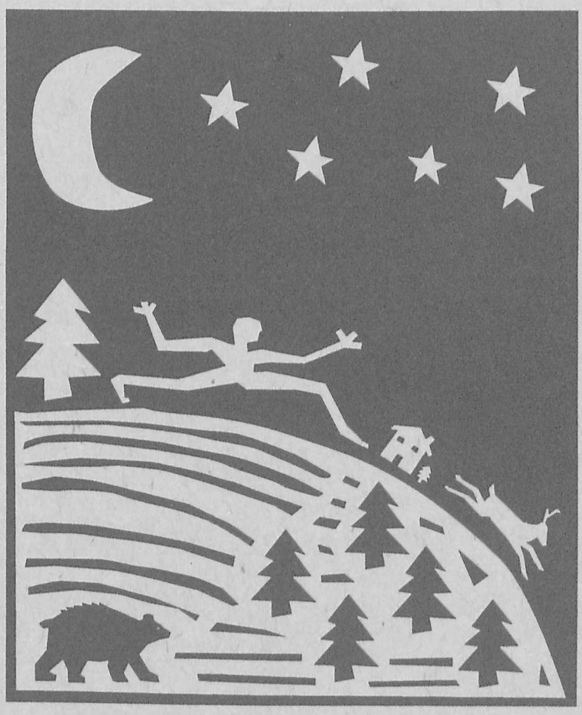
A SENSE OF PLACE

Issues, Attitudes And Resources In The Yellowstone To Yukon Ecoregion



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Y2Y

Yellowstone to Yukon Conservation Initiative

The Yellowstone to Yukon Conservation Initiative (Y2Y) is a bi-national network of over 170 conservation organizations and individuals that seeks to conserve the beauty, the health and the natural diversity of the Rocky Mountains from the Greater Yellowstone Ecosystem in the south to the Yukon's Mackenzie Mountains in the north. Drawing from the best available science, Y2Y's mission is to restore and maintain landscape and habitat connectivity along 3200 kilometres (1990 miles) of mountains by establishing a system of core protected wildlife reserves that are linked by wildlife habitat and movement corridors. Existing national, state and provincial parks and wilderness areas will anchor the system, while the creation of new protected areas will provide the additional cores and corridors needed to complete it.

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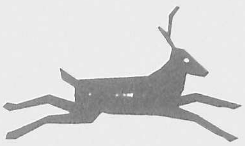
Corridors: Key to Wildlife from Yellowstone to Yukon



Richard Walker
and Lance Craighead

Introduction

Habitat reduction and fragmentation at a variety of spatial scales has been widely acknowledged as a primary cause of the decline of many species worldwide (Ehrlich 1986; Lovejoy et al. 1986; Harris 1984). Habitat fragmentation generally leads to smaller and more isolated animal populations. Smaller populations are then more vulnerable to local extinction, due to periodic extreme events (e.g. fires, disease, etc.) (Shaffer 1978, 1981; Gilpin and Soulé 1986), and they are more susceptible to the negative effects of inbreeding depression. To reduce the isolation of habitat fragments, many conservation biologists (e.g. Noss 1983, 1987; Noss and Harris 1986; Craighead et al. 1998; Craighead and Vyse 1995; Paetkau et al. 1998) have recommended maintaining landscape "connectivity"—preserving habitat for movement of species between remaining fragments.

At regional scales, connecting large core areas of wildlife habitat requires corridors—land managed for its function as routes for wildlife movement and dispersal (Saunders and Hobbs 1991). The notion of connective habitat corridors implies a system of corridors and the core areas of habitat which they serve to link. Conceptual models of core areas, movement corridors and buffer zones have been proposed by several scientists (Noss 1992; Noss et al. 1996) as frameworks for long-term regional-scale conservation of wildlife.

The Ninth U.S. Circuit Court Of Appeals provided a working definition of a wildlife corridor[1]:

> ...avenues along which wide-ranging animals can travel, plants can propagate, genetic interchange can occur, populations can move in response to environmental changes and natural disasters, and threatened species can be replenished from other areas.

While there is general agreement on the need for corridors, few scientific studies have as yet attempted to delineate them over a region such as the northern Rockies of the United States. For our research, we used the best available habitat and roads information to determine the routes offering the best potential as corridors for a key umbrella species—the grizzly bear. The purpose of this mapping exercise is to identify probable movement corridors with the least risk to wildlife moving between the three large core protected areas in the U.S. northern Rockies: the Greater Yellowstone, Salmon-Selway, and Northern Continental Divide ecosystems. If habitat for grizzly bears is protected, there is evidence to suggest that the needs of many other species will also be met.

Corridors In The Y2Y

The region from Yellowstone to the Yukon harbors some of the last vestiges of North America's great biological heritage. Here are the last remaining populations of wild grizzly bears and free-ranging bison. In several areas, the full complement of large native predators present at the time of Columbus's arrival in the New World still persists.

With increasing human development, however, wildlife habitat in the region is becoming ever more fragmented. New roads, housing developments, and natural resource extraction activities have caused major changes in the natural landscapes over the past few decades, and in the process have removed or isolated areas of habitat formerly available to wildlife. Projections are for this trend of habitat fragmentation to continue and accelerate, as the U.S. northern Rockies is one of the fastest growing regions in the country in terms of human population (USDA Forest Service 1996).

One result of the regional-scale fragmentation in the U.S. northern Rockies is the current situation of the grizzly bear, which is now isolated in a handful of remnant disjunct populations. The bear populations are centered in large, relatively undeveloped and undisturbed areas including the Greater Yellowstone Ecosystem, the Northern Continental Divide Ecosystem and, to a much lesser degree, in the mountains of northern Idaho and northwest Montana (USDI Fish and Wildlife Service 1993). A process has been initiated to restore the grizzly to the Salmon-Selway area in central Idaho.

The grizzly bear is a sensitive regional indicator of fragmentation and the effects of human development. It is considered an "umbrella species"—a species whose proper long-term management would likely help to ensure the persistence of many other species which also occur in the ecosystem. Because they require large areas of relatively

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[1] Marble Mountain Audubon Society v. Rice, 914 F2d 179, 180 n. 2 (1990)

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undisturbed habitat, solving for the habitat requirements of grizzlies can assist in defining large core protected areas, smaller protected areas to serve as nodes in a networked regional landscape habitat system, and corridors to facilitate bear movement between the protected areas.

Modeling Potential Grizzly Bear Corridors In The U.s. Y2y

Understanding the need for a scientific assessment of potential linkage habitat for wildlife movement in the region, American Wildlands began a 3-year project in 1995 entitled "Corridors of Life," envisioned and supported by Clif Merritt and Sally Ranney. The authors were employed to establish a GIS lab and conduct the analysis reported in this paper. As scientists, we sought an objective understanding of the best potential routes linking the three large protected areas in the U.S. portion of Y2Y. Because bears are now absent from many of the potential corridor routes, it was necessary to employ a model to account for habitat quality and impediments on a site-specific basis.

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Using Geographic Information System (GIS) computer software and the best available spatial data on habitats and human developments, we modeled potential regional-scale grizzly bear corridors between the three large U.S. core protected areas. Our approach offers a biologically defensible assessment of probable corridor routes and suggests one means (least-cost) of estimating the relative "connectivity" of alternate routes. For our purposes, delineating corridors at a regional scale entailed determining which routes, based upon the observed needs of wildlife, would offer an animal the best chance of survival if it were to disperse between core protected areas. In this effort we have attempted to balance two general factors affecting wildlife movements: the most suitable connected habitat (in the absence of humans) and the degree to which human-related impediments are present in the landscape.

We do not make the claim that these routes are the most likely to be used by dispersing individuals. Due to highly variable individual behavior this would be a very tenuous assumption. Rather, our analyses indicate that other routes, while perhaps equally likely to be taken by an individual, would reduce his/her probability of survival in the process of dispersing from one core protected area to another, generally because of increased transit time and risk of encountering significant impediments.

Thus the route delineations from our analyses are "prescriptive" rather than strictly "descriptive." The objective of protecting such corridors would be to leave the best routes open to wildlife, but without implying any mechanism of forcing animals to choose those routes (other than the fact that increasing development and change outside of potential corridors will continually make those areas less suitable habitat for most wildlife species).

Methods

Model assumptions

Wildlife responds to landscapes (and habitat) at several scales. Foraging and hunting activities, for example, can be geared to microsite occurrences of vegetation or prey (e.g., see Apps 1996). We assumed that dispersing animals are less sensitive to local environments, and respond to a larger landscape in their movements. For modeling best regional scale corridor routes we made the following assumptions:

1. good corridors are comprised primarily of preferred habitat types;
2. humans pose problems for successful wildlife transit;
3. current human developments are permanent;
4. "least-cost paths" constitute best routes of transit.

GIS model inputs

We developed three input GIS coverages to model best potential corridor routes: (1) habitat quality (per species per vegetation type), (2) amount (length) of forest and shrub/grassland interface, and (3) road density. The first two are measures of the quality of an area in terms of its utility to

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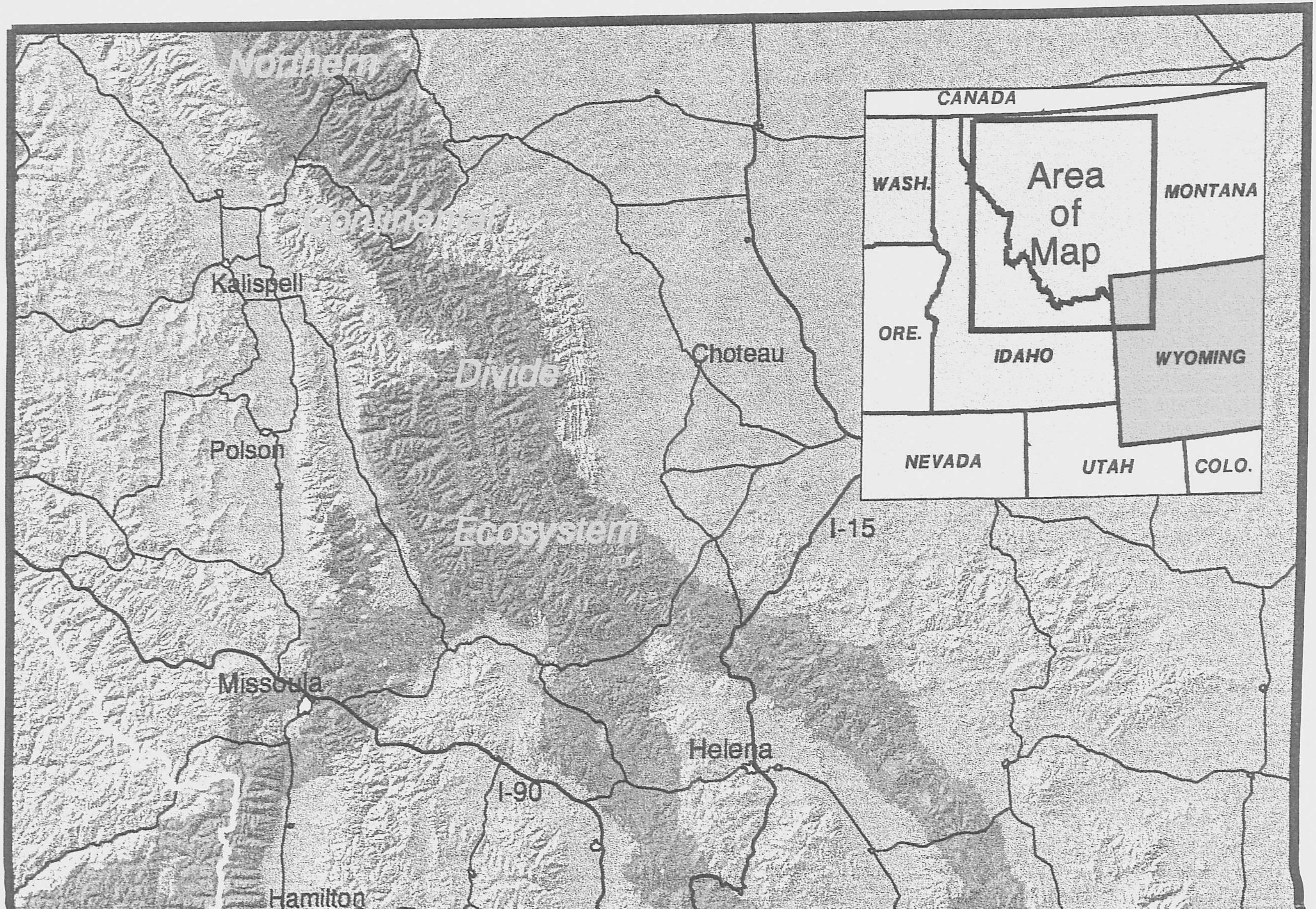
Figure 1 (next page): For the long-term future of wildlife in the US Northern Rockies, the three large core protected areas (shown in magenta) need viable corridors connecting them. The best potential corridors are displayed in red, green and blue. Red indicates the centers of the potential corridors, while green and blue indicate progressively more peripheral corridors. Four-lane freeways are displayed as wider black lines, with secondary highways and roads as narrower black lines.

To produce the maps, Corridors of Life Project scientists used the best available data on habitat and human use. GIS was used to model the routes according to a 'least-cost path' methodology, which balances the factors of habitat quality and barriers with the shortest possible distances between core areas. The work has identified a small but important subset of a whole range of corridors that will be important to the future of wildlife throughout the US Northern Rockies and the whole of the Y2Y ecoregion.



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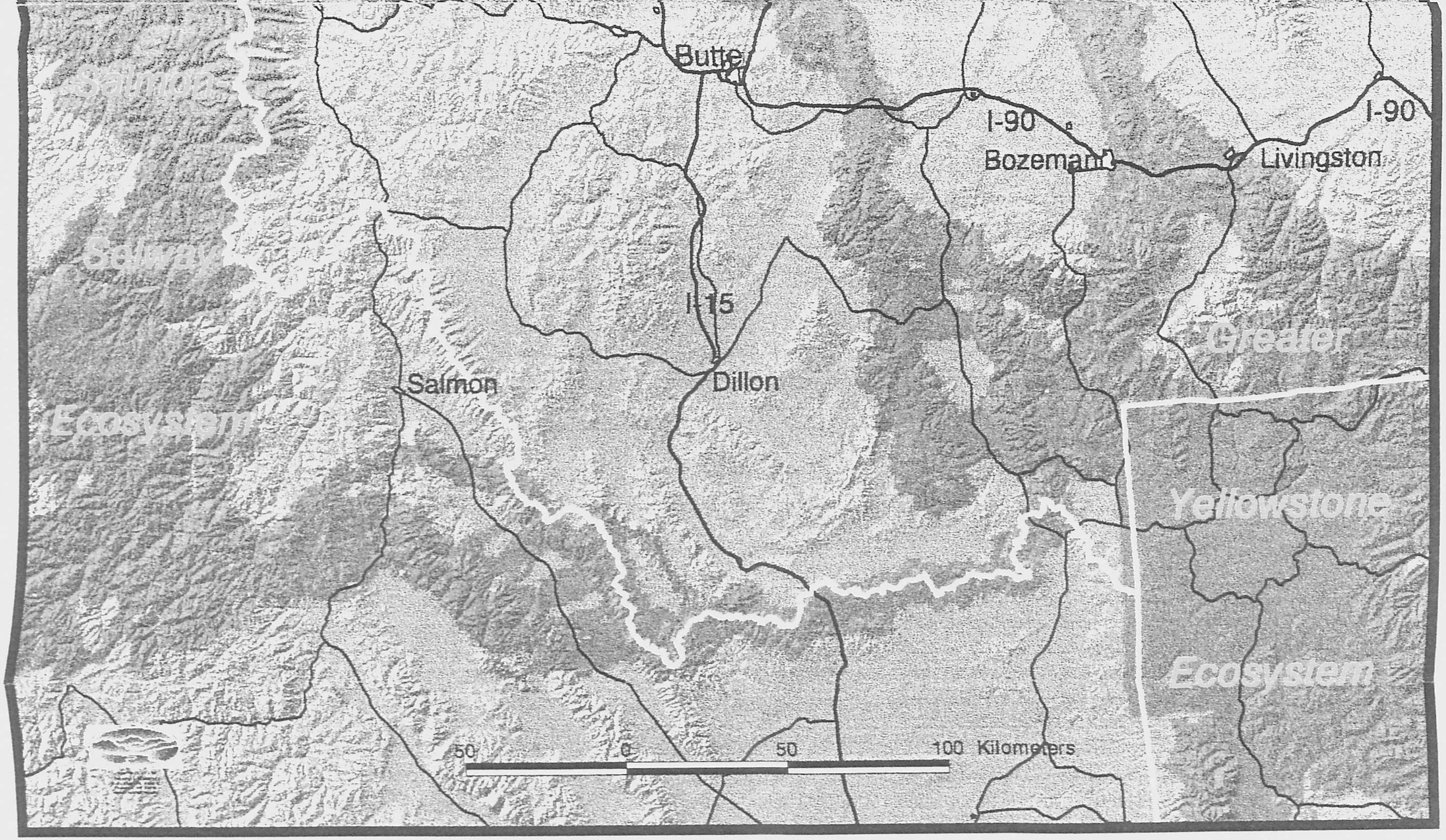
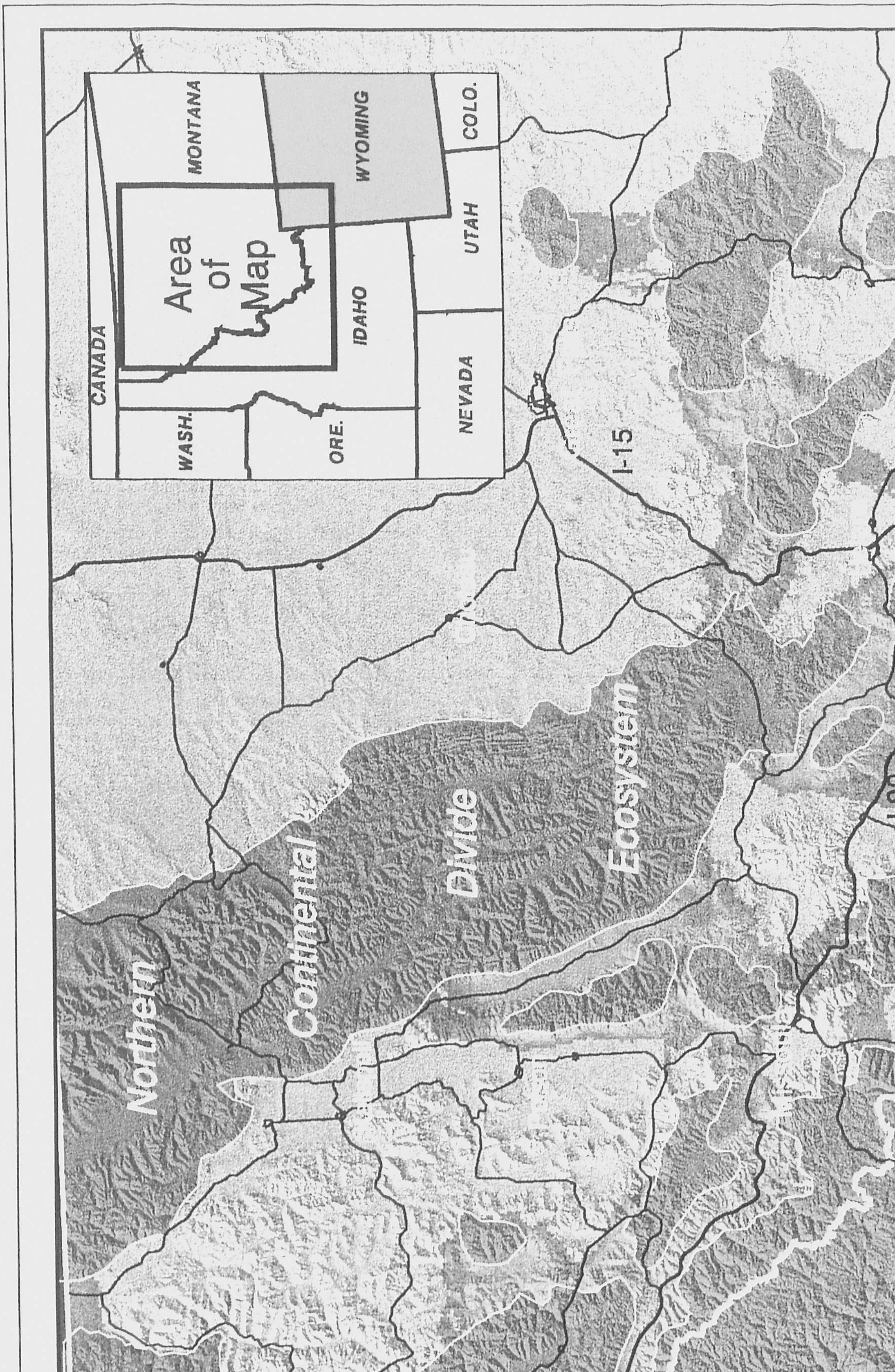


Potential Main Wildlife Corridors Connecting Three Core Ecosystems of the US Northern Rockies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Northern Continental Divide Ecosystem

Potential Regional Wildlife Corridors of the U.S. Northern Rockies

grizzlies, while the third is a good indicator of the amount of human use and disturbance in the area. These measures are similar to the parameters developed for the computer-based Cumulative Effects Model for the Grizzly Bear, by researchers with the Interagency Grizzly Bear Committee (ICE6 1994), and others.

Habitat quality. The Montana Gap Analysis project recently produced detailed GIS coverages of dominant vegetation cover for most of western Montana and central and northern Idaho. For our habitat quality model we used a computer-based map containing more than 50 different cover types, including some which were not native vegetation (e.g. barren, agriculture). Based upon an extensive review of the literature, we then rated each vegetation type according to its quality for grizzly bears. Rating values ranged from 0 (unsuitable) to 3 (highly preferred).

Habitat quality, however, is not strictly a function of the presence of preferred types. The spatial pattern of type mixtures can enhance or detract from the overall habitat quality. Grizzly bears are known to prefer a mixture of cover (for security) and open areas (for food or prey) over singular forest or grassland types. To indicate this "metatype" quality of habitat mixes, we derived the length of forest/grassland and forest/shrubland boundaries for the Gap Analysis region.

Because they require large areas of relatively undisturbed habitat, solving for the habitat requirements of grizzlies can assist in defining large core protected areas, smaller protected areas to serve as nodes in a networked regional landscape habitat system, and corridors to facilitate bear movement between the protected areas.

Roads data. We extracted roads information from two digital sources—U.S. Census Bureau TIGER files and U.S. Forest Service Cartographic Feature files. While some inconsistencies in the source files were evident, overall the quality of the data was high. Since all roads do not have equal impact on wildlife and the landscape, we weighted the roads according to their estimated use. Major highways were given a weight of 3, other major roads a weight of 2, and all other roads and railroads a weight of 1. The weights are roughly proportional to amount of disturbance or degree of difficulty an animal might have in attempting to cross the given road.

Integrating landscape variables at regional scale

A central question in modeling wildlife habitat and corridors is determining the best scale, or set of scales, at which to perform the analyses. Many ecological studies demonstrate that animals learn and "map" their home range areas and know where food, cover and other requirements are located on a "micro-scale" that can often be measured at a scale as fine as square metres. In order to reach areas they prefer, however, animals such as grizzly bears regularly move over long distances through habitat that is not of any particular value to them. In addition, dispersing individuals may wander for days through poor habitat before encountering better habitat where they can find food.

For regional-scale corridor routes, estimating habitat variables at the scale of 30 metres (the resolution of Landsat Thematic Mapper and Montana Gap Analysis) cannot be supported by the level of detail of the data. A model using data of such fine scale would be highly sensitive to local small changes in suitability rating, and might be unrealistic in its results. Thus, to examine possible regional-scale movement routes, given the limitations of GIS data and habitat characterization, we integrated habitat quality and roads data over larger areas. The choice of area unit size was critical—too coarse a scale could obscure important variations in suitability of the landscape for a wildlife corridor.

For this analysis we integrated the landscape (and habitat) variables at a resolution of one square kilometre. This scale offered a reasonable balance between the fine-scaled information base (30m in the case of habitat data, continuous in the case of roads data) and a broader scale unit (e.g. a small watershed). Ignoring the filtering effect of the 2.5 hectare minimum mapping unit of the Montana Gap Analysis database, integrating the habitat value coverage involved averaging approximately 1110 30m cells per square kilometre.

Based upon the literature and expert opinion, we derived mean habitat quality values for each UTM-based square kilometre cell for the grizzly bear. The mean values varied from 0 to 3. For each cell we also derived the total length of forest/shrubland edge and forest/grassland interface. These values ranged from 0 to about 11 kilometres per square kilometre. Though they are not strictly independent, the habitat value and edge length coverages provided us with two measures of the suitability of each square kilometre for these species.

Road density was obtained in a similar manner to the forest edge coverage. Roads were assigned weightings according to their approximated traffic load, then the weighted length totals were derived for each UTM cell. The range of the cells was very wide—from 0km/km^2 in roadless and wilderness areas to nearly 20km/km^2 in highly urbanized areas.

Figure 2 (previous page): Based upon GIS analysis of elk, cougar, and grizzly bear habitat effectiveness, scientists at American Wildlands delineated potential links between areas still containing significant good habitat (shown in magenta). In the prospective corridors, warmer colors offer the best potential, transitioning through the cooler colors to areas of lower potential.

Results

Using GIS inputs, we created a map of best potential grizzly corridors connecting the three large core protected areas of the U.S. northern Rockies (Figure 1). The corridors in this figure are color-coded, with warmer colors indicating better areas of habitat connectivity. Bottlenecks are indicated in parts of the corridors which are more constricted. Obstacles are likely where corridors cross roads or pass near urban areas. For the core areas we took units managed specifically for wilderness on public lands which were contiguous within an ecosystem. The potential routes determined by this analysis shown in Figure 1 tend to follow tree cover and mountainous terrain, as bears are less likely to successfully negotiate the expanses of wide open grasslands and shrublands which occur in the region.

The Greater Yellowstone–Northern Continental Divide connection

The distance between the Greater Yellowstone Ecosystem (GYE) and the Northern Continental Divide Ecosystem (NCDE) is approximately 200 kilometres. The area in between consists of a complex of forested mountains and open grassland/sagebrush valleys, with varying connectivity among them. Two major corridor routes for grizzly bears are depicted, with one route being superior to others. According to our work, the potential corridor offering the best chance of successful transit consists of the Gallatin, Bridger, and Big Belt mountain ranges. A secondary route for bears, inferior to the primary in this analysis, due largely to intense roading in the Helena National Forest, is to the west and is comprised primarily of the Taylor-Hilgard, Gravelly, Tobacco Root, Whitetail/O'Neil, and Boulder mountain ranges.

The Greater Yellowstone–Salmon-Selway connection

Grizzly bears originating in either the GYE or Salmon-Selway Ecosystem (SSE), according to our model, might best transit this roughly 380-kilometre distance along a route comprised mainly of the Centennial Mountains dividing Montana from Idaho. From the east this corridor begins from the south end of the Madison Range, follows nearly 200 kilometres along the Continental Divide (following the Centennial Mountains), and then crosses over the Lemhi Valley to the Lemhi Range of Idaho. From the Lemhi Range two routes fork and head west into the Frank Church–River of No Return Wilderness Area.

The Salmon-Selway–Northern Continental Divide connection

The minimum distance between the Salmon-Selway (SSE) and Northern Continental Divide Ecosystems (NCDE) is much shorter in air miles than the routes between the other core areas. Within the constraints of the methods, the best routes cross from the Bitterroot Mountains to the north end of the Sapphire mountains, then arc to the north, passing west of the Rattlesnake Wilderness Area. The corridor then takes a fairly direct route to the southwest lobe of the Bob Marshall Wilderness complex. This route passes close to the densely inhabited area around Missoula, Montana. Another, higher-cost route passes north of Missoula through the Evaro Hill area.

Summary

Radiotracking and genetic data in the Northern Rockies show that wildlife disperse on a regional basis (Paquet and Hackman 1995). Some species such as wolves or cougars can cover the distance between protected reserves in a single season; others, such as grizzly bears, fisher, lynx, or pine marten, may take several generations to move from one large reserve to another. We used a first approximation model to define the areas most useful to maintain this regional level connectivity for grizzly bears. With grizzlies as the umbrella species, the results of our regional scale wildlife corridor analyses define several routes which may provide the best opportunities for successful animal transits between core protected areas in the U.S. northern Rockies. Applying this least-cost-path analysis between smaller, intermediate "nodes" of suitable grizzly habitat outlines a regional network of habitat patches and connecting corridors. The resultant map (Figure 2) was based upon grizzly bear habitat effectiveness, but overlaps those based upon elk and cougar habitat effectiveness. This map can be considered a first step in designing a regional reserve network for the U.S. northern Rockies. Subsequent analysis should focus on refining these simple habitat models and focusing on finer spatial scales.

Acknowledgements

This paper reports the results of American Wildlands' (AWL) "Corridors of Life" project. We would like to particularly acknowledge Clif Merritt and Sally Ranney, former board members of AWL: Clif's vision and understanding are the foundation of this project; Sally's enthusiasm and support made the project possible. The staff of AWL saw the project through difficult times and this report summarizes the light at the end of the tunnel. Finally, this work would not have been possible without the financial support of many foundations and individuals (too many to list) and the moral support of the Y2Y family of conservationists. We are indebted to you all.

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