A Landscape of Connectivity

Priority Corridors for Biodiversity and Communities in a Time of Climate Change

October 2014
Wildlife Protection: Ensuring a diversity of well-connected natural areas or corridors along rivers and elsewhere to support the movement of species in response to climate change, and to sustain healthy populations into the future.

-- Council on Climate Preparedness and Resilience
Connecting America’s Wildlands: An Urgent Call to Action

From the iconic grizzly to the graceful monarch butterfly, America’s native wildlife is already under threat from climate change. In 2012 the Obama Administration issued a “call to action” to protect our wildlife with its multi-agency National Fish Wildlife and Plants Climate Adaptation Strategy. Recognizing the many services that wildlife provide to people and communities, this report lists “Conserve and Connect Habitat” as its first goal.

**Strategy 1.1:** identify areas for an ecologically-connected network of terrestrial, freshwater, coastal, and marine conservation areas that are likely to be resilient to climate change and to support a broad range of fish, wildlife, and plants under changed conditions.

-- National Fish Wildlife and Plants Climate Adaptation Strategy2012

In October 2014 The Council on Climate Preparedness and Resilience Climate and Natural Resources Working Group issued its *Priority Agenda for Enhancing the Climate Resilience of America’s Natural Resources*. Key themes in this report such as: “foster climate-resilient lands and waters,” “manage and enhance US carbon sinks” and “enhance community preparedness and resilience by utilizing and sustaining natural resources” all point to the connection and linkage of large landscapes as an important part of creating a resilient landscape for people and wildlife.
A resilient landscape or ecosystem may be characterized as an area with sufficient options to enable species and ecosystems to rebound in the face of great stresses without transforming into an undesirable condition. Such options, or characteristics that foster resilience include a high diversity of species, multiple core habitat areas with redundant linkages among them, topographic and elevation diversity…and minimal barriers that restrict adaptive movement of species or ecosystems. — Priority Agenda for Enhancing Climate Resilience 2014

The Federal agencies have begun the important work of protecting linkages for species. In 2008, the U.S. Forest Service established the nation’s first federally designated wildlife corridor, the Path of the Pronghorn. This critical migration corridor, which runs between Grand Teton National Park and the Wyoming’s Upper Green River Valley, is one of the longest terrestrial mammal migration corridors in North America, and the longest in the Greater Yellowstone Ecosystem.

The Connectivity Policy Coalition

Guided both by conservation principles and climate modeling, the Climate Policy Coalition has initiated a collaborative effort to identify our most important wildlife linkages across the landscape. This partnership of science with local and national advocacy groups is proposing a number of key areas that can be protected in the next several years with largely administrative actions.
This document details just a few examples of core habitats and those important wildlife corridors that connect them. In addition to protecting wildlife, protecting these places also will: 1) sequester carbon and therefore advance climate change mitigation objectives; 2) safeguard streams and aquifer sources, therefore maintaining vital clean water for communities; and 3) conserve the habitat that sustains game and watchable wildlife both of which help Americans recreate and stimulate local economies.

Theodore Roosevelt established the frame for American conservation. He saw the land, especially the American West, as a vital heritage and common patrimony, and that diminishing it diminishes our successors and us. With climate change, our generation faces new challenges, but also new opportunities to protect America’s natural heritage for our nation and for our future.
Mapping Connectivity
The science of mapping connectivity is widely embraced, and the results are profound as shown in the following examples.

Natural Landscapes

Mapping of Natural Landscapes [Theobald 2010], is based on national datasets such as natural land cover types, presence of roads, highway traffic volume, housing density and others.
A new method, Wild LifeLines™ then depicts potential movement pathways in the U.S. between the Mexican and Canadian borders that emphasize the least human modification and highest extant connectivity for wildlife. These pathways are the result of a novel modeling approach that is based on the above map of Natural Landscapes and then identifies the least fragmented connections between remaining natural areas.

Wild LifeLines™ complement identification of cores and linkages within conservation planning boundaries that might secure landscape capacity for broad-scale wildlife movement within extant high-connectivity lands. Wild LifeLines™ is a powerful new expression of places and pathways that are important for maintaining connected landscapes, providing for the movement of wide ranging species, and facilitating adaptation to climate change.
This map shows connectivity routes that are expected to be most permeable to movement among areas with low degrees of human modification. Betweenness centrality is a metric describing the relative importance of a given connectivity route to the broader landscape configuration. Protected areas (GAP Status 1 and 2) are overlaid for reference. This map is intended for illustrative purposes only.

Data Sources:
Regional Connectivity Mapping

The Eastern Wildway contains some of North America’s most beloved national parks, preserves, forests, scenic rivers and other wild places. From the wilderness of Québec, the Adirondacks, and the Shenandoah, to the wilds of the Great Smoky Mountains and Everglades National Park, this continental corridor traverses a wide array of eco-regions including: the Northern and Central Appalachians, the High Allegheny Plateau, the Southern Blue Ridge and Tropical Florida. Its mountains and valleys, forests and farmlands feature climates from arctic to tropical. The related species diversity in these regions is accordingly impressive and includes predators such as wolf, marten and cougar to prey such as moose, deer and groundhog. Many plants, birds, fish, and butterflies are endemic (found nowhere else in the world) but particularly in the southeastern United States.
The Western Wildway runs 5,000 miles along the entirety of the Rocky Mountains and associated ranges, we are re-constructing the world’s most extensive network of protected, connected landscapes. Our vision is one of coordinated international conservation action that will protect, connect, and restore a contiguous network of private and public lands along the spine of the Rocky Mountains and associated ranges, basins, plateaus, and deserts from Alaska’s Brooks Range to the Mexican Sierra Madre Occidental.
Priority Wildlife Corridor Examples

#1

Wolf Creek Pass Landscape Connectivity Hub
1. Wolf Creek Pass Landscape Connectivity Hub

Wolf Creek Pass straddles the Continental Divide between two of the largest intact wilderness areas in the Southern Rockies – the Weminuche and South San Juan wildernesses. Wolf Creek Pass is a critical constriction for movement of species dependent on high-elevation habitats and deep snowpack, including lynx and wolverine. Our goal is to maintain its function as a connectivity corridor as climate change shifts mountain habitats towards higher elevations in the Southern Rockies, and to improve security for listed or candidate species.

Wolf Creek Pass bisects the San Juan Mountains core area, where Colorado Division of Wildlife (CDOW) successfully reintroduced lynx to the Southern Rockies beginning in 1999. CDOW has documented heavy usage of the Wolf Creek Pass linkage by lynx since reintroduction, and considers it vital to the recovery of lynx in Colorado. With climate change reducing snow pack in western North American mountains and shifting distribution of forests northward and up mountain slopes, high elevation linkage zones including Wolf Creek Pass will gain increasing importance as climate change alters the geographic location and distribution of lynx habitat.

While climate change generally is expected to result in warmer winters, earlier spring snow melt, and a reduction in the extent of snow cover in the southern Rockies, climate models predict large areas of persistent snow will be retained in the high elevations of the Colorado mountains. Wolverine distribution worldwide directly corresponds to areas that maintain persistent spring snowpack. At an elevation of 10,850 feet, Wolf Creek Pass frequently accumulates the largest snowpack in the Southern
Rockies, averaging 400 inches of snowfall per year and occasionally exceeding 600 inches. Consequently, the San Juan Mountains have been identified as a priority location for potential future reintroduction of wolverines.

Colorado could support 100 wolverines, a 33% increase in the current population of roughly 300 wolverines in the Northern Rockies, thereby providing an important hedge against climate change impacts to wolverines.

**Administrative Opportunities:**
The area within the Wolf Creek Pass landscape connectivity hub is largely in national forest ownership with several key private inholdings under conservation easements. Several administrative actions can further safeguard the security of the corridor and improve its function. One critical private inholding has been the focus of a decade-long environmental analysis associated with a proposed year-round resort development housing 10,000 people atop Wolf Creek Pass that would irrevocably fragment the corridor. The development proposal is pending the discretionary decision of the Rio Grande National Forest whether to proceed.

U.S. Highway 160 crosses the Continental Divide at Wolf Creek Pass. Vehicular collisions cause significant mortality for lynx in portions of the southern Rockies – thirteen of the 102 mortalities documented for lynx translocated into Colorado were caused by vehicle collisions. Reduced permeability across Highway 160 or increased mortality could have negative impacts on the continued recovery of lynx in Colorado. An in-depth assessment of wildlife crossing patterns has identified locations for highway crossing structures to increase permeability.

*Proposal submitted by Rocky Mountain Wild and San Juan Citizens Alliance.*
#2

*Kettle River Range Climate Refuge and Habitat Connectivity Hub*
Kettle Range Climate Refuge Area Map

This map shows the perimeter of the Kettle Range Climate Refuge within the Colville National Forest and Washington state. The Refuge is comprised of inventoried Roadless areas (IRAs) and a Restoration Zone mapped by the Northeast Washington Forestry Coalition.
2. Kettle River Range Climate Refuge and Habitat Connectivity Hub

The Kettle River Range, in the Colville National Forest of northeast Washington, serves an essential role as refuge and habitat stepping stone for wildlife adapting to a changing climate. Protecting and restoring landscapes to withstand changing environmental conditions and to support wildlife movement are fundamental to the success of climate adaptation strategies advanced by state and regional agencies. In these respects, the Kettle Range ranks well high in both preparations and expected results.

Recent habitat modeling indicates the Kettle Range will provide refuge for a diversity of keystone fish and wildlife species and habitats. Research conducted by University of Washington’s Landscape Ecology and Conservation Lab shows that lynx and wolverine are expected to continue to rely on the Kettle Range into the 21st century, even as their predicted ranges shift. Other researchers found that the Kettle Range will provide long-term bull trout habitat, riparian corridors and watershed resiliency over the long term. Conditions will be further enhanced by the Colville National Forest’s eight year, $32 million conservation strategy to restore landscape resilience through USDA’s Collaborative Forest Landscape Restoration Program.

The Kettle Range is a key linkage for wildlife moving between the Cascades, Rocky Mountains, and British Columbia’s upper Columbia mountains. Early habitat permeability modeling highlights the Kettle Range as a habitat concentration area and as connectivity habitat for
grizzly bear, wolverine, wolf, and Canada lynx. Subsequent work by the Washington Wildlife Habitat Connectivity Working Group identified core and connectivity habitat for lynx, black bear, elk, and marten in the Kettle Range. More recently, in the Colville National Forest rating of inventoried roadless areas in the Kettle Range for connectivity value in six of the nine roadless areas (including its two largest and most prominent roadless areas) were rated moderate-to-high value for connectivity. Models show that “the upper elevation forests associated with the Kettle Range may provide important stepping-stone habitats that could increase the permeability of the landscapes between the Rocky Mountains and North Cascades.” For reasons including the foregoing, the National Fish and Wildlife Foundation launched this May its seven year Working for Wildlife initiative to maintain and enhance habitat connections between the Cascades and Kettles.

The area within the proposed refuge polygon is comprised of inventoried roadless areas, as identified by the US Forest Service, and restoration zones proposed by a collaborative known as the Northeast Washington Forestry Coalition. The goal is for the entire area to be permanently managed for climate resilience objectives through a national monument designation that prescribes wilderness-type direction for roadless areas and limits activity within restoration zones to that which advances ecological objectives (commercial extraction only as a byproduct). Recreation infrastructure should be retained at no more than present levels.

This proposal is submitted by Conservation Northwest, The Lands Council, and Kettle Range Conservation Group, and is in faith with previous proposals that have been backed by the Northeast Washington Forestry Coalition and its members and partners.
#3

Grand Canyon Watershed

National Monument
A Landscape of Connectivity

Proposed Grand Canyon Watershed National Monument

Explorations:
- Proposed UNESCO World Heritage Site
- National Park Service
- Native American Reservation
- Water Source
- National Forest
- State Highway
- City Limits
- Wildlife Movement

Location Map

October 2014
3. Grand Canyon Watershed National Monument

The Grand Canyon and its surrounding, unprotected lands are the critical link in the Blue Range-Grand Canyon-Yellowstone megalinkage. The nearly two million acres of imperiled public lands adjacent to and draining directly into the Grand Canyon comprise dramatic escarpments, plateaus and canyons affording spectacular landscapes. They also support a unique diversity of native species consisting of at least 22 sensitive species including the endangered California condor, mountain lions, pronghorn antelope and mule deer.

The region’s forest also shelters important bird species include: golden eagles, northern goshawks, ferruginous hawks, northern harriers, western burrowing owls and the threatened Mexican spotted owl. Carnivore scientists also consider this region essential for eventual recovery of the critically endangered Mexican wolf.

As the Southwest faces climate change and increasing probability of prolonged drought, preservation of remaining intact ecosystems is critical not only for wildlife, but for humans as well. Grand Canyon’s best defense against climate change is to protect and restore ecological resiliency to the Park’s vulnerable adjacent public wildlands, including old growth forests, grasslands and wildlife corridors that provide native species safe passage to the other wildlife core areas of northern Arizona and southern Utah.

Adjacent but integral to Grand Canyon National Park lies the Kaibab Plateau, the Southwest’s largest unprotected old growth ponderosa pine forest. Conservation of naturally evolving old-growth forests requires protection and restoration of native species biodiversity (including wolves) as well as a return of natural fire regimes. Destructive uranium mining-driven industrialization, continued logging of ancient trees and
inappropriate livestock grazing are the primary threats surrounding Grand Canyon National Park that need to be eliminated to restore resilient habitats and give species the fighting chance they deserve.

In 1908, Theodore Roosevelt, proclaimed the area a national monument, laying the foundation for the eventual National Park. Unfortunately, the plan left out most of the forested Kaibab Plateau and other ecologically critical lands.

The looming threats compel conservationists to work tirelessly with the Obama administration and Congress to permanently protect America’s Grand Canyon from these and additional threats that could push wildlife over the brink. The Sierra Club, in close cooperation with Grand Canyon Wildlands, has elevated Grand Canyon Watershed National Monument designation as a top national conservation priority. Among our specific objectives for this treasured landscape are:

- Protect and restore core areas and critical buffer zones and migration corridors on public wildlands surrounding Grand Canyon;
- Secure action from President Obama to protect the old-growth ponderosa pine and mixed conifer forest of the Kaibab Plateau and the forest south of the Park (South Rim Headwaters);
- Reduce non-climate stressors by shielding more than one million acres of Grand Canyon’s watershed from uranium exploration, including Kanab Creek, Grand Canyon’s South Rim watershed and House Rock Valley;
- Work with Native communities to prevent resource development harmful to Traditional values and places; and
- Ensure that resilient habitats principles are incorporated into new resource management plans for the Grand Canyon ecoregion, including the provision for permanent, voluntary retirement of grazing permits.
#4

Vail Pass Wildlife Movement Corridor
4. Vail Pass Wildlife Movement Corridor

Vail Pass is an important wildlife movement corridor connecting the Eagles Nest Wilderness to the northeast and the White River National Forest lands and the Holy Cross Wilderness Area to the southwest of Interstate 70. It has been identified as an ecologically significant site both statewide and regionally for wildlife and habitat connectivity – especially to snow dependent species such as Canada lynx and wolverine, and especially as the landscape continues to be transformed by a changing climate. However, Interstate 70 currently severs any connection here. Our goal is to restore its function as a wildlife movement corridor by reestablishing safe crossing opportunities for the area’s wildlife.

Between 1999 and 2006, the Colorado Division of Wildlife (now Colorado Parks and Wildlife) launched an ambitious reintroduction effort, releasing 218 Canada lynx into the San Juan Mountains of southwestern Colorado. Now deemed a major success, the cats have spread throughout much of the state.

Some projections suggest that rising temperatures may result in a substantial decline in lower-elevations above 8200 ft. Studies suggest that elevation is a factor in snowpack changes, and that increases in rain vs. snow, reduction in snow water equivalent, and decreases in snowpack, will be of smaller magnitude at elevations about 2500m. With the highest average elevation of any state in the U.S, and much of its snowpack above 2500m, Colorado and the surrounding states that make up the Southern Rocky Mountain region will likely serve as a refugium for cold-loving, snow-dependent species such as Canada lynx and wolverine as climate models predict large areas of persistent snow will be retained in the high elevations of the Colorado mountains, while snow conditions may already be deteriorating at lower elevations.
Occurrences of Canada lynx in the southern Rockies are, in general, at higher elevations than other areas in the contiguous U.S. This is especially true compared to areas outside the western U.S. Research predicts that the forests that are prime lynx habitat will move upslope making the higher elevations in the southern Rockies critical to the recovery of the lynx. Further, the elevation separation or topographic relief in Colorado may prove to be essential to the conservation of lynx by keeping the species range separate from that of bobcats in the region. This will be extremely important during the winter months when lack of competition for resources makes survival more likely.

High elevation linkage zones, including Vail Pass at 10,666 ft., will gain increasing importance as climate change alters the geographic location and distribution of lynx and wolverine habitat in the western U.S. Most of the area within the Vail Pass wildlife corridor is in public ownership with the exception of one large and several small non-federal inholdings not officially considered part of the corridor.

In Colorado, I-70 is one of the largest and most dangerous roadways for wildlife, bisecting major migration routes with four to six lanes of high-speed traffic and concrete dividers. Traffic counts on I-70 are already well above the levels at which many species are known to completely avoid roads, thus causing these species to instead modify important daily, seasonal and life behaviors. For some species, the road represents a threat to their continued survival in the areal. Several administrative actions can improve the function of the Vail Pass wildlife movement corridor, in particular emphasizing the area as a priority for future transportation funds to build appropriate wildlife crossing structures.

Proposal submitted by Rocky Mountain Wild and Wilderness Workshop.
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#5

Aquarius Plateau
Western Wildway Priority Wildlife Corridor
Aquarius Plateau

This regional wildlife corridor is one of 20 critical habitat corridors essential to connecting the 6,000-mile Western Wildway from Mexico to Alaska. The corridor was identified and ground-truthed through Wildlands Network’s “TreeWest” corridor protection campaign by outdoor adventurer John Davis, scientists and conservationists in 2013. Conserving the key unprotected parts of this priority wildlife corridor is critical to allow wide-ranging native species to safely migrate between already protected wild habitat such as wilderness, national monuments and national parks. Citizens are urged to participate in the “Adopt Your Wildlife Corridor” initiative associated with this priority corridor.
5. *Aquarius Plateau, including Dixie National Forest*

Rising to elevations of 11,000 feet at the headwaters of the Escalante River basin, the lake-dotted Aquarius Plateau is a mosaic of alpine tundra and forest, a slice of Alaska floating incongruously a vertical mile above the intricate maze of slick rock canyons and desert badlands that surround it. The highest of Utah’s high plateaus, it also is the roof top balcony of the Colorado Plateau country.

Little more than one lifetime ago, the Escalante river and nearby Henry Mountains were among the last rivers and mountains discovered, mapped and named by explorers and geographers. In subsequent decades the landscape has remained relatively undeveloped--a largely intact high desert ecosystem that provides sanctuary for rare native plants such as the Aquarius Paintbrush and for ecologically critical “keystone” wildlife species including beaver, fox, elk, mountain lion and bear, that have been extirpated from smaller, more impacted western natural areas.

Unique in this desert region, the Aquarius, captures moisture from prevailing westerly winds, accumulating a snow pack of up to 10 feet deep in wet winters. The snow melt of early summer collects in over 800 lakes and small ponds, feeds over 30 named streams, many teeming with native trout, drops in feathery waterfalls over the plateau’s 600-foot southern cliff wall, and seeps into the plateau’s porous basalt bedrock, charging aquifers that feed copious springs.

The Aquarius Plateau is nearly 411,000 acres of National Forestlands with few private inholdings. If designated as a National Monument or Research Natural Area, it would join the Grand Staircase-Escalante National Monument with the Glen Canyon National Recreation Area.
Surrounding National Monuments and wilderness still leave large missing links, the most important of which is the old growth forests of bristlecone pine, spruce, Douglas fir, Ponderosa Pine, the vast swaths of aspen forest, and the lake-dotted meadows. Crucial to ecosystem integrity, they provide abundant water and critical high-elevation summer foraging and calving habitat for large populations of deer and elk, which in turn supports a healthy population of cougar and the potential for reintroduction of wolf and grizzly.

In summer 1996 President Clinton’s Council on Environmental Quality briefly considered including the Escalante River headwaters country within the proposed new Grand Staircase-Escalante National monument; however, in the end chose to confine the new monument boundaries within lands managed by the Bureau of Land Management. Much of the adjoining national forest land on the Aquarius Plateau was later identified, in administrative rulemaking by the Clinton administration, as “roadless,” thus earmarking it for long-term protection from new road building and as a candidate for future inclusion in the National Wilderness Preservation System.

Without long-term protection, the Aquarius will be at ever-greater risk for continued destructive logging practices, oil exploration and development, intensive timber and mining road construction, overhunting of keystone wildlife species, soil erosion and destruction of fragile alpine meadow and wetlands by indiscriminate off-road vehicle use. By contrast, the future task of restoring and improving the ecological health of a protected ecosystem could provide jobs to residents of small southern Utah towns for decades to come, making the region a world leader in the emerging global industry of ecosystem restoration.
#6

Hoffman Forest
#6 Hoffman Forest, North Carolina

Hofmann Forest is a 79,000-acre tract of public land in coastal North Carolina and the largest tract of public forest in North Carolina, exceeded only by a few federal properties such as Great Smoky Mountains National Park and the National Forests. Also, it is one of, if not the largest university research and teaching forests in the world.

Situated between Marine Corps Base Camp Lejeune and Croatan National Forest, it is the headwaters for the White Oak, Trent, and New Rivers, which contain endangered species of sturgeon. Home to a robust population of black bears, Hofmann Forest provides critical for habitat connectivity for bears and other wildlife species up and down the NC coastal plain. The Forest is roughly 2/3rds pine plantation and 1/3 natural pocosin wetland habitats - potentially restorable to better habitat for native wildlife.

The triangle of publicly owned land formed by Hofmann Forest, Croatan National Forest, and Camp Lejeune represents almost 400,000 acres, but this triangle will be broken up if Hofmann is sold and developed. The part of Hofmann at greatest risk of being destroyed is called Block 10; this is the land along US Highway 17 outside of Jacksonville, NC, and without Block 10 the essential wildlife corridor between Hofmann and Camp Lejeune will be lost.

Hofmann Forest has been owned for the benefit of NC State University Endowment Fund for 80 years. In 2013, University administrators decided to place the land up for sale, a decision that poses significant risks to water quality, wildlife habitat connectivity, and the military training mission at
Camp Lejeune. A coalition of groups led by Wildlands Network is working to protect the land with a conservation easement.

**Current Status:**
NC State University signed a sale agreement in September 2014 with two buyers, RMS (a timber investment group, 56,000 acres) and Hofmann Forest LLC (principal investor Jerry Walker, a corn farmer from Illinois, 23,000 acres). The sale agreement does not legally protect Hofmann Forest as a forest.

Currently there are 18 different groups who are cooperating together to help protect Hofmann Forest, including environmentalists, foresters, hunters, and fishermen. Thousands of NCSU alumni, faculty, staff, and students have signed on to oppose the sale, as have thousands of local residents in eastern North Carolina.

Working in Networks

Connectivity requires that many networks of people work together to protect networks of land. Often networks are nested within larger networks, all united by a common vision. The connectivity movement across the West is strongly aligned; and the East has several regional networks underway.
A Landscape of Connectivity

Western Wildway Network: Connecting and Restoring the Spine of the Continent
A Landscape of Connectivity

Critical Cores & Corridors in the Yellowstone to Yukon Region

LEGEND
1. Greater Yellowstone Ecosystem
2. Centennial-Tobacco Root-Granite Mountains
3. Clark Fork Corridor
4. St. Joe-Goose Flats-Upper Clearwater
5. Selkirk-Schweitzer-BC Rockies
6. Columbia/Watcha
7. South Selkirk Mountains
8. Northern Continental Divide Ecosystem
9. Northern Crown of the Continent Ecosystem
10. Canadian Rocky Mountain Parks Complex
11. Block Mountain Trench
12. Pense River Basins
13. Muskwa-Kechika Management Area
14. Upper Maine Basin
15. Greater Nahanni Watershed
16. Weta Lake Ecosystem
17. Peace Watershed

Regions of overlap
Connectivity Policy Coalition (CPC):

The CPC is the sole inter-organizational coalition dedicated to advancing connectivity conservation through federal policy.


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