encompasses the area defined as the Great Northern Geographic Area (see Appendix 1 for map). This area includes the mountain and transitional habitats in regions of Wyoming, Montana, Idaho and the upper Green River basin in southern Wyoming and small parts of Colorado and Utah, and portions of the Interior Columbia Plateau reaching into Oregon and Washington westward to the Cascade Mountains. The GNLCC also includes the international landscapes of interior British Columbia and Alberta, Canada, to cover the entirety of the northern Rocky Mountains and mid-continent lowlands of the interior northwest.

The habitats represented in the Great Northern Geographic Area (GNGA) include sagebrush steppe ecosystems, high elevation mountain habitats, interspersed with glaciated valleys and transitional breaklands, diverse wetland ecosystems and waterbodies ranging from small streams and mountain lakes to high order rivers and large watersheds dependent on these waters (e.g., upper Snake and Columbia, upper Missouri, upper Yellowstone and upper Green rivers). The following sections describe ecotypes within the GNGA, some of which extend into Canada. As our Canadian partners work with us on conservation across international boundaries, we anticipate adding additional ecotype and species information.

Northern Rockies Ecotype

Several distinct ecotypes lie within the larger GNGA. The Northern Rockies includes the Continental Divide and is characterized by a variety of coniferous forest habitats. Drier areas are dominated by ponderosa pine, Douglas fir and lodgepole pine with intermittent patches of aspen. Engelmann spruce and Subalpine fir occur at higher elevations. Head water streams provide high quality water resources, including high elevation lakes and meadow wetlands. Intermountain valleys, scattered throughout this region are dominated by native bunch grass prairie, depressional wetlands, spring upwellings, and cottonwood and willow riparian areas.

Columbia Plateau Ecotype

The Interior Columbia Basin lands are highly diverse, ranging from the Cascade Mountains on the west to the continental divide in the Rocky Mountains on the northeast and east; most of the Basin is drained by the Columbia River and its tributaries. The Columbia Plateau ecosystem consists of arid sagebrush steppe and grasslands, flanked by moist, predominately forested ecoregions on all sides. The Okanogan Highlands extends from the crest of the Cascades to the Selkirks in the far northeast corner of Washington. Much of this area is montane conifer forest with six or seven forest vegetation zones from low elevation ponderosa pine to high elevation subalpine fir. The Owyhee Uplands include mountains and a rolling plateau transected by deep canyons and covered by sagebrush, bunchgrasses, and junipers. The Snake River Plain is characterized by plains and low hills. The Snake River region has many large springs along the Snake River that support endemic fish and mollusk species. Irrigated croplands dominate valleys, plateaus, and uplands. The Columbia Basin is in a transition-type climate zone where climate patterns are dominated by topographic features. One of the most dramatic ecological transitions occurs here where the lush, moist old-growth forests on the western side give way to an arid shrub-steppe environment on the eastern side.

Green River Basin Ecotype

The GNLCC also includes the upper-most portion of the Green River Basin in south western Wyoming and northern Utah and Colorado. Rugged hills and mountains give way to valleys ranging from forests to grass-shrub to grasslands. Vegetation is generally classified as sagebrush steppe (sagebrush-wheatgrass), saltbush-greasewood, and wheatgrass-needlegrass shrub-steppe. Climate throughout the Basin varies, but generally follows the pattern of a high desert region. Higher precipitation and lower temperatures generally accompany higher altitudes.

Unique Attributes of the Great Northern

The GNLCC is unique in social values, natural resources, and managerial challenges. The GNLCC includes one of the largest surface areas of all of the geographic areas in North America and spans over 447,000 square miles in the United States (57%) and Canada (43%).

The GNGA is dominated by public lands that are managed by Federal (e.g., FWS, Forest Service, National Park Service, and Bureau of Land Management) and State agencies, and Tribes. Other Federal (Bonneville Power Authority, Army Corps of Engineers and Bureau of Reclamation) and State agencies are also responsible for managing significant water resources in the upper Columbia River drainages. The area also includes extensive private timber, agricultural, and ranch lands. While this diverse land and water ownership and management provides a great opportunity to support ecosystem resilience in a coordinated fashion, it also provides significant challenges in the prospective alignment of the respective agencies' missions, management objectives, and authorities.

Ecologically, the GNGA represents one of the most relatively intact and functional ecosystems in the United States with diverse groups of species and important conservation and restoration opportunities. Habitat found throughout the GNGA

supports plant and animal species with cultural significance to multiple Native American Tribes and important societal and conservation value to the U.S., Canada and world. Cultural traditions are tied closely to the land's natural resources as are contemporary ways of life, such as ranching, logging, and recreational and subsistence hunting and fishing. The United States' greatest communities of free-roaming bison, elk, deer and other ungulates, wolves and bears and diverse salmon and trout populations are hallmarks of the Great Northern geographic area.

Resource utilization and fragmentation stressors are evident across the Great Northern landscape. Large tracts of forest and ranch lands, previously accessible to resident and seasonal migratory wildlife, are being converted and fragmented. Outbreaks of insect infestations across forested landscapes have significantly increased the risk and extent of catastrophic wildfire. Large portions of the landscape are realizing increased exploration and development for traditional and renewable energy sources. Lastly, the Geographic Area is experiencing ever increasing competition for water resources - for hydroelectric generation, transportation, and agricultural, municipal and residential uses, with potentially dire implications for wildlife's access to this limited resource.

The Great Northern LCC shares transitional and osmotic boundaries with four other LCCs: North Pacific, Great Basin, Plains and Prairie Potholes, and Southern Rockies. Coordination among and between LCCs will offer opportunities to leverage resources and accomplish more seamless landscape conservation. It is anticipated that the DOI and State partners can participate in more than one LCC. This should facilitate sharing of information and coordination along with internal Service coordination on LCC development.

Climate Effects in the Great Northern Landscape

Scientific information suggests that the Great Northern landscape has already undergone observable environmental and ecological changes as a result of global warming trends. Current patterns in climate change are expected to affect high mountain ecotypes and lower elevation, snow-melt dependent watersheds more acutely than some other landscape ecotypes (Pachauri and Reisinger 2007). Information supporting these conclusions indicates habitat and species that are ecologically tied to climate-related parameters (e.g., snow depth, snow-melt hydrology, snow-dependent water balance) in montane and connected watersheds may already be experiencing effects of a changing climate.

Temperature records indicate that Pacific Northwest temperatures increased 1.5°F since 1920. Regionally downscaled climate models project increases in annual temperature of, on average, 2.0°F by the 2020s, 3.2 °F by the 2040s, and 5.3°F by the 2080s (compared to the 1970-1999 period) Projected changes in annual precipitation, averaged over all models, are small (+1 to +2%), but some models project wetter autumns and winters and drier summers.

Increased summer temperatures, decreased summer precipitation, and a decline in snowpack will all lead to increased insect and fire damage to forest ecosystems.

Researchers project that the probability of more than 2 million acres burned in a given year will increase from 5% (observed) to 33% by the 2080s (Littell et-al., 2009). Changes in temperature and precipitation will continue to decrease snow pack, and will affect stream flow and water quality throughout the GNGA. Warmer temperatures will result in more winter precipitation falling as rain rather than snow throughout much of the region, resulting in earlier peak streamflows and higher stream temperatures. This will have dramatic effects on cold water fish. Additionally, air temperature changes will equate to mountain pine beetle infestations at higher elevations, exposing greater areas of pine forests to disease and wildfire risk..

The decline of the region's snowpack is predicted to be greatest at low and middle elevations due to increases in air temperature and less precipitation falling as snow. The average decline in snowpack in the Cascade Mountains, for example, was about 25% over the last 40 to 70 years (Littell et al., 2009).

The physical character of montane ecotypes and dependent lower elevation watershed ecosystems are largely defined by the annual timing, temperature and rate of precipitation and the ecological outcome of these, as they interact with the landscape. Species populations, communities and habitats therein directly result from and respond to the snow, rain, runoff and growing season to the extent that minor shifts in these could have far-reaching ecological impacts. Species with direct life-history links to the first-order of change will experience unprecedented landscape-scale stress not comparable to rates of change in our history. As an example, only 20% of the current sagebrush would remain, within the range of the sage-grouse, under the most extreme predicted temperature increases.

Functional Subunits Proposal

Through an initial assessment of the geographic distribution of ecotypes, FWS priority species, land use patterns, existing conservation partnerships, and projected climate effects, the FWS's assessment team recommends that the GNLCC be stratified into two functional subunits. While overall LCC coordination and science support services (data management, GIS products) can be provided across the GNGA as a whole, we believe that the research, assessments, decision support tools will be better aligned within two rather distinct provinces within the GNGA. We propose to create two subunits within the GNLCC that will be focused on the montane habitats and the Columbia Plateau. A logical societal, meteorological, and ecological subdivision exists between the montane habitat types of the Northern Rocky Mountains and the shrub-steppe habitat types of the Columbia Plateau. It follows that the scientific knowledge and technical skill sets required to address the conservation design needs of the key resource management practitioners within these two somewhat distinct areas will be different. Therefore, we anticipate the need to ultimately confer with our conservation partners to explore the needed scientific utilities that may be desired for two subunits of the GNLCC. These potentially differential science support needs will need to be addressed as the Service and partners build capacity for LCC functions and products through time.

Partners within the Great Northern Landscape

The Mountain-Prairie and Pacific Regions of the FWS have taken the first steps toward convening the Great Northern LCC, as a conservation alliance of science and management with other bureaus in the Department of the Interior, other Federal agencies (e.g., US Forest Service, NRCS and NOAA), the State natural and wildlife resource offices representing Idaho, Montana, Oregon, Washington and Wyoming (and small portions of Colorado and Utah), Canadian Provinces of British Columbia and Alberta, and academic and other non-governmental organizations. There are 21 federally recognized tribes in the GNLCC area representing Native American resource management interests. The scope of need for coordinated conservation science and management will require a scale of cooperation, collective understanding and on-the-ground effort far beyond that previously conceived or attempted.

The GNLCC will complement and leverage the numerous successful conservation partnerships already functioning within the GNGA. The Interagency Grizzly Bear Committee, Columbia Basin Federal Caucus, Western Governors' Association Wildlife Corridors Initiative, Greater Yellowstone Coordinating Committee, the Crown of the Continent Partnership, the Intermountain West Joint Venture, the Columbia Basin River Management Joint Operating Committee, and the Wyoming Landscape Conservation Initiative represent the breadth of GNGA partnerships. Federal and State agencies, Native American tribes, the Provinces of Alberta and British Columbia, and several influential non-governmental organizations participate in these groups to varying degrees.

Science organizations within the Great Northern landscape develop substantial scientific information and decision-support tools that contribute to conservation and ecology in this landscape. These organizations will be essential to conducting research needed by the GNLCC. A number of universities and research partnerships within the GNGA are recognized as national leaders in climate change research. Federal research agencies include U.S. Geological Survey Science Centers: Northern Rocky Mountain Science Center, Western Fisheries Research Center, Forest and Rangeland Ecosystem Science Center, and Fort Collins Science Center; Forest Service Research Stations: Rocky Mountain Research Station, Pacific Northwest Research Station; NOAA Fisheries Research Centers, Environmental Protection Agency, and the Agricultural Research Service. The USGS is expected to be a key science partner in this effort with their development of the Regional Climate Change Response Centers and direct contributions of staff and resources to the LCCs. Other important research collaborations will include Universities throughout the GNGA and non-governmental research organizations.

The GNLCC has begun early communications with potential partners in the GNGA to describe LCCs and solicit input and interest to the development of the LCC. These communications have included presentations at resource management workshops, face to face meetings with Federal, Provincial and State agencies, and multiple webinars. The FWS R6 Regional Director has had, and continues to have, personal conversations with senior executives and leaders of key science and management partners within the GNGA,

so as to educate about purpose and intent, and to solicit their respective commitment to engage in this enterprise. Organizations contacted to date include:

- Confederated Salish and Kootenai Tribes
- Chippewa Cree at Rocky Boy
- BIA Regional Office
- Native American Fish and Wildlife Society
- NPS Regional Director - Intermountain Region
- BLM State Director - MT
- BLM State Director - WY
- USGS Regional Director for Central Region
- USFS Regional Foresters for Rocky Mountain Region (R2) and Intermountain Region (R4)
- Alberta Fish and Wildlife Division
- Alberta Dept of Sustainable Resource Development
- BC Fish and Wildlife Branch
- BC Ministry of Environment
- Director of Wyoming Game and Fish Department
- Director of Montana Fish, Wildlife and Parks Department

As part of the webinar series hosted by the R6 and R1 Regional Directors, participants were asked to complete a survey describing their science information needs and priority management issues in the GNGA. Refer to Appendix 2 (Matrix of Partnerships) for a more comprehensive list of partners and how they currently work together within an array of conservation and science oriented partnerships to collaborate on natural resource management and conservation delivery. The Matrix also indicates which of the partners and partnerships have been contacted and through which venue(s).

Using new and leveraged resources, the LCCs can help partners to: (1) organize known and needed information and data, (2) acquire appropriately scaled climate, habitat and species data, and (3) measure, model, predict, and monitor effects of climate change on ecological systems, habitats, communities and species; and (4) target and implement effective conservation measures to reinforce ecosystem resiliency. With such information, the GNLCC conservation alliance can begin an appropriately scaled response to climate change working towards mutual habitat and species conservation goals for the Great Northern landscape. The FWS is recommending that through an adaptive management framework (i.e., Strategic Habitat Conservation), the GNLCC partnership can iteratively adjust coordinated landscape goals and respond with effective actions as we realize and embrace a new era of conservation in a changing landscape.

Though our initial assessment of conservation partnerships operating within the GNGA, it has become evident that the Interagency Grizzly Bear Committee (IGBC) and the Intermountain West Joint Venture (IWJV) represent a comprehensive array of effective and committed partners organized to assess, promote, and deliver conservation successes across the landscape. Combined, these partnerships represent the collaborative interests of key Federal, State, Provincial, and Tribal partners across the landscape. We suggest that the IGBC and IWJV be conferred with, so as to be considered the core of a steering

committee to guide the functions of the GNLCC. Both partnerships have been briefed on the prospective functions and goals of the LCC and have expressed interest in supporting such a role. We anticipate that the GNLCC will be able to build upon and leverage the both scientific and conservation delivery capacities that currently exist across these two organizations and capitalize upon broader opportunities for landscape conservation.

The Service will bring fiscal resources to support these priority science needs in this geographic area, beginning in 2010, and we are seeking cost share opportunities to leverage these funds. The following describes the GNLCC proposal for FY2010 and how we will use new fiscal resources. Implementation of this plan will result in measurable success in acquiring science needs applicable to imminent conservation management decisions of the GNLCC partnering organizations and will set the stage for a partnership that can deliver conservation and affect a response to climate change and other landscape issues within the Great Northern landscape.

Great Northern LCC Species Priorities

Although the Service has identified preliminary priority species, science needs, and science capacity, it is fully recognized that the final Great Northern LCC priorities will be defined in collaboration with GNLCC partners. Therefore, the priorities presented below are expected to be modified as the GNLCC evolves into a full partnership effort.

Focal Species

A critical first step to prioritizing the most vulnerable ecosystems and habitats and the appropriate conservation delivery response is to define focal species that are a vital component of a functioning ecosystem. In consideration of anticipated climatic changes and the resulting potential ecological impacts, the following species are currently considered to be focal species for the GNLCC.

Species	Primary Habitat	Unique Attributes
bull trout <i>Salvelinus confluentus</i>	rivers, streams, wetlands	ESA listed, some anadromy, migratory, temperature sensitive
pacific lamprey <i>Lampetra tridentata</i>	ocean, estuarine, rivers, streams, sediments	anadromous, cultural value for tribes
salmon/steelhead <i>Oncorhynchus sp.</i>	ocean, estuarine, rivers, streams, wetlands	ESA listed, anadromous, high social and commercial value
grizzly bear <i>Ursus arctos horribilis</i>	Diverse low elevation wetlands, high mountains	ESA listed, wide-ranging, top order carnivore, high social value
Greater sage-grouse <i>Centrocercus urophasianus</i>	sage steppe, grasslands	Status review (listing decision) in progress

Lewis's woodpecker (<i>Melanerpes lewis</i>)	Riparian cottonwoods (mature), ponderosa pine woodland, recently burned forest	BCC, BMC, wide distribution; ABC and Audubon Red Watch List, SGCN in State Wildlife Action Plans
trumpeter swan <i>Cygnus buccinator</i>	rivers, lakes, wetlands	Umbrella species for migratory waterfowl
willow flycatcher <i>Empidonax traillii</i>	Riparian areas	IUCN red list, migratory
Columbia Spotted frog <i>Rana luteiventris</i>	rivers, streams, lakes, wetlands	Candidate species
Cutthroat trout subspecies (<i>oncorhynchus clarki sp</i>)	Rivers, streams, lakes	Conservation Agreement Wide distribution Temperature and habitat sensitive
Arctic grayling (<i>Thymallus arcticus</i>)	Rivers, streams, lakes	Candidate species Temperature sensitive
wolverine (<i>Gulo gulo</i>)	High elevation, snow-associated ecosystems	Wide ranging, snow dependent, low density carnivore

All of these species have been selected due to their importance as a representative for key ecosystems and habitats, as well as being priority resources for many of the partners within the GNLCC. Based on past and ongoing efforts with partners, these species have all been recognized as important to achieving conservation goals in this geographic area, to address existing conservation challenges. ***Following more extensive collaboration with partners, it is expected this list will be modified to more fully reflect a wider array of partner priorities.***

Conservation Delivery in the Great Northern

The ultimate intent of the GNLCC is to assist the FWS and its partners in conserving habitats that ensure the long-term resiliency of ecosystems that sustain priority species and maintain viable populations and habitats in the face of climate change and other threats. A well-developed science capacity that generates applicable science products is crucial achieving these objectives. The GNLCC fully recognizes the critical role of conservation delivery in the strategic habitat conservation process and is committed to working with a wide range of partners to facilitate science-based, on-the-ground conservation delivery.

Conservation Delivery Strategies

The GNLCC is characterized by largely intact terrestrial landscapes and a mixture of intact yet highly compromised aquatic systems. As such, conservation delivery approaches vary significantly by taxa and geography throughout the area. For example, avian habitat conservation in the Northern Rockies generally focuses on protecting wetland, grassland, and riparian habitats through landscape-scale conservation easement

acquisition initiatives. These landscapes currently provide key habitats for species such as lesser scaup and greater sandhill crane. As such, the foremost priority is protecting the best habitats from fragmentation. Across the Columbia Plateau, there are numerous threats to the integrity and function of shrub-steppe ecosystems, requiring a variety of restoration and management techniques. In contrast, significant fish passage barriers exist for native migratory fish throughout large river systems, thus fisheries management is highly focused on the improvement of fish passage and maintenance of genetic diversity. In summary, specific conservation strategies vary across the landscape depending on the issues, habitat and species affected.

The GNLCC will positively influence conservation delivery as follows:

- Provide scientific information to inform water, land, and species management decisions in the face of climate change.
- Design monitoring strategies to determine the effectiveness of management actions and to adapt future actions.
- Support existing partnerships, coalitions and programs to deliver on-the-ground conservation using the information produced through the GNLCC. For example, partnerships such as the Interagency Grizzly Bear Committee, Intermountain West Joint Venture and Columbia Basin Fish and Wildlife Authority comprise government, tribal and NGO partners collaborating on targeted, effective, and efficient conservation delivery.
- Provide the scientific information needed to support conservation actions across multiple jurisdictions.
- Establish and maintain communications between the science and conservation delivery communities to ensure that 1) LCC science activities are appropriately targeted to the needs of those engaged in conservation delivery and 2) LCC science products are translated, marketed, and applied to the conservation delivery community such that they are fully understood and used in conservation delivery.
- The GNLCC will seek and promote new funding to further expand conservation delivery. This approach is built on the model of Joint Ventures (JV) that has successfully articulated the need for increased conservation delivery funding (e.g., North American Wetlands Conservation Act, Farm Bill conservation programs). JVs have developed model-driven habitat objectives and employed decision support tools that have collectively provided compelling rationale for the growth of key conservation delivery funding sources.

Conservation Delivery Mechanisms

A diverse array of conservation delivery mechanisms exist within the Great Northern geographic area that can be strengthened through the science capacity and science products of the GNLCC. Ultimately, the GNLCC will focus on conserving priority

species and habitats through collaboration on mutual science needs, and partnering on effective on-the-ground conservation delivery actions. Key conservation delivery tools include: 1) fee-title and conservation easement acquisitions, 2) habitat restoration and enhancement, 3) flow management and instream flow protection, 4) Best Management Practices for land and water management, 5) recovery planning, and 6) community problem-solving, education, and awareness. The decision support tools and science applications (e.g., data sets, models, reports, guidance) produced by the GNLCC will help deliver results-driven conservation action within the GNLCC.

Specific delivery mechanisms in the GNLCC include:

Land Protection NGOs and Land Trusts: The Great Northern geographic area is characterized by a strong land protection movement. Land protection conservation organizations ranging from large NGOs (e.g., TNC, Rocky Mountain Elk Foundation, Ducks Unlimited) to small land trusts (e.g., Teton Regional Land Trust, Five Valleys Land Trust, Vital Ground) are highly engaged in the protection of critical lands. Conservation easements are the principal tool for maintaining the ecological integrity of intact landscapes and ensuring linkages needed for species to adapt to climate change. The GNLCC science products will play a meaningful role in securing foundation (e.g., NFWF) and/or federally administered grant funds (e.g., NAWCA).

Farm Bill Conservation Programs: The Farm Bill conservation programs administered by the Natural Resources Conservation Service (NRCS) offer unprecedented funding levels for the conservation of fish and wildlife habitat on private lands and certain public lands within the GNLCC. Projected appropriations to the Wetland Reserve Program, Farm and Ranchland Protection Program, Grassland Reserve Program, Environmental Quality Incentives Program and Healthy Forest Reserve Program will make over \$100 million available annually for perpetual conservation easement acquisition and support conservation best management practices within the GNLCC. Hence, NRCS is potentially a strong partner for science-based conservation delivery in the GNLCC.

Partners for Fish and Wildlife Program: The FWS Partners for Fish and Wildlife Program (PFW) is an active and important player in cooperative and collaborative private lands conservation within the GNLCC. The PFW in each State catalyzes substantial habitat conservation in LCC Focus Areas through provision of biological staff capacity, project funding, and support for community-based conservation partnerships in these key landscapes.

USFS Forest Management Plans and BLM Resource Management Plans: The public land management agencies that control much of the land in the GNLCC have an on-going need for science products that can be incorporated into land management decision-making and establishment of Best Management Practices, as well as decision support systems that can support relative risk assessments for competing management alternatives.

State Fish and Wildlife Agency Habitat Programs: The State fish and wildlife agencies within the GNLCC each operate programs for conservation delivery. While the states have developed many of their own decision support tools to inform delivery of their habitat programs, State agencies are important partners for targeted GNLCC science products. The state agencies are heavily involved in the IWJV, IGBC, and other partnerships engaged in conservation delivery, and are currently committed to a number of partnership-based habitat conservation involving state, federal, and private funding.

North American Wetlands Conservation Act (NAWCA): NAWCA is a primary driver of wetland conservation in the GNLCC through provision of \$2-6 million per year in federal funding that typically leverages nonfederal funding contributions at a minimum of a 2:1 non-federal to federal funding ratio.

The Endangered Species Act: The Endangered Species Act (ESA) programs provide conservation funds through (1) a range of recovery-related funding mechanisms (Section 4); (2) species-specific funds to State agencies as per Section 6 (State Coordination), (3) agency-specific funds to address Section 7 (Interagency Conservation and Consultation) and (4) targeted funds for Habitat Conservation Planning as per Section 10.

Although some of the existing conservation delivery mechanisms have been presented here, the most appropriate and effective tools for conservation delivery will ultimately be determined by each partner. The GNLCC steering committee can make recommendations to improve coordination and effectiveness of landscape-level implementation and to better leverage sources of existing or new funding

Preliminary Assessment of Great Northern Landscape Science Needs

To ensure expedient and effective use of FY2010 funds that will result in measurable conservation contributions, the FWS, in collaboration with partners, will identify and fund priority science needs while concurrently promoting the establishment of a formal GNLCC partnership. A GNLCC Team employed a multi-tiered assessment process and criteria-driven evaluation, as described below, to identify the highest priority science needs for this plan in the short time available.

During FY2010, initial funding expenditure decisions will be predominately determined by FWS due to limited time; however the FWS will, to the extent possible, solicit partner input as we move toward a more partner-driven funding process. There is an immediate need for more scientific information on climate change impacts, and it is expected that early stages of the GNLCC effort will focus on funding downscaling of climate models, science application tools, designing shared data management capability, and acquiring foundational data. As better information, tools and additional funding become available, the GNLCC partnership will have the opportunity to shift resources to coordinate and collaborate in conservation delivery, monitoring and evaluation.

Multi-tiered Science Needs Assessment

The GNLCC Team identified the need to reach a wide audience, both internal FWS staff and our partners, to orient our initial efforts towards priority science and conservation delivery needs. This was accomplished through a science needs assessment that included seeking input from existing partnerships and organizations, reviewing previously prepared science need assessments, and soliciting input from FWS and other Federal and State partners.

As part of this assessment, existing priority science needs reports that were prepared by existing partnerships, workgroups and recent workshops were reviewed. Examples of these assessments included the Climate Change Collaboration (C3) in the Pacific Northwest “first ten” priorities assessment, Greater Yellowstone Science Planning Workshop, FWS/WCS Grizzly Bear/Wolverine Climate Workshop, and Wyoming Land Conservation Initiative Science Assessment. Appendix 3 provides a comprehensive list of the sources contributing to the assessment.

The GNLCC team also conducted informational inreach and outreach webinars and web-based surveys. Regional Directors from Regions 6 and 1 conducted a series of 5 webinar/conference calls in November 2009. As part of the webinar, participants were asked to complete a survey indicating their priority science and conservation needs relative to climate change. The results of the surveys were analyzed to identify highest conservation and science needs as characterized through responses for:

- Functional applications (e.g., ecological planning units and appropriate scale)
- Areas of emphasis (i.e., terrestrial, aquatic, avian, landscape, etc.)
- Priority Land use and land management activities (i.e., fire, urbanization, etc.)
- Science applications and disciplines (i.e., population modeling, GIS, etc.)

Although the survey was general and results provided only a qualitative overview, they do provide basic insight into the science and conservation issues and priorities within the Great Northern Landscape. Respondents were asked to identify the top 3 priority policy, management or regulatory issues that affect their work as well as the 3 highest priority science and conservation needs and those most likely to be affected by climate. The survey also asked for information on capacity needs both programmatically and across the GNLCC landscape. In all cases, the following four conservation and science needs were identified as the top 3 priorities with Land Cover and Vegetation Change as the highest priority by all survey participants:

- Land Cover and Vegetation Change
- Habitat Conditions
- Water Management and Instream Flows
- Invasive Species

Specific Science Needs

The following projects have been identified through the multi-tiered assessment process as important first steps to develop climate-related, landscape-scale science applications and decision support systems.

(1) An accessible spatially-explicit land-cover database for the GNGA.

A variety of information systems on land cover exist (e.g. NLCD, Landfire and other databases specific to individual agencies). To facilitate achieving the objectives of the GNLCC, we need to develop a consistent, contiguous, multi-agency database on land-cover. This will require an interagency evaluation of existing data sources and identification of sources that will best meet the needs of conservation managers of the GNLCC. The database requires skilled maintenance over time and appropriate level of infrastructure (computational and storage capacity) to support. Design and delivery of application and decision support systems are also needed for conservation practitioners to use this database. Several of these types of efforts are underway including a transboundary effort involving both US and Canadian mapping and coverage data in the Crown of the Continent area. Funding will be directed to complete, expand or enhance appropriate land cover efforts.

(2) Collection and assimilation of downscaled climate information to project potential shifts of ecological functions and processes, so as to ultimately support vulnerability assessments for priority populations and habitats. The production of downscaled climate data and projected hydrologic response simulations will be completed for the GNLCC by the Climate Impacts Group at University of Washington by the end of March 2010 as per existing contracts through US Forest Service and US FWS. Deliverables include statistical and graphical summaries of initial results along with the model output data. Next steps include the organizational capability of this information on an interagency basis to: (a) archive data, (b) perform maintenance and quality control, (c) develop value-added products which meet the needs of managers beyond the initial deliverables, and (d) support data and information transfer for further research. This requires computer capacity and data management and analysis skills. These products will serve as a foundation for continuing efforts to project plant community shifts, aquatic community shifts, and shifts in key plant foods for wildlife in response to changes in temperature and precipitation. The CIG downscaling is fully funded but follow up applications described above (i.e. impact analyses) require funds to complete.

(3) Enhanced efforts to document fine scale linkage areas (areas where movement between the large blocks of habitat in the Northern Rockies is still possible). In the Rocky Mountains, human development is concentrated in the valley bottoms. This creates fracture zones of high-risk habitat between the large blocks of public land. Fracture zones limit successful movement and dispersal by many wildlife species like grizzly bears and wolverines, which is critical to maintaining species resilience to the effects of climate change. There is a need to identify specific linkage areas through identification of key area and vulnerability to facilitate prioritization of conservation delivery efforts. This work will identify movement opportunity locations by using all available information including GPS radio collar tracking, DNA “capture” of animals on both sides of valleys, and expert opinion. This will be used to develop Resource Selection

Function (RSF) models to identify specific movement opportunity areas in the main valley areas of the Northern Rockies using the methods described in Procter et al. (2008).

(4) NWI Geospatial Data Acquisition and Assemblage. Improved land cover, land use, and habitat inventory data are needed in key landscapes for priority species, especially NWI or similar wetland GIS layers. Large sections of the GNLCC area do not currently have any available NWI data. Much of the available NWI data across the GNLCC is greater than 20 years old and may not reflect current landscape conditions. Thus, basic inventory of wetland abundance and distribution is generally unavailable, or uninformative, for much of the GNLCC. Consequently, development of effective landscape level conservation plans for wetland dependent wildlife is significantly compromised in this region. Updated and completed NWI data will be needed throughout the GNLCC to adequately inventory potential habitat availability for wetland dependent wildlife across the landscape. Periodic updates of such land cover information will greatly help the GNLCC and its partners assess net landscape change with climatic parameters and would facilitate understanding of how various wetland habitats within the landscapes may change over time in response to altered climatic conditions.

(5) Water Resource Vulnerability Assessments: This project will produce an assessment of the vulnerability of water resources and focal aquatic species to climate induced-changes in hydrologic processes. The resultant vulnerability assessment will incorporate projected changes to streamflow patterns (e.g., timing and magnitude of peak flows and low flows), disturbance regimes such as flood events and extreme low flows, stream temperatures, and existing population status and connectivity. The downscaled climate projections and hydrologic response simulations produced by the Climate Impacts Group will provide the foundation. The assessment will be spatially explicit and evaluate the relative vulnerability of watersheds (i.e., 5th or 6th field hydrologic units) within an assessment area. Finer-scale modeling of 4-6 individual watersheds will supplement the broader assessment. This project will produce information critical in helping conservation practitioners and the public:

- visualize projected climate-induced changes to individual watersheds
- understand the ecological risks to water resources and aquatic species
- update and refine existing conservation strategies for native fish species
- prioritize investments in actions to improve the resiliency of aquatic ecosystems.

Key deliverables will include documentation of assessment methods, results, limitations, and guidelines for conservation delivery applications. The project will produce easily-accessible maps and other graphical information on projected changes in streamflow patterns, stream temperatures, and fish species distributions. This project extends and complements a similar aquatic vulnerability assessment of Oregon and Washington watersheds being conducted by the USFS's PNW Research Station. The project builds on recent and ongoing research by the USGS, USFS, and others by producing user-friendly decision support tools for conservation delivery.

(6) Coordinated Avian and Habitat Monitoring. Population level relationships to landscape composition and habitat quality are currently poorly understood for many priority species within the GNLCC. For example, avian population surveys (abundance/density) at key sites that integrate habitat specific metrics will be critical to

development of reliable models of avian population and habitat relationships. Such surveys will need to be conducted at appropriate times that coincide with critical life cycle events (e.g., breeding season, migration, winter). The value of these surveys will become increasingly important through time as they will provide the raw data to 1) track population changes in response to habitat/landscape changes and environmental conditions (i.e., climate change), 2) improve power and confidence in preliminary predictive and explanatory models, 3) provide independent datasets to validate assumptions of models, 4) assess avian population response in relation to conservation delivery actions (or lack thereof). Development of reliable models regarding current population/landscape relationships will be critical to facilitate understanding of how priority wildlife populations may respond to altered landscapes via projected climate changes. The GNLCC would support growing partner-supported activities such as the BCR-Grid Based Coordinated Bird Monitoring Strategy that is being increasingly implemented across the GNLCC by members of the Partners in Flight community. This could be the first step in a process to improve monitoring for a range of species or species types.

While the science needs outlined above represent the preliminary findings from the GNLCC Team's assessment, FWS Regions 6 and 1 have identified multiple priority science needs for climate adaptation. These additional needs are outlined in Appendix 4. It is our intent to further evaluate all identified science priorities with the as-yet-formed LCC steering committee, in a structured forum (early in 2010, held in conjunction with USGS), to identify specific projects for the dedication of the \$875,000 regional allocation. Any prioritized science needs that exceed the allocation will be submitted for consideration respective to the \$2 million being administered by the WO.

Preliminary Assessment of Great Northern LCC Science Capacity Needs

The FWS is recommending that specific goals and objectives for the GNLCC be defined through a steering committee process. It is proposed the steering committee will develop an annual or bi-annual operational plan to define the goals and objectives for the LCC and the various tasks to achieve success. This is the process where efficiencies can be identified and realized as partners bring their resources together to address common needs. The first steering committee meeting is proposed for March or early April 2010.

The steering committee will also work together to identify the needs, available in-house staff, and other resources that can be used to build science capacity and meet the goals and objectives of the LCC. It is envisioned that some of these science support roles will be addressed through contracts with universities, contractors and the science partner organizations, cooperative FTEs among logical entities or partially supported in existing positions through LCC funding. As this process evolves, it is likely that additional key support positions will be identified through joint agreement of the LCC steering committee. These might include such positions as a communications/outreach specialist, biometrician, or population modeler(s). The steering committee will define the necessary skills and requirements for the positions as well as the desired station locations.

At this early stage in the GNLCC development process, the FWS is recommending that LCC Coordinator, Science & Technology Coordinator, and GIS Analyst/Data Steward positions be developed and hired within several months. An interim LCC Coordinator has been appointed and will serve until these positions are filled. As referenced above, dedication of remaining funds for science capacity, from the \$1.2 million allocation to the GNLCC, will be consistent with the findings and recommendations of the LCC steering committee.

As mentioned previously, the USGS will receive funding dedicated to collaboration and support of the LCCs. Therefore, the USGS will play a role in providing support to the development of the GNLCC science capacity. We have been collaborating with the USGS NOROCK Science Center in the conceptual development of collaborative science application and decision support capacity for the GNLCC - see <http://nrmssc.usgs.gov/SADS> for description. It is expected this capacity could be in the way of science products, contracts, cooperative positions or new FTEs. It is our understanding that USGS allocations specific to support the GNLCC are likely to be associated with the NOROCK Science Center in Bozeman. Preliminary discussions with USGS suggest that funds will include the provision to hire at least one full time scientist to meet GNLCC science capacity needs. At this time, we are prepared to recommend that the USGS hire one science coordinator to develop and provide science application and decision support capacity to the GNLCC partnership. If this comes to fruition, it is anticipated that this USGS scientist would be able to focus his/her expertise toward science and decision support needs germane to the montane habitats subunit, while the FWS-staffed Science & Technology Coordinator would be able to provide similar applied science support to issues and needs relevant to the Columbia Plateau (see “Functional Subunits Proposal”, above).

Next Steps

The FWS is recommending that specific objectives and goals for the GNLCC be defined through a steering committee process. It is proposed the steering committee will develop an annual or bi-annual operational plan to define these goals and objectives and the various tasks to achieve success. This is the process where efficiencies can be identified and realized as partners bring their resources together to address common needs.

The FWS will take the following steps to initiate a formal partnership of the Great Northern Landscape Conservation Cooperative. By June 2010, several key products will be developed:

- 1) a communications and coordination plan
- 2) a multi-dimensional synthesis of effort and organizations
- 3) an operational framework and plan
- 4) a GNLCC website
- 5) an annual work plan

GNLCC Communications and Coordination Plan

A communications and coordination plan will be completed by early January 2010. This plan will describe an inreach and outreach strategy, specific coordination objectives and identify the need for additional webinars, and other outreach and feedback strategies to ensure Service staff and partners are able to understand and engage in the GNLCC development.

The plan will describe inreach to Service staff within the GNLCC area and the functions of the new regional program area within the Mountain-Prairie and Pacific Regions.

- Specifically coordinate on cross-regional opportunities/needs with the NWR system, Ecological Services and Fisheries within R6 and R1.
- Internal website and web information
- Potential field station LCC coordination and I&E

The plan will describe outreach to and coordination with conservation agencies, organizations, and academic institutions:

- Specifically direct coordination with DOI and other Federal agencies involved in conservation with regards to:
 - USGS Climate Response Centers and other USGS climate related activities
 - National Park Service climate related activities (scenario planning and eco-regional inventory and monitoring networks)
 - Bureau of Land Management Eco-regional assessments
 - USFS Strategic Framework and Landscape Conservation Assessments
- Specifically direct coordination with State and Provincial Governments with regards to:
 - Wildlife Action Plans
 - Western Governors' Association and Initiatives
 - Natural resource, landscape and other climate related planning or activities
- Specifically direct coordination with Native American Tribes across the GNLCC

The plan will describe key public forums, local organizations and citizens groups for targeted coordination and involvement:

- Public website
- Citizen science-conservation programs
- Web-based feedback surveys and other feedback tools (e.g. survey monkey, RD Q&A sessions)
- Public outreach materials and projects (i.e. podcasts, newsletters)

GNLCC Synthesis of Effort and Organization

Various efforts are underway within the GNGA to assess potential effects of climate change on key resources (e.g., water resources, fish, wildlife, etc.) at local and landscape levels. Such efforts are occurring either related to climate or other landscape-scale issues to varying degrees throughout the GNLCC. It will be necessary to gauge each

effort for its scale, scope and resources in order to understand how the LCC can integrate with these efforts in a way that adds value to ongoing efforts. A multi-dimensional synthesis within the Great Northern landscape would provide GNLCC partners with a common analysis and summary of information about the state of knowledge concerning climate change and landscape conservation in the GNGA. The NPS, USGS and USFS and various universities have already shown an interest in partnering on a synthesis effort with in-kind and funding resources. Some existing partnerships such as the Greater Yellowstone Coordinating Committee and the C3 group have voiced a need for this type of information. This synthesis will comprise:

- Organization/agency (i.e., proposed and ongoing actions of each agency)
- Ecological services or natural resource management
- Climate data, information and understanding
- Monitoring and evaluation

To deal with multi-dimensional issues, this synthesis will include a cross sectional review of:

- data structure, hosting, organization, format
- geographic or ecological commonalities or gaps
- scale

Other Products

The website, operational framework and annual work plan will be developed under the guidance of the GNLCC Steering Committee.

Proposed Timeline for Next Steps

December 2009 to January 2010

- Complete communications and outreach plan for GNLCC
- Schedule additional webinars and survey input for January
- Initiate multi-dimensional GNLCC synthesis
- Coordinate with the NWR Inventory and Monitoring Program to delineate contributions and interactions within the GNLCC and potential to target climate adaptation
- Coordinate with other Service Program Areas on opportunities/needs
- Conduct ½ day executive forums with members of the Interagency Grizzly Bear Committee and the Intermountain West Joint Venture to initiate formation of the GNLCC steering Committee. The GNLCC assessment team has identified these two robust and effective landscape conservation partnerships as the likely core membership of the Steering Committee. The majority of respective members have expressed interest and willingness to participate.
 - Discuss ad-hoc Steering Committee membership
 - Discuss results of science needs assessment
- Initiate hiring process for GNLCC science planning staff:
 - Coordinator
 - Science Coordinators
 - GIS Analyst/Data Steward

February to April 2010

- Charter and hold first meeting of Steering Committee. In conjunction with USGS, this would entail a structured forum to:
 - Review of GNLCC synthesis report
 - Propose and approve GNLCC operational framework
 - Identify final science needs for FY2010

April to May 2010

- Develop framework and needs assessment for data-sharing platforms and data repository functions
- Approve funding for science needs for FY2010
- Identify capacity needs and potential means to fill (new FTEs, cooperative FTEs, contractual FTEs)
- Initiate contracts for science services

June 2010

- Develop draft FY2011 work plan

Budget Needs Summary

The following budget outlines FY 2010 funding needs to support the initiation of the GNLCC. This budget takes in consideration FWS funding for science planning (\$1.2M), science capacity (\$875K), and administration (\$150K). Only part of the funding has been allocated to particular tasks or staffing to allow for the GNLCC steering committee to be part of determining the full allocation. This budget also includes existing funding from the USGS/FWS Science Support Program (\$100K) and additional funding expected from USGS to support GNLCC science staff and to conduct research (\$600K). It is hoped that over time other partners will contribute funding or staff to support the GNLCC.

GNLCC Funding Needs				
Funding Source	FWS Science Planning	FWS Science Capacity	Assumed USGS LCC Support	SSP
LCC Coordinator	\$140,000			
Science Coordinator (Montane)			\$140,000	
Science Coordinator (Columbia Plateau)	\$140,000			
GIS Analyst/Data Steward	\$140,000			
Shared Data Repository Platform				\$100,000
Science planning (e.g., equipment, additional	\$780,000			

staffing), TBD with LCC Steering Committee				
Science capacity (e.g. data acquisition, modeling, synthesis, DSS), TBD with LCC Steering Committee		\$875,000	\$460,000	
Total Funding	\$1,200,000	\$875,000	\$600,000	\$100,000

The FY10 Budget estimates, above, do not recognize additional costs associated with operation and administration of the Great Northern LCC. These anticipated additional costs include:

- 1) Travel, equipment, and office space for FWS staff
- 2) Administrative costs to R6 (\$150,000 available in FY10 budget)
- 3) R6 RO staff positions for LCC oversight, administration, and services (e.g., ARD for Science Applications, Communications Specialist)

Additional obligations for the above costs will be determined at a future date. At this time, we have not determined the location of facilities to house the dedicated science planning positions. Positions are likely to be located at multiple locations within the Geographic Area, and optimally collocated at FWS and/or USGS facilities so as to have access to and leverage existing science support capacities.

Citations

Littell, J.S., M. McGuire Elsner, L.C. Whitely Binder, and A.K. Snover (eds). 2009. *The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate*, (PDF 14.1 MB) Climate Impacts Group, University of Washington, Seattle, Washington

Pachauri, R.K. and A. Reisinger (eds). 2007. Interagency Panel on Climate Change Summary for Policy Makers Synthesis Report, Geneva, Switzerland. 104pp.

Proctor, M. F., C. Servheen, W. Kasworm, and T. Radandt. 2008. Grizzly bear linkage enhancement plan for the Highway 3 corridor in the south Purcell Mountains of British Columbia. Report of the trans-border grizzly bear project. Grizzly Bear Recovery Office, USFWS, Missoula, Montana USA. 34 pp.

Appendix 1:



Appendix 2: Great Northern Landscape Conservation Cooperative Matrix of Partners, Roles, Contributions and Conservation Partnerships

This matrix represents preliminary information on LCC outreach, roles and partnerships. Information will be added and refined as the LCC Partnership develops.

Organization	Tier(s)	Communication	Role	Contribution		Participation in Existing Conservation Partnerships (see legend below for explanations)											
				Funding	Science	WLCI	SWAP	WGA	BC	C3	COC	GYCC	IGBC	IWJV	YGCC	WNTI	NFHP
US Fish and Wildlife Service	Mountain Prairie R6 Pacific R1	Lead; engaging partners in face to face meetings, follow up communication and interagency LCC team	Invested Partner	FY10 \$,200K \$875K \$150K	new FTEs existing FTEs ongoing projects A, B, C, D, E	x	x		R6	R1	R6	R6	X	x	R6	X	x
US Geological Survey	NOROCKSC, PNWSC BRD, WRD GCP Regional Director for Central Region	Co-lead Working with FWS to develop LCC vision/plan; FWS Region 6 Director holding personal conference calls or briefings with Central Region Director	DOI Invested Partner	NOROCK FY10 \$600K FORT/SSP \$175K	New FTEs Existing FTEs Ongoing projects A, B, E	x		x		x		x	X		x	x	x
National Park Service	Yellowstone NP Glacier NP Cascade NP Regional Director of Intermountain Region	FWS Region 6 Director holding personal conference calls or briefings; YNP engaged and participating LCC staff in MT; GNP informed; CNP informed; Webinar	DOI Invested Partner		A, B, C, D, E	x				x	x	YNP	YNP GNP		x		
Bureau of Land Management	ID, MT, OR, WA, WY State Director's Office, Resource Planning staff	FWS Region 6 Director holding personal conference calls or briefings with MT/WY BLM State Directors; R6 staff held face to face meetings and ongoing	DOI Partner		A, B, C, D, E Eco-Regional Assessments	x				x				x	x		

		email exchanges with MT/WY BLM to share vision and information															
Bureau of Indian Affairs	Regional Office	FWS Region 6 Director holding personal conference calls or briefings; Webinar	DOI Partner														
Bureau of Reclamation		Webinar, emails, meeting with Idaho State Director	DOI Partner		A,C	x											
EPA		Webinar and emails	Federal Partner							X							
BPA	OR, WA, ID	Webinar and comments	Interested Partner		A,C												
US Forest Service	Northern (1), Intermountain (4) and Rocky Mountain (2) regions; Regional Foresters	FS R1 engaged and participating R2&4 informed; Working closely with regional climate coordinator R1; FWS R6 Director holding personal conference calls or briefings with USFS R2 & R4 Foresters	USDA Partner		A, B, C, D Rocky Mtn and Pacific NW Research Stations, Climate Research funding	x			x	x	x	x	X	x	x	x	x
NRCS	State field offices	Webinar	USDA Partner			x								x			
NOAA and NOAA Fisheries	WA, OR, ID	Webinar and working closely with USGS and R1 LCC staff	Federal Partner		A, B, C, E Science/RISAs					x							
Idaho	IFG and other departments	R1 held Face to face meeting with ID Fish and Game; Webinars	State partner		A, C, D		x	x						x	x		x
Montana	Fish Wildlife and Parks; Forest Division and DEQ	FWS R6 Director holding personal conference calls or briefings with MT FWP	State partner		A, C, D Interested in coop FTEs		x	x	x		x		x	x		x	x

Society																		
EMRI		webinar	NGO partner		B, E													
NCCSP		Phone/email communication webinar	NGO partner		B, E													
DU		webinar	NGO partner			x												
TU		webinar	NGO partner															
Vital Ground		webinar	NGO partner															
NWF		webinar	NGO partner		E		x											
RMEF		webinar	NGO partner			x												
SWSD		Presentation in MT; webinar	Community partner		A, C	x												

Federal - Management
Federal - Science
State
Tribal
University
Non-Governmental

Contribution Codes

- A Potential for cooperative funding from existing sources and programs
- B Existing science capacity at field offices
- C Potential for future climate-related resources towards monitoring and evaluation
- D Potential for future climate-related resources towards conservation delivery
- E Potential for conservation/climate planning assistance

Partners and Partnership Acronyms

- BPA – Bonneville Power Authority
- BC - Blackfoot Challenge
- C3 – Climate Change Collaboration
- COC – Crown of the Continent
- DU – Ducks Unlimited
- EMRI – Ecosystem Management Research Institute
- EPA – Environmental Protection Agency
- FB – Farm Bill funding
- GYCC – Greater Yellowstone Coordinating Committee

IGBC – Interagency Grizzly Bear Committee
IWJV – Intermountain West Joint Venture
LTA – Land Trust Alliance
NCCSP – National Center for Conservation Science and Policy
NFWF – National Fish and Wildlife Foundation
NOAA – National Oceanic and Atmospheric Administration
NRCS – Natural Resources Conservation Service
NWF – National Wildlife Federation
RMEF – Rocky Mountain Elk Foundation
SWCD – Soil and Water Conservation Districts
SWAP – State Wildlife Action Plans
TPL – Trust Public Land
DU – Ducks Unlimited
TU – Trout Unlimited
WGA – Western Governors’ Association
WLCI- Wyoming Landscape Conservation Initiative
YGCC – Yellowstone Grizzly Bear Coordinating Committee

Appendix 3: List of Information Sources contributing to Preliminary GNLCC Science Needs Assessment

Ongoing collaborative climate and landscape-themed workshops and assessments within the GNLCC:

- C3 (Climate Change Collaboration in the Pacific Northwest) “first ten” priorities assessment (Completed, May, 2009)
- Greater Yellowstone Science Planning Workshop (November 4, 5 2009)
- FWS/WCS Grizzly Bear/Wolverine Climate Workshop (Oct 6, 7 2009)
- Rocky Mountain Front Science Needs Ad-hoc Workshop (November 16, 2009)
- Wyoming Land Conservation Initiative Science Assessment (November 17, 2009)
- Montana Fish, Wildlife and Parks Climate Workshop (2008)
- Crown of the Continent Climate Workshop (November 2008)
- Bull Trout and Climate Change (May 2008)

Science needs identified through focal species- and habitat-oriented partnerships or workgroups within the GNLCC:

- Interagency Grizzly Bear Committee (Grizzly Bears)
- Intermountain West Joint Venture (waterfowl, shorebirds, waterbirds, landbirds)
- North American Salmon Stronghold Partnership
- Salmon and Steelhead Technical Review Teams
- Bull Trout Working Groups
- Westslope, Yellowstone and other Cutthroat Trout Workgroups
- Sage Grouse Technical Working Group
- Western Governor’s Wildlife Corridors Initiative
- Lamprey Technical Working Group
- Pacific Flyway Council-Rocky Mountain Population of Trumpeter Swans - Greater Yellowstone Trumpeter Swan Working Group
- Canadian Intermountain Joint Venture

Science needs identified through geographic- or watershed-based collaborations within the GNLCC:

- State of Oregon’s Subcommittee on Fish, Wildlife, and Habitat Adaptation, Oregon Global Warming Commission (and other similar State efforts)
- State Wildlife Conservation Action Plans
- Blackfoot Challenge
- Heart of the Rockies Initiative
- Greater Yellowstone Coordinating Committee
- Intermountain West Joint Venture
- Upper Salmon Basin Watershed Technical Advisory Committee
- Watershed Councils or Soil/Water Conservation Districts
- Yakima Basin Fish and Wildlife Recovery Board
- Clearwater Technical Group
- Kootenai/Kootenay River Network
- Columbia Basin Trust
- Wyoming Landscape Conservation Initiative

Direct input from FWS field leadership and key partner science or management organizations:

- FWS Project and Program Leaders
- USGS Science Centers
- National Park Service Science and Resource coordinators
- USFS Regional coordinators and Research Stations
- BLM State Coordinators
- State fish and wildlife agency leadership
- Tribal fish and wildlife agency leadership
- NGO leadership and key representation

Appendix 4: Priority Science Needs for Climate Adaptation, as identified by R6 and R1 Resource Programs

1) Model how climate change will affect discharge regimes and consequently, habitat availability and access, in large river systems across GNLCC. Temporal scope would include time-series analysis of the next 50 years.

Geographic influence area: Upper Missouri River system, Columbia River system, Upper Green River system

Annual cost and time horizon: \$1 million/year for 2 years.

2) Identify key threatened and endangered species likely to be affected by climate change and design and implement monitoring techniques throughout the GNLCC to assess their status and evaluate how respond and adapt to climate change.

Geographic influence area: Throughout the GNLCC.

Annual cost and time horizon: \$0.5 million/year for 20 years.

3) Identify critical needs for fish passage and fish barriers and increase efforts throughout the GNLCC to expand access to fish habitat and the ability of aquatic species to adapt to climate change and protect vulnerable fish populations from nonnative fish invasions through barriers where appropriate.

Geographic influence area: Throughout the Mountain-Prairie Region.

Annual cost and time horizon: \$1.5 million/year for 25 years.

4) Identification and Protection of Fish and Wildlife Genetic Strongholds and Associated Migration Corridors for Environmentally-Sensitive Species

Climate change will place significant biological stress on genetic, physiological, and other biological characters of fish and wildlife species. Genetic strongholds, with the potential biological capability to respond adaptively to changing environments, need to be identified and protected to allow environmentally-sensitive species the opportunity to survive and propagate in altered habitats. Genetic strongholds, by definition, represent populations with relatively large effective population sizes that already inhabit variable habitats. Such populations are expected to have the greatest likelihood of possessing the genetic variation and biological resiliency to respond adaptively to changing environments.

Geographic influence area: Throughout the GNLCC

Annual cost and time horizon: \$500K annually over 3 years.

5) Technological applications to monitor the physical condition of sensitive mammal species and relate these physical conditions to changing temperature, precipitation and snowpack and the resulting impacts on the food species these animals depend upon. Use of stable isotopes to measure annual and life time changes in food habitats over time in selected species in response to climate change.

Geographic influence area: Northern Rockies, Yellowstone ecosystem northward into British Columbia and Alberta.

Annual cost: \$45,000/year for 10 years.

6) Detailed long-term radio monitoring of selected sensitive species to document current baseline data and response over time to changes in temperature and precipitation with resulting changes in vegetation. These long-term monitoring efforts will document response mechanisms of key species as change continues and will inform an understanding of movement patterns, food habits, elevational range, seasonal use areas, movements and habitat use related to climate effects, so as to inform spatially explicit conservation actions.

Geographic influence area: Northern Rockies, Yellowstone ecosystem northward into British Columbia and Alberta.

Annual cost: \$0.6 million/year for 10 years.

7) Landscape-scale Screening for Climate Change Impacts to River Habitat in the Pacific Northwest. This project will characterize peak flows, summer base flows, sediment sources, and nonresistant watershed attributes (such as landslides, high debris levels, and reaches with low channel stability) in multiple watersheds to predict watershed resiliency to climate change at multiple scales. This 3 year project will better inform Regional habitat restoration priorities, improve effects analyses in Endangered Species Act consultation efforts, and improve prioritization of Service actions.

Geographic influence area: Columbia Basin portion of GNLCC

Annual Cost and time horizon: \$1 Million over 3 years.

8) Projections of expected vegetation changes in high elevation areas above 1800 meters are likely to see more rapid changes in vegetation community structure and distribution as temperature, precipitation and snowpack changes. Identify vulnerable forest and plant communities and project shifts in forest communities due to climate change.

Geographic influence area: Northern Rockies, Yellowstone ecosystem northward into British Columbia and Alberta.

Annual cost: \$66,000/year for 3 years.

9) Detailed ecological studies on key plant food species – e.g. huckleberries (*Vaccinium* spp.) and white bark pine whose productivity appears to be linked to climate variables and are important alpine plants that provide nutrition to sensitive species.

Geographic influence area: Northern Rockies, Yellowstone ecosystem northward into British Columbia and Alberta.

Annual cost: \$62,500/year for 4 years.

10) Enhanced vulnerability analyses concerning expected climate change impacts on key species and ecosystems. This work could result from a vulnerability analysis by species combined with an analysis of key variables that each species is dependent upon (i.e. denning snow cover or nesting habitat).

Geographic influence area: Northern Rockies, Yellowstone ecosystem northward into British Columbia and Alberta.

Annual cost: \$75,000/year for 6 years.

11) Assess the interrelatedness of hydrological changes due to climate change and the spatial and temporal incidence of parasites and other disease issues affecting amphibian

species. Assessment would identify wetland characteristics that exacerbate or buffer disease- and parasite-caused amphibian malformations across a changing landscape; providing decision support for management. This initial study could serve as a template for consistent assessments across wetland landscapes

Geographic influence area: GNLCC affected wetlands.

Annual cost: \$155,000/year for 3 years.

12) Acquire adequate technical capacity to conduct comprehensive hydrologic evaluations, including facility-based water resources assessments and watershed assessments in two priority ecoregions (Northern Rockies and Columbia Basin) to identify water resource limiting factors and provide a more accurate and detailed information on the impacts of climate change. After assessments across the two focus areas, the team will be available to support water resource assessments and decision support in other priority locales.

Geographic influence area: Throughout the GNLCC with initial focus in two priority ecoregions.

Annual cost: \$0.5 million/year for 10 years.

13) Expand capability for early detection and response to for management and control of invasive species, both terrestrial and aquatic. This capability includes ability to model probabilities of invasion as influenced by changing climate patterns, conduct risk assessments to priority species and habitats, detect invasions in situ, and implement prioritized control actions.

Geographic influence area: Throughout the GNLCC.

Annual cost: \$1.5 million/year for 10 years.

14) Capability to understand and predict how agricultural and wetland landscape will change to ensure adequate food and water resources to sustain wildlife populations at desired levels. Changes in the agricultural landscape and associated availability of water due to climate change could dramatically affect cropping patterns and hence availability of important foods for wildlife. Hence, we require the ability to investigate and model various tolerances to climatic variables, so as to support the development of landscape strategies.

Geographic influence area: GNLCC

Annual cost: \$0.5 million/year for 5 years.

15) Projecting Habitat Loss, Species Vulnerabilities, and Cumulative Effects of Potentially Developing Renewable and Nonrenewable Energy Projects Across the GNLCC. Taking a broad view of the west, create models of potential future energy developments across the west, including pipe- and transmission lines, wind, solar, and other projects, and estimate habitat and species effects from those developments. Results will inform the response of States, FWS, and partners to proposed developments, and in the design of protected landscapes.

Geographic influence area: GNLCC

Annual Cost and time horizon: \$360K/yr for 3 years

16) Model current and future energy demand and develop scenarios regarding the likely extent of wind energy development on the landscape, and assess impacts to wildlife. Develop decision-support tools to assist wind energy developers in siting wind farms to minimize impacts to wildlife.

Geographic influence area: Throughout the GNLCC.

Annual cost: \$0.5 million/year for 10 years

17) Disease management. Aquatic resource pathogens are spreading as a result of warming water and changes in flow patterns. The Wild Fish Health Surveys need to be expanded so that we understand where and how pathogens are spreading and so we know where non-affected areas persist as we focus on refugia and restoration actions.

Geographic influence area: Throughout the Great Northern LCC.

Annual cost: \$0.5 million/year for 10 years

18) Tribal Assistance. Some tribes in GNLCC have only rudimentary fish and wildlife conservation programs and rely on the Fisheries Program for technical assistance aimed at their management of big game, waterfowl, fish, mussels, and habitat sustainability. With climate change, the rapid assimilation of information and conversion of information into conservation actions is essential. Additional resources are needed to enhance engagement with and provide technical support and assistance to Tribal partners.

Geographic influence area: GNLCC

Annual cost: \$.2 million/year for 5 years

19) Enhanced surveys for sensitive species in key linkage areas (connections between the large blocks of public land in the Northern Rockies) and within these blocks of habitat. These could be camera and DNA hair grid sampling to look for sensitive species like wolverines and grizzlies and other survey methods to document pikas and ptarmigan. These surveys are important now because as temperatures and precipitation change with resulting impacts on vegetation, we need to know what distribution and presence changes are occurring for sensitive species as they happen. These data will become increasingly important as climate change effects continue.

20) Application of measures to monitor the physical condition of sensitive species like the use of bioimpedance meters to directly measure fat levels in living animals and relate these physical conditions to changing temperature, precipitation and snowpack and the resulting impacts on the food species these animals depend upon.

21) Detailed ecological studies of important alpine plants that provide nutrition to high elevation species like pika and ptarmigan as well as grizzly bears.

22) Enhanced efforts to find controls for mountain pine beetle population expansion that is changing forested landscapes across western North America. Bring together specialists in entomology and plant ecology in an attempt to address this most serious issue.

23) Spatial assessment of water temperature increases in higher-elevation areas of our region where many aquatic species, such as cutthroat trout, are already near the limits of

their range, leading to the development of a predictive model to identify core areas to support metapopulation resilience (adequate representation of seasonal habitats and linkages).

24) Interagency Climate Change Collaboration Coordination

Federal agencies within the Pacific Northwest recently created a Climate Change Collaboration (C3) dedicated to efficient information exchange and coordination of all federal climate change adaptation efforts. A full time coordinator funded by FWS would ensure leadership on a regional scale for partnerships, federal caucuses, research centers, etc. that span multiple LCCs.

Geographic influence area: GNLCC

Annual Cost: \$150K annually.

25) Monitor response of invasive plant species to climate changes. This effort would 1) create long-term monitoring sites where invasive species have established and/or have been treated (attempts to “control” them have or will be accomplished), and would collect long-term data at these sites to help managers determine which control methods are successful, which are most cost effective, which system components (water, soils, disturbance regime, species abundance, species diversity, etc.) are driving these results and how climate might change these parameters and response.

Geographic influence area: Sample locations in the Northern Rocky Mountains

Cost: \$50K in collaboration with MSU, TNC and others.

26) Provide state-of-the-art climate change projections for wolverine habitat in the contiguous US through the utilization of downscaled climate change data (under development by UW-CIG) to estimate the impact on wolverine habitat of anticipated climate changes over a time scale that will be relevant to the upcoming 12-month finding (Due Dec. 2010) for the ESA status for wolverine. The analysis will utilize a new wolverine habitat model developed by the USFS Rocky Mountain Research Station (recently published in Can. J. Zool.). The results of the study will support the determination if climate change is likely to threaten wolverines in the foreseeable future. It will also inform management decisions by highlighting important habitat areas that may be lost as well as habitats that may be robust to climate changes so that appropriate decisions can be made about prioritizing conservation efforts. Cost-share project with USDA Forest Service.

Geographic influence area: Northern Rockies (including the GYA) as well as the North Cascades

Cost: \$15K