Great Northern Landscape Conservation Cooperative

Strategic Conservation Framework

November 2012

Foreword

The purpose of this strategic conservation framework is to articulate the rationale, approach, and priorities for the Great Northern Landscape Conservation Cooperative (GNLCC) that reflects the unique geography and regional natural resource issues. The information presented in this document is summarized from background research on existing landscape initiatives (place-, issue-, or species-based) and other regionally summarized ecological and landscape information relevant to the Great Northern geography.

The conservation targets identified in this document are based on research with conservation partners and ongoing landscape-scaled initiatives. We collected and reviewed over 50 documents that may be relevant to the Great Northern LCC and conducted nearly 60 interviews with members of the Steering Committee, Advisory Team, and Partner Forum representatives. The conservation targets (i.e., ecosystem processes, ecosystems or habitats, and species or focal resources) provide a common focus for organizations to move toward a collective landscape vision using specific ecological outcomes within the GNLCC.

The GNLCC Strategic Conservation Framework (as described in the GNLCC Governance Charter) is intended to guide priority setting for annual work plans over a five- to ten-year time period. The framework provides the foundation for specific research and technical actions, institutional collaboration, and the application of ecological information, including future additions through GNLCC Partner Forums (see the GNLCC Governance Charter).

We recognize that this document is a starting point, and that the priorities expressed herein will continue to evolve and be refined. We are grateful for the contributions of partners and advisory team members who helped shape this document. We are also grateful to our colleagues leading the partner forums, who will take the concepts in this framework the next steps.

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Cover photo: Glacier National Park, NPS

Introduction

Landscape Conservation Cooperatives (LCCs) are applied conservation science partnerships that provide scientific and technical support for conservation and inform sustainable resource management at landscape scales. Landscape Conservation Cooperatives are intended to inform sustainable management of land, water, fish, wildlife, and cultural heritage resources in response to climate change and other landscape-level challenges.

The Great Northern Landscape Conservation Cooperative (GNLCC) is a voluntary network of partners working to address common landscape conservation goals. We work together to identify commonalities among our efforts and build consensus to enact a regional approach to landscape conservation. We work across boundaries and jurisdictions, and share data, science, and capacity to achieve common goals.

The GNLCC is creating the conditions that enhance individual and collective partner implementation of landscape-level conservation. Through information sharing, capacity building, effective analyses and decision-support tools, and collaborative networks, the GNLCC creates efficiencies and reduces the challenges of working in complex ecological and jurisdictional systems.

VISION

A landscape that sustains its diverse natural systems to support healthy and connected populations of fish, wildlife, and plants; sustains traditional land uses and cultural history; and supports robust communities.

MISSION

Coordinate, facilitate, promote, and add value to large landscape conservation to build resource resilience and inform sustainable resource management in the face of climate change and other landscape stressors through the following:

- **SUPPORT SCIENCE DEVELOPMENT**
  Identify and facilitate the development, integration, and application of social and natural scientific information needed to inform conservation actions and sustainable resource management decisions to conserve water, land, fish, wildlife, and cultural heritage.
- **EFFECT COORDINATION**
  Support coordination and integration of conservation science and actions across ecosystems at the landscape scale, leveraging the capabilities of respective agencies/organizations/ partnerships, and provide real-time situational awareness of on-going conservation efforts.
- **INFORM CONSERVATION ACTION AND SUSTAINABLE RESOURCE MANAGEMENT**
  Provide scientific information and decision support tools informing conservation action and sustainable resource management that conserve water, land, fish, wildlife, and cultural heritage.
- **MONITOR AND EVALUATE**
  Support efforts to monitor landscape-scale indicators, test scientific assumptions, and evaluate effectiveness of conservation actions and sustainable resource management to inform adaptive management decision making.
- **COMMUNICATE AND EDUCATE**
  Communicate relevant science information and GNLCC activities and opportunities to partners and users. Facilitate collaborative conservation and seek to leverage capabilities and support.

The GNLCC supports the missions and mandates of its partners. Working together in partnership, the GNLCC can add value to existing efforts through:

- Creating a vehicle for collaborative, collective effort to address landscape-level challenges;

- Putting science in the hands of practitioners through shared information, accessible tools, and resources; and
- Facilitating the interaction of existing partnerships and initiatives and supporting alignment for greater effectiveness.

GUIDING PRINCIPLES

- WORK COOPERATIVELY AND COLLABORATIVELY to improve effectiveness of each organization's large-scale landscape conservation programs and efforts.
- CONDUCT OPEN AND FREQUENT COMMUNICATIONS within the GNLCC network, between related climate change and landscape programs, and among the expanded climate change and landscape conservation community.
- CONSIDER AND RESPECT each participating organization's unique mandate and jurisdiction.
- COORDINATE WITH OTHER committees, work groups, or organizations that add mutual value, maximize capacity, avoid redundancies, and leverage resources.
- FOCUS ON SOLVING scientific, ecological, and biological issues to promote scientifically sound, outcome-based adaptive management.
- RESPECT SOCIAL, POLITICAL, AND LEGAL LIMITATIONS while promoting solutions to landscape-level stressors that benefit the greater GNLCC conservation community.
- BE TRANSPARENT in operations and ensure equal and open access.

Organizational Structure

The Great Northern LCC is a network of partners working toward a collective landscape vision and conservation goals. This network comprises diverse U.S. federal, Canadian provincial and federal, Tribal Nations, state, nongovernmental, and academic conservation organizations. These groups work together within an organizational structure as described in Figure 1.

Figure 1. Organizational structure of the GNLCC, identifying main committees, their roles, and functions.

Scope

The Great Northern is an international, transboundary landscape and a complex mosaic of geography, organizations, and jurisdictions. The U.S. portion includes large parts of Idaho, Montana, Oregon, Washington, and Wyoming—an area of approximately 260 million acres. A large portion of British Columbia (BC), and a portion of Alberta, Canada make up approximately 40 percent of the Great Northern region. The GNLCC has embraced an international approach to transboundary conservation; however, there are fundamental differences in government structure and jurisdiction among the partners. Canadian partners are coordinating to determine the right model of landscape conservation that can interface with U.S. efforts within the Great Northern area. Collectively, this will define the GNLCC; at this point, however, this strategy was developed primarily through coordination of U.S. partners with involvement from Canadian partners in transboundary issues. It is recognized that this strategy may be broadened at some point in the future to represent the priorities of the Canadian partners, as the organizational model and appropriate international interface is developed.

The Great Northern Landscape

As a landscape, the Great Northern area includes interior British Columbia and portions of Alberta in Canada, the eastern portion of Washington, northeastern Oregon, northern Idaho, and western Montana and Wyoming. It includes a large portion of the Rocky Mountains (central and north) as well as portions of two major U.S. river basins (the Upper Columbia and Upper Missouri) with topography ranging from high alpine peaks and northern boreal forest to rolling plateaus, deep canyons and desert sage-steppe plains (Figure 2). This landscape is home to iconic North American wildlife and fish such as the grizzly bear and wild Pacific salmon; it includes some of the largest, most intact, and most protected areas outside of Alaska.

Landcover throughout the GNLCC is dominated by coniferous forests (44%) and shrublands (34%). Grasslands (9%), cropland (5%), barren land (3%), and water (2%) are other significant components (Figure 2). In the U.S. portion of the GNLCC, federal agencies (U.S. Forest Service, Bureau of Land Management, National Park Service, Bureau of Reclamation, and U.S. Fish and Wildlife Service) manage 53% of the land base; 37% is held privately; and states own 5%. In Canada, 94% of the landbase is Crown (public) land.

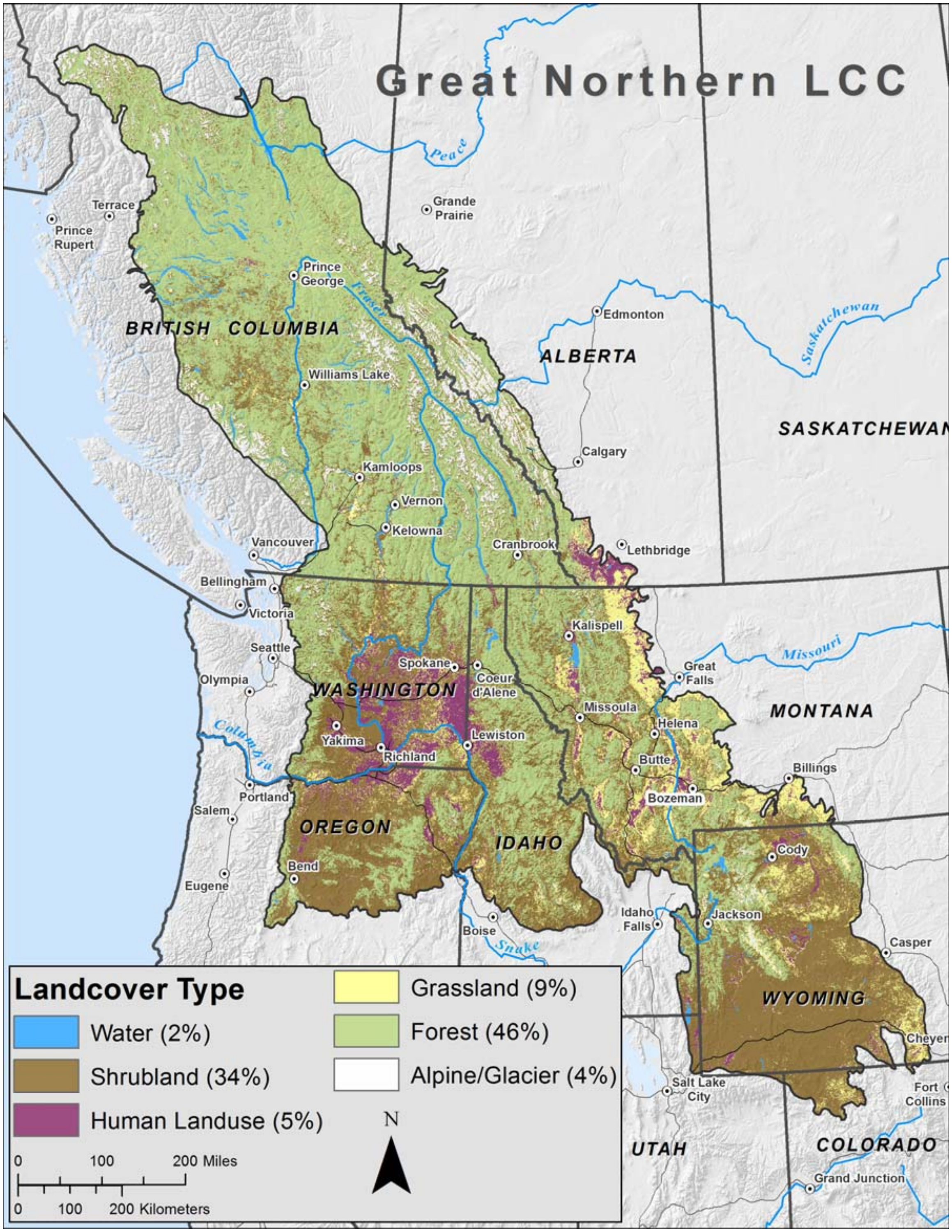

Figure 2. Map of the GNLCC landscape.

Landscape Stressors and Impacts

The overall ecological integrity of the Great Northern geography is impacted by landscape-level stressors. The three main stressors considered in this framework are climate change, invasive species, and land use change. The interaction of these stressors contributes to loss of habitat, fragmentation, changes in ecological function, and impacts on terrestrial and aquatic integrity. These stressors act at a scale that challenges the capacity and resources of partners.

Climate Change

The climate is changing, and the effects are seen in the Great Northern's valuable ecosystems and in the economies and communities that depend on plants, animals, and habitats. Warmer temperatures and changing precipitation patterns are expected to cause more fires and more pest outbreaks such as the mountain pine beetle epidemic, while boreal forest are expected to move north into what is now tundra. Grasslands and shrublands are more likely to be invaded by non-native species and wetlands may suffer losses from drier conditions. Climate change can exacerbate the impacts of habitat fragmentation and loss of ecosystem integrity caused by other landscape stressors.

Invasive Species

Invasive species are a threat to native biodiversity and have major implications for the conservation of public and private lands and the production potential of working landscapes. Invading landscapes at alarming rates, invasive species are adversely impacting aquatic and terrestrial ecological function. Landscape effects have been documented from a range of invasive species including blister rust, cheatgrass, and aquatic invasive fish, macroinvertebrates, and pathogens such as whirling disease.

Land Use Change

From wildlands to working lands, the GNLCC landscape comprises a complex matrix of land uses reflecting diverse and changing economic reliance on natural resources. One major impact affecting natural resource management in Great Northern landscapes is energy development. This includes conventional development such as oil and gas, renewable energy development such as wind farms, and the infrastructure of transmission corridors and roads to support them. Land use decisions require specific kinds of science and information on key wildlife, ecological and landscape function, in order to minimize the loss of habitat connectivity and ecological function during development and operation of energy infrastructure. Increasing human populations in the regions instigate urban and exurban development and lead to increased human-use impacts on connectivity and ecological integrity.

Conservation Goals and Targets

To accomplish the vision of a landscape that sustains its diverse natural systems, the GNLCC intends to work toward ecological integrity at a landscape scale. Ecological integrity is defined as the ability of an ecological system to support and maintain a community of organisms that has the species composition, diversity, and functional organization comparable to those of natural habitats. Areas of highest ecological integrity have unfragmented natural landscapes, biotic and abiotic components well within the natural range of variability, and few impacts from invasive species. These areas are resilient to change, often contain large intact blocks of land, and sustain healthy and connected populations of fish, wildlife, and plants.

Landscape goals and interrelated, scaled conservation targets (ecosystem processes, ecosystems, and species) reflect the shared objectives of GNLCC partners.

Goals

This strategic framework maps hierarchically scaled interrelationships among conservation targets in order to allow partners working at all scales (local, regional, and national) to understand how their science and conservation efforts tier to the priorities of the GNLCC and contribute toward the over-arching goal of ecological integrity. These are described in greater detail in the following sections (see Figure 3).

Goal 1: Maintain large, intact landscapes of naturally functioning terrestrial and aquatic community assemblages.

Large landscape conservation aims to ensure that large, intact areas connect and sustain diverse habitat types, and maintain ecological function and resilience in the context of existing stressors. The region's biodiversity exists in a mosaic of landscape elements including diverse habitat types across a variety of scales. Areas of refugia, connectivity, and smaller habitats are necessary to ensure resilience and the interactions among species and the ecological processes that support high integrity systems.

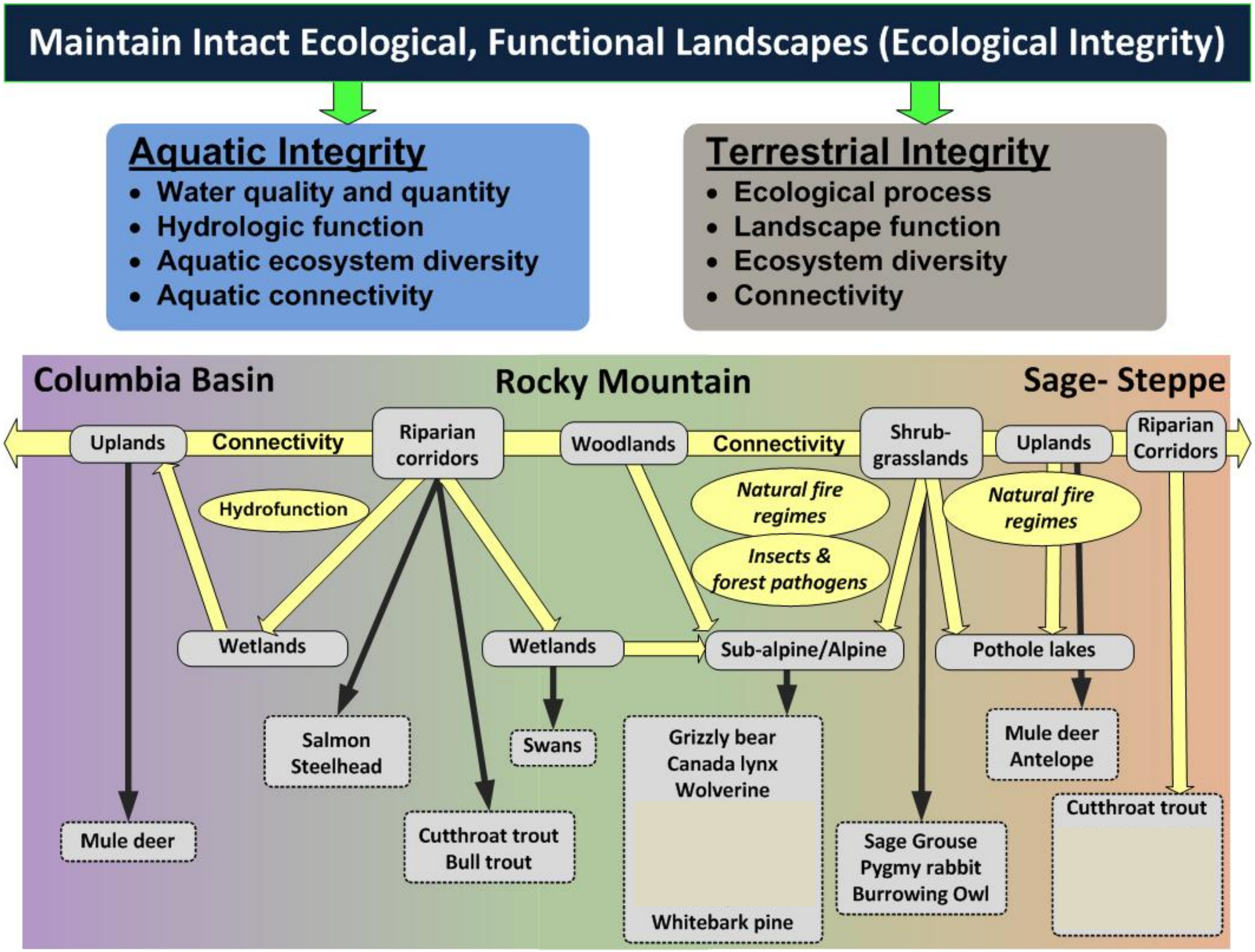

Figure 3. Summary of the hierarchical relationships among conservation targets. [Note: additional species (elk, flammulated owl, black-backed woodpecker, flannelmouth sucker, blueheaded sucker, and roundtail chub) were also suggested, but have not been vetted, so are not included at this time.]

Goal 2: Conserve a permeable landscape with connectivity across aquatic and terrestrial ecosystems, including species movement, genetic connectivity, migration, dispersal, life history, and biophysical processes (recognizing this is species dependent, and recognizing in some circumstances connectivity is not desired).

Habitats are likely to shift due to climate change and other stressors. In order to maintain desired connectivity (and limit connectivity in certain cases to minimize detrimental impacts) we need to understand the current level of landscape permeability, identify existing corridors and anticipate how these might shift or change in condition in the future. Maintaining and restoring connectivity can help species adapt to climate change and mitigate other impacts of landscape stressors.

Goal 3: Maintain hydrologic regimes that support native or desirable aquatic plant and animal communities in still and moving water systems.

Hydrologic regimes (e.g., the timing, magnitude, and quality of water flow) are likely to shift due to climate change and other stressors. The ecological structure (e.g., configuration, connectivity, and size) and function of native or desirable riparian, aquatic, and wetland community assemblages provide habitat for aquatic-dependent species. Maintaining the functional matrix of aquatic and hydrologic systems is critical to maintain aquatic biodiversity, resilience, and ecosystem processes.

Goal 4: Promote landscape-scale disturbance regimes that operate within a future range of variability and sustain ecological integrity.

Disturbance regimes are shifting in time and space due to climate change (e.g., frequency and intensity of fire, spread of forest insects and disease, frequency and severity of drought and flooding). Risk assessments can help identify future conditions and the potential for extreme events, help identify vulnerable areas, and focus management efforts on areas with the greatest ecological contribution to the landscape. Maintaining ecosystem processes within the range of variability of disturbance can facilitate climate adaptation efforts.

Conservation Targets

The GNLCC has conceptually related broad conservation issues to three "ecotypic areas"—Columbia Basin, Rocky Mountain, and Sagebrush Steppe. These ecotypic areas cover large expanses within the GNLCC, have similar ecological systems with relatively consistent species compositions and configurations, and are facing common conservation issues. Our intent in identifying ecotypic areas is to connect local landscape partnerships working on similar conservation issues to broaden their positive affects to larger landscape scales.

Species were identified based on the documentation of their importance in relevant foundational documents, their representation of the ecotypic area, and their occurrence and distribution throughout the GNLCC landscape. Species were considered based on their role as: (Tier 1) umbrella species whose function and outcomes represent many other species; (Tier 2) ecological process indicator species that have direct ties to critical ecological processes which can indicate change or threshold effects; and (Tier 3) species of iconic or social importance which serves as a flagship for landscape effects. Table 1 provides an example of how species are related to each goal.

Table 1. An example of species relationships to ecological integrity goals[1].

	Goal 1: Maintain large intact, resilient landscapes of naturally functional terrestrial and aquatic community assemblages.	**Goal 2:** Conserve a permeable landscape with connectivity across aquatic and terrestrial ecosystems, including species movement, genetic connectivity, migration, dispersal, life history, and biophysical processes.	**Goal 3:** Maintain hydrologic regimes support native or desirable aquatic plant and animal communities in still and moving water systems	**Goal 4:** Promote landscape-scale disturbance regimes that operate within a future range of variability that sustains ecological integrity
Columbia Basin	T1, T3: Salmon	T3: Mule deer	T2: Salmon Steelhead Bull trout	T2: Bull trout
Rocky Mountain	T1, T3:Grizzly bear Wolverine Canadian lynx	T2: Wolverine Canadian lynx	T2: Bull trout Cutthroat trout Trumpeter Swan	T2: Wolverine White-bark pine T3: Bull trout Cutthroat trout
Sage Steppe	T1: Sage Grouse	T1: Sage Grouse T2: Antelope Burrowing Owl Pygmy rabbit T3: Mule deer	T2: Cutthroat trout	T2: Sage Grouse Burrowing Owl

[1]Species listed here and throughout the framework are examples based on input to date, and may be refined or changed over time.

Figure 4 is a conceptual model that demonstrates, through simple relationship arrows, the complexity of the interrelationships among these scaled conservation targets. Additional analysis will examine the species-species (trophic interaction), species-habitat, and species-landscape relationships. It is expected that these conceptual models and the information therein, will be refined by expert review and in the development of the GNLCC science strategy. In the meantime, these models provide an example of how specific ecological information can be used to elucidate complexity and inter-relatedness.

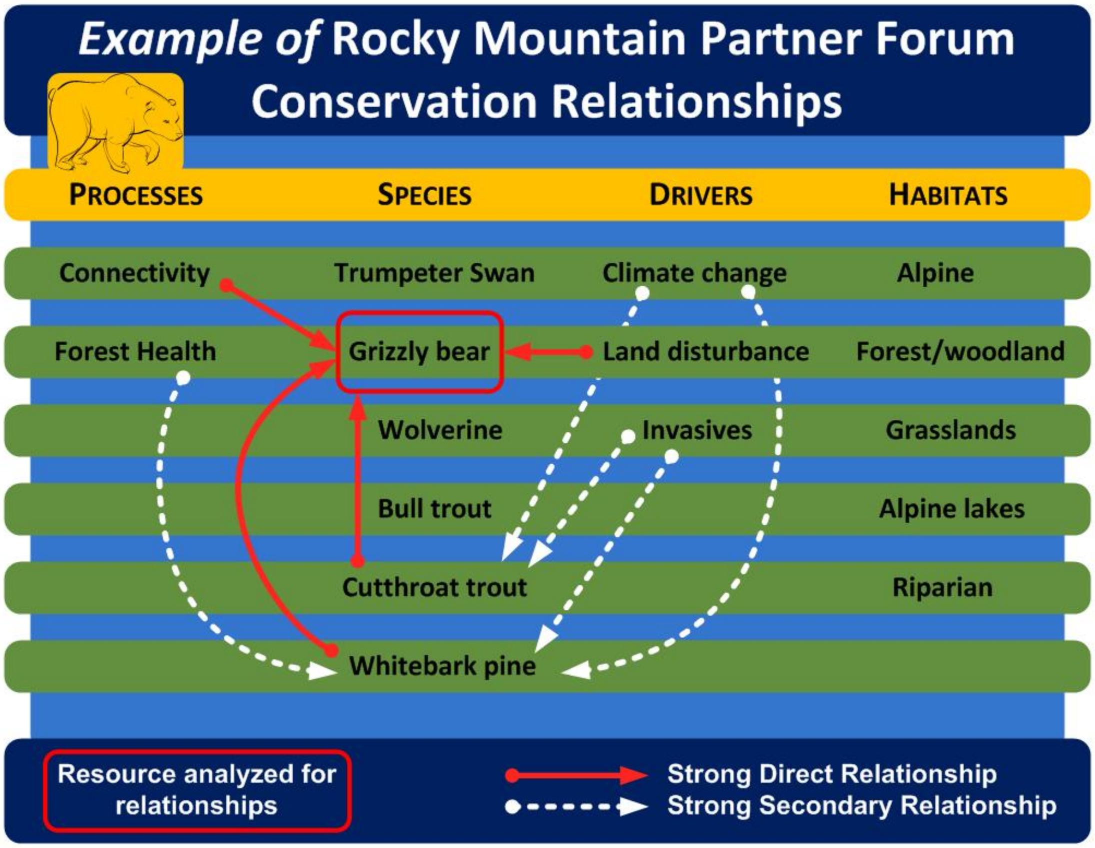

Figure 4. A conceptual model that demonstrates, through simple relationship arrows, an example of the complexity of the inter-relationships among scaled conservation targets.

COLUMBIA RIVER BASIN

The Columbia River drains a 259,000-square-mile basin that includes portions of several states of the interior western U.S. and British Columbia. The river is arguably the most significant environmental force and ecological lifeline in the Pacific Northwest and flows for more than 1,200 miles, from the base of the Canadian Rockies to the Pacific Ocean. The Columbia River is a snow-charged river that seasonally fluctuates in volume with an annual average discharge of 160 million acre-feet of water, the highest volumes between April and September, and the lowest from December to February. Although people have lived along the river for more than 10,000 years, modern engineering in the 19th and 20th centuries has dramatically altered the hydrology and ecology of the Columbia.

Stressors and Impacts

The expected effects of climate change in the Columbia Basin include: earlier spring runoffs, greater peak flows, and reduced late-summer flows that will cause many smaller tributaries to become intermittent and reduce wetlands. Increased erosion from flood events and lower in-stream flow increase water temperature, which favors warm-water fish and a decreased survival of native cold-water fish. A better understanding of how climate changes and water use effect hydrologic regimes is critical.

Human water development and use are a major ecological impact in the Columbia Basin. The invasion of exotic aquatic species create competition with native fish or damage natural habitats; and expected temperature increases are incompatible with native cold water fish and may encourage the persistence and dominance of non-native species.

Conservation Targets

The riverine and riparian systems of the Columbia River, the Snake River, and their many tributaries define the local watersheds and biological diversity of the Columbia Basin. Critical landscape-scale ecological processes in the Columbia Basin include connectivity of aquatic systems and hydrologic function. Wetlands and the watershed uplands are important to ecological and hydrological function as they provide important habitat and maintain the health of the riparian and aquatic systems. To maintain these ecosystems and their functionality, a set of interrelated conservation targets have been identified for this ecotype (see Table 2).

Table 2. Summary of conservation targets for the Columbia Basin ecotypic area.

Ecosystem Processes	Habitats and Ecosystems	Species
aquatic connectivity	riverine	salmon
	riparian corridors	steelhead trout
	wetlands	bull trout
	watershed uplands	mule deer

For thousands of years, salmon thrived in the Columbia Basin. In less than 150 years, salmon have been driven to the brink of extinction due to barriers to their migration and degradation of habitat. Salmon are central to Native American cultures in the Columbia Basin, and are considered among the sacred "First Foods." Extensive recovery efforts are underway. Steelhead trout are sea-run rainbow trout that, like salmon, return to their freshwater hatching grounds to spawn. They are impacted by the same threats as salmon and are also valued by Native American cultures. Bull trout have exacting niche-habitat demands, requiring water temperatures generally below 55 °F (13 °C), clean gravel beds, deep pools, complex cover such as snags and cut banks, and large systems of interconnected waterways to accommodate spawning migrations. Thus, they favor the deep pools of cold lakes and large rivers, as well as high, cold mountain headwaters. Bull trout require clean, cold water for survival; are sensitive to habitat degradation; and have declined due to the introduction of non-native fish species.

Mule deer are common and widely distributed throughout the GNLCC region. The mule deer is significant as one of the traditional "First Foods" of Native American tribes and an economically important species to state-based wildlife management and conservation programs. They are an important species when considering the connections between the aquatic and riparian ecosystems with watershed uplands and are sensitive to the loss of sage-steppe habitat.

ROCKY MOUNTAINS

The Rocky Mountains are a dominant geomorphic feature of the GNLCC landscape. We consider mountain ecotypes in other parts of the Great Northern area, such as the Cascades of eastern Washington and Oregon as part of the Rocky Mountain ecotype. Generally, the mountain environment is divided into three main life zones: montane, subalpine, and alpine. Each provides a unique mixture of climate, landscape, and vegetation.

The Rocky Mountains provide habitat for a diverse variety of wildlife species, and most importantly, provide the connectivity and extent of habitat needed for wide-ranging, reclusive species such as grizzly bear, wolverine, and numerous other iconic and wide-ranging species.

Stressors and Impacts

The results of climate change expected in this ecotypic area include: glaciers retreating more rapidly, drought and fire regimes changing and becoming more frequent, invasive species and forest diseases spreading more rapidly, and streams generally warming. The land use conversion of this ecosystem to exurban residential development, energy development, and human infrastructure is a major stressor that can result in fragmentation and a loss of connectivity. Invasive species impact both terrestrial and aquatic ecosystems degrading ecological integrity and threatening native species.

Conservation Targets

These Rocky Mountain ecosystems are unique to the GNLCC. Many wildlife populations in the Rocky Mountains rely on habitat connectivity and corridors to range widely based on the size of their home ranges, seasonal uses of habitats, and in some cases, specific migration routes. As climate change and other stressors impact the landscape, more information is needed to better understand how those ranges and corridors might shift and change in condition. The health of montane woodlands and other habitats are critical to maintaining ecological integrity. The modification of natural fire regimes, warming trends that have facilitated the increase of pine bark beetles, and drought stress have all contributed to a decline in forest health in the region. To maintain these ecosystems and their functionality, a set of interrelated conservation targets have been identified for this ecotype (see Table 3).

Table 3. Summary of conservation targets for Rocky Mountain ecotypic area.

Ecosystem Processes	Habitats and Ecosystems	Species
connectivity	alpine	grizzly bear
natural fire regimes	sub-alpine	wolverine
insects and forest pathogens	woodland	Canada lynx
	sage shrub/grasslands	whitebark pine
	alpine lakes	trumpeter swan
	rivers and riparian corridors	cutthroat trout
	wetlands	bull trout

The Rocky Mountains include diverse ecosystems. The mosaic of these diverse systems and their connectivity is critical to maintaining ecological integrity. Riparian systems

support some of the highest biological diversity and crucial wildlife habitat in this mountainous region, as they help connect the many ecosystems. Alpine and montane waterways are sensitive and critical to maintain native fish species. Alpine ecosystems are particularly sensitive to the impacts of climate change, and these impacts may be more readily evident as we study ecological shifts.
Some species, such as the grizzly bear, wolverine, and lynx, are wide-ranging species iconic to this region. Grizzly bear are more general in their habitat requirements but whose key habitats provide an umbrella for many others; whereas a species like wolverine is dependent on conditions related to climate and snowpack and can serve as an indicator for certain landscape and climate related processes.

Whitebark pine is typically the highest-elevation pine tree of the Rocky Mountains, and is an important food source for many species—from grizzly bear to seed-eating birds and small mammals. Non-native blister rust, a tree pathogen, and infestations of native pine beetles have dramatically impacted the populations of whitebark pine in this region. As a result, whitebark pine is declining throughout its range and was recently listed as "warranted" but precluded for status as an endangered species.

Although the Rocky Mountain population of trumpeter swan is healthy, some locations in the heart of its range (the greater Yellowstone region) are experiencing a decrease in number of birds and reproductive success.

Native fish species in the Rocky Mountains are threatened by changing hydrologic cycles (and warming water temperatures) and invasive nonnative species. Bull trout have exacting niche-habitat demands, requiring water temperatures generally below 55°F (13°C), clean gravel beds, deep pools, complex cover such as snags and cut banks, and large systems of interconnected waterways to accommodate spawning migrations. Thus, they favor the deep pools of cold lakes and large rivers, as well as high, cold mountain headwaters. Bull trout are sensitive to disturbance. Cutthroat trout have evolved into a number of subspecies, several of which are native to the GNLCC.

SAGEBRUSH STEPPE

Sagebrush steppe ecosystems are some of the most threatened in North America and represent some of the most unique shrubland systems in the world. These semi-arid shrub and grassland systems are typical of broad stretches of lowlands in the Intermountain West, and occur in the Columbia Basin as well as montane valleys of Wyoming and Montana. The sagebrush steppe region is characterized by sagebrush and perennial bunchgrasses in semi-arid uplands occurring between 1,900 and 6,900 feet in elevation.

Stressors and Impacts

The results of climate change expected in the sage-steppe include an increase in temperature and shift in precipitation from summer to winter. This is predicted to favor pinyon pine-juniper woodland expansion and to create a positive feedback loop of annual grass establishment and greater fire frequency.

The land use conversion of this ecosystem to agriculture, energy development, residential development, and human infrastructure (e.g., transmission corridors, water development, and fencing, among others) is a major stressor. Invasive species such as cheatgrass can become established due to soil disturbance, shrub mortality, fire, and the timing of rainfall (i.e., winter/early spring rains encourage the growth of annual exotics over native bunchgrasses, which are dependent on summer rains). Once these exotic annual grasses become established, they alter the fire regime and encourage more frequent, intense, and extensive fires, which in turn favor annual grasses over shrubs and native forbs.

Conservation Targets

The semi-arid, sage-dominated shrub and grasslands are the primary focal ecosystems for this ecotype. It is recognized that transition zones, riparian areas, pothole lakes, and other aquatic ecosystems are critical to maintaining ecosystem function and various ecosystem components. Sage-steppe ecosystems are threatened by habitat conversion, encroachment, and fragmentation by roads, land cover conversions, and other infrastructure. Connectivity is needed to sustain ecosystem integrity. The invasion of exotic plants and grasses has altered natural fire regimes in sagebrush/grassland ecosystems in a way that is advantageous to these invasive species. To maintain these ecosystems and their functionality, a set of interrelated conservation targets have been identified for this ecotype (see Table 4).

Table 4. Summary of conservation targets for sage-steppe ecotypic area.

Ecosystem Processes	Habitats and Ecosystems	Species
connectivity	sage shrub/grassland	greater sage-grouse
natural fire regimes	riparian corridors	pygmy rabbit
	pothole lakes	burrowing owl
		pronghorn antelope
		mule deer
		cutthroat trout

The greater sage-grouse is being considered for protection under the Endangered Species Act. Evidence suggests that habitat fragmentation and destruction across much of the species' range has contributed to significant population declines over the past century. Other sagebrush obligate species include the pygmy rabbit and burrowing owl. Burrowing owls are commonly found in sage-steppe areas where shrub cover is less-dense. However, they remain susceptible to negative impacts, especially those which expose them to increased predation risk.

Pronghorn are relatively common species in the sage-dominated arid grasslands, however, they are North America's most wide-ranging migratory mammal and many migration corridors are threatened by landcover and land-use changes that block traditional migration routes. Mule deer are also common and widely distributed throughout the GNLCC region, but significant as one of the traditional First Foods of Native American tribes and an economically important species to state-based wildlife management and conservation programs. Both pronghorn and mule deer need large areas of diverse habitat and connected landscape.

Native fish species are also important in the sagebrush steppe region. They are threatened by changing hydrologic cycles (including water quantity and quality impacted by energy development) and invasive nonnative species. For example, cutthroat trout have cold-water requirements and have been identified as high priority for conservation in the region.

Next Steps

The Great Northern LCC is a network of partners working toward common goals. This strategic conservation framework is intended to provide the landscape-level institutional and conceptual frameworks to facilitate cooperative and responsive adaptive management in the face of three common large scale stressors: climate change, land development, and invasive species.

The Great Northern LCC has identified an initial set of collective conservation targets that have been developed through a preliminary participatory process among federal, state and tribal land management agencies and non-governmental science stakeholders. The purpose of these conservation targets is to frame and focus the work of the Great Northern LCC and address large-scale landscape issues critical to this region. The strategies identified by the GNLCC partners incorporate the scale-appropriate conservation actions of existing efforts and at the same time, the larger goals identified for the entire breadth of the GNLCC (see Appendix A).

The next steps for implementing the GNLCC strategy include:

- Building organizational capacity by supporting the partner forums to work collaboratively and effectively to effect landscape conservation at the broadest scale
- Aligning and sharing existing information and conducting a gap analysis to determine how and where GNLCC efforts are most strategically invested.
- Developing a science strategy based on the gap analysis to guide strategic science investment.
- Partnering with inventory and monitoring programs to collect and share information and cross-walk data across agencies and organizations.
- Identifying resource managers' needs for information and present that information in a useful, accessible way and developing tools to disseminate information and inform management decisions.
- Creating a communications strategy to keep the GNLCC network of partners engaged and informed.
- Identifying opportunities to focus and leverage resources on priority issues.
- Linking conservation to sustainable communities through socioeconomic analysis.

In pursuing these steps, the GNLCC and its partners seek to manage the region in an adaptive fashion by incorporating new information and adjusting strategies accordingly.

Appendix A: Strategies to Achieve GNLCC Goals

The following strategies were identified by the GNLCC Advisory Team as a starting point for moving forward towards accomplishing these goals.

Goal 1: Maintain large, intact landscapes of naturally functioning terrestrial and aquatic community assemblages.

Outcome 1a. Ensure large, intact areas bridge and sustain diverse habitat types.

Strategy 1.Conduct a gap analysis of protected lands to identify priorities (identify refugia)

Strategy 2. Maintain enduring features (biophysical)

Strategy 3. Maintain areas with highest ecological integrity

Strategy 4. Maintain biodiversity hot spots

Strategy 5. Maintain specialized habitats within large intact areas

Strategy 6. Maintain important areas for species of concern

Strategy 7. Maintain keystone species; predator/prey assemblages

Strategy 8. Maintain ecologically productive areas (valley bottoms and other features)

Strategy 9. Identify diverse, isolated, small habitats that are important for maintaining ecological diversity and integrity

Strategy 10. Maintain small patches of ecologically intact areas within larger altered landscapes

Strategy 11. Monitor microhabitats as indicators of larger landscape processes

Strategy 12. Support efforts to protect and maintain those areas important to First Nations and Native Americans, such as medicinal plants; provide information related to climate change (adaptation strategies) to sustain those values

Outcome 1b. Maintain ecological function in the face of stressors.

Strategy 1. Analyze existing information to identify or predict changing ecosystems and how to address them

Strategy 2. Conduct landscape and species vulnerability assessment for climate change; align existing assessments; identify those areas of highest integrity (currently and predicted vulnerabilities)

Strategy 3. Use scenario planning tools to guide action—including the interaction of stressors (climate change, land use/land development, invasives--and others?)

Strategy 4. Identify and anticipate changes in ecotones due to climate change

Strategy 5. Ensure organisms can disperse to new suitable locations

Strategy 6. Develop common priorities to focus actions together (identify high priority areas) and develop coordinated work plans

Strategy 7. Ensure conservation actions are directed at highest priority areas:

Outcome 1c. Increase ccommunities' resilience to invasives, disease, and other disturbances.

Strategy 1. Coordinate existing strategies, share information and data, and identify gaps

Strategy 2. Conduct risk analysis to identify key areas for focused efforts

Strategy 3. Maintain diversity, minimize human impacts

Measure 1. patch size

Measure 2. proportion of land cover types

Strategy 4. Minimize fragmentation

Strategy 5. Restore priority areas

Strategy 6. Implement adaptive management—review progress, incorporate new information

Goal 2: Conserve a permeable landscape with connectivity across aquatic and terrestrial ecosystems, including species movement, genetic connectivity, migration, dispersal, life history, and biophysical processes (recognizing this is species dependent, and recognizing in some circumstances connectivity is not desired).

Strategy 1. Compile and share existing information and use it to build collaborative, landscape-scale strategies

Strategy 2. Conduct a species-specific connectivity analysis where sufficient data are available, including a meta-analysis and development of interagency strategies

Strategy 3. Evaluate existing mitigation strategies to increase connectivity

Strategy 4. Identify and reduce barriers to migration and dispersal (roads, infrastructure, etc.)

Strategy 5. Maintain and improve permeability (cover, etc.)

Strategy 6. Identify and manage circumstances where connectivity is not desirable

Strategy 7. Anticipate shifting habitat needs related to climate change when considering connectivity and species habitat use needs

Strategy 8. Identify priorities for focusing efforts: areas of robust connectivity values into the future; landscape features that are attractants for migration, stopover sites, calving/fawning areas, etc.

Strategy 9. Identify opportunities within a public-private land matrix for connectivity, develop policies and market-based tools for conservation, voluntary land conservation strategies

Goal 3: Maintain hydrologic regimes support native or desirable aquatic plant and animal communities in still and moving water systems.

Strategy 1: Identify critical areas across the entire GN landscape

Strategy 2: Assess (in a spatially explicit way) how climate change, invasive species, and land development may affect this outcome, including:

- Which systems/places are most likely to persist (resistant or resilient) under scenarios of climate change
- Which systems/places are most likely to change (for those places most likely to change, what might future trajectories look like?)
- Where invasives are already a problem
- Where invasives are most likely to become a problem (including because of climate change)
- What types of land development has greatest effect on particular aquatic systems

Strategy 3: Maintain and restore habitats that are most likely to persist (resistant or resilient) in the face of climate change (include thermal refugia)

Strategy 4: Maintain a functional matrix of aquatic and hydrologic systems (geomorphic, vegetation templates underlying aquatic habitats)

Strategy 5: Identify strategies for aquatic systems expected to undergo the most amount of change

Strategy 6: Address invasive aquatic plants and animals where they have detrimental effects at a landscape scale

Strategy 7: Address impacts of invasive species on hydrologic connectivity, regimes, and function throughout the watershed (e.g., stream-floodplain connections, aquifer recharge)

Strategy 8: Address (direct and indirect) detrimental effects of land development on (important) aquatic systems at a landscape scale

Strategy 9: Address impacts of land development on hydrologic connectivity, regimes, and function throughout the watershed (e.g., stream-floodplain connections, aquifer recharge)

Strategy 10: Inform landscape-scale land-use planning to reduce harmful effects on aquatic systems

Strategy 11: Address impacts of climate change on hydrologic connectivity, regimes, and function throughout the watershed (e.g., stream-floodplain connections, aquifer recharge)

Strategy 12: Assess how stream flow magnitude, timing and quality influence aquatic-dependent species and ecosystems (lentic and lotic), and how climate change, invasives species, and land development may affect in-stream flows

Strategy 13: Maintain and restore streamflow conditions necessary to support native and desirable species

Goal 4: Promote landscape-scale disturbance regimes that operate within a future range of variability that sustains ecological integrity.

Strategy 1. Compile and share information and results from existing efforts; use this as a starting point to coordinate actions

Strategy 2. Conduct a risk assessment of future conditions of interactions with climate; identify potential for extreme events and potential impacts

Strategy 3. Understand the range of future conditions and expected impacts

Strategy 4. Anticipate and manage future disturbance regimes in the most vulnerable areas, prioritize optimal places to focus

Strategy 5. Identify and focus efforts on areas where there is the greatest ecological contribution at the landscape scale to ecological integrity

Strategy 6. Coordinate an approach to manage and respond to disturbance (timing and intensity of grazing, thinning, other resource uses)

Strategy 7. Influence policies and planning to reduce the impacts of land conversion; increase the ability to respond to disturbance

Strategy 8. Restore those disturbed areas where we can make the greatest contribution to ecological integrity