Landscape Prioritization and Reserve Design in the Interior Columbia River Basin

Open File Report - SBI1995-2

Peter Morrison
Methow Research Station
Sierra Biodiversity Institute

April 1995

OBJECTIVES

Sound ecosystem management of the Interior Columbia River Basin (ICRB) must protect biological diversity at all scales of organization: genes, species, ecosystems, landscapes and natural processes. Adequate habitat must be provided for many species that do not fair well in more intensively managed landscapes. This protection is best accomplished through an integrated network of existing protected areas, newly designated reserves, restoration areas, and linkage zones. An integrated reserve system in the Columbia Basin will further many of the following objectives:

1. Protect rare, threatened and endemic species that are sensitive to human induced impacts.
2. Maintain/restore functioning ecosystems - which include broad environmental gradients, natural disturbance regimes, and a complete suite of native plant communities and wildlife habitats.
3. Maintain viable populations of all native species well distributed throughout their range.
4. Provide representation of all natural communities and successional stages across the natural range of variation.
5. Provide refugia of native flora and fauna that are relatively resistant to biological invasions of exotic organisms.
6. Provide areas of adequate size, number and connectivity to allow for inevitable changes due to natural disturbance processes and long-term climatic shifts.
7. Terrestrial and aquatic elements should be well integrated in a reserve network.

PRINCIPLES

Why Reserves?

Any ecosystem management strategy for the ICRB which seeks to maintain regional biodiversity needs to incorporate a systems of reserves. Large unexploited landscapes where natural ecosystem processes and natural communities predominate provide essential roles as controls in our experiments in ecosystem management. Since proposed ecosystem management actions are likely to be widespread and affect large landscape areas, controls for these experiments also need to involve large landscapes and be well distributed in the ICRB. Comparison of reserves and more intensely managed landscapes can provide an important gauge of the success or failure of our efforts to ensure healthy, productive and diverse ecosystems.

An integrated reserve system acts like an insurance policy - it allows us to take risks (which are inevitable) in the rest of the managed landscape without risking the irretrievable loss of key elements of native biodiversity. Reserves certainly are not the only means of maintaining and enhancing regional biodiversity. The management of unreserved lands (i.e. matrix) is of equal importance. Matrix lands can enhance or isolate reserves depending on management.

Reserves do not imply a lack of management, rather, they are areas where active management is directed at maintaining and restoring biodiversity. In the ICRB, considerable research and management effort needs to be directed toward restoring natural fire regimes in existing protected areas and additional reserves. A set of general recommended guidelines for the management of reserves is presented in the final section of this paper.

Most currently protected areas in the ICRB were chosen largely for scenic, recreational and political reasons than for ecological value. Existing protected areas do not contain adequate habitat to ensure viability of many species. They contain disproportionate amounts of high elevation, biologically unproductive terrain. The current set of protected areas generally provide poor representation of many ecosystem types and habitat (Noss 1991, Wright et al 1994, Noss and Cooperrider 1994). The most productive and biologically diverse landscapes in the ICRB are largely under represented in protected areas. An expanded reserve network is needed to insure the viability of sensitive species and to provide adequate representation of the diverse array of native ecosystems present in the ICRB.

Although the existing network of federal Research Natural Areas and Nature Conservancy preserves provides some representation of many natural communities, the network is still very incomplete and lacks the redundancy necessary to protect regional biodiversity. A great failing of this network is that the protected natural areas are generally very small and isolated. A steady decline in effectiveness due to edge effects, small size and isolation is predictable (Noss 1991, Noss and Cooperrider 1994, Meffe and Carroll 1994). Many species with large habitat requirements receive little benefit from small reserves (Meffe and Carroll 1994).

Reserves are appropriate for the ICRB.

Concerns associated with any future establishment of reserves in the ICRB can be addressed through appropriate reserve design and management. Everett et al (1994) are concerned that reserve areas: (1) could isolate species or habitat from the larger system in which it evolved and interacts, (2) may prevent disturbances necessary for species viability and ecosystem sustainability, and (3) may jeopardize adjacent lands due a presumed decline in "forest health" within the reserve.

In the first case, isolation of species and habitat protected in a reserve is a function of the state of the surrounding landscape, not the state of the reserve. Adequate matrix management and the design of a reserve network which includes linkages and restoration areas minimizes isolation of reserves in a landscape managed for commodity production.

The second concern is entirely dependent on the management guidelines for individual reserve management. These guidelines need to reflect the dynamic nature of ecosystems and encourage (not prevent) disturbances necessary for species viability and ecosystem sustainability. Prescribed fire can be effectively used within reserves where forests are outside the historic range of variability for fire frequency.

The third concern is largely voided by adequate reserve management encouraging natural disturbance processes which will promote sound ecosystem health. Health of individual trees should not be the measure of ecosystem health in reserves. Usually, reserves will be put in much greater jeopardy by activities and processes in the surrounding human dominated landscape than the threat they pose to that landscape. Adequate management at reserve boundaries (e.g.- activities such as thinning and fuel reduction) will allow natural processes to proceed within reserves while greatly reducing the possible threat that disturbances such as wildfire will spread from reserves to damage the surrounding landscape (Agee 1993, 1994, Olson et al 1994).

The concept of "emphasis areas" in place of reserves has recently been promoted (Everett et al 1994). These would be areas with "soft" boundaries with a management focus on the maintenance of certain species or ecosystem elements. While there is some merit in this concept, it also has significant shortcomings. First, the concept as presented, focuses conservation efforts on individual species and ecosystem elements. Everett et al (1994) presented the example of an emphasis area to protect a population of are Delphinium veridescens in a small watershed. This single species focus through special management of a small area has merit in certain situations but does not offer a viable alternative to conservation of regional biodiversity where populations of hundreds of sensitive, threatened, endangered species are at stake. While there may be a continuing need to alter the boundaries of reserves based on new information and objectives the implementation of flexible or "soft" boundaries (Thomas and Raphael 1993, Everett et al 1994) is likely to lead to decisions driven by economic forces and have adverse consequences to the protection of biodiversity.

The growing acknowledgment of the influences of disturbances and the conservation implications of the nonequilibrium paradigm need to be considered in the design and management of reserves (Meffe and Carroll 1994). A reserve protection strategy that does not consider the effects of disturbances and influences from surrounding areas will not succeed in its long-term objectives. Reserve design and management should operate under the assumption that a reserve network will be able to incorporate unpredictable magnitudes and directions of change and still maintain species diversity and ecological processes (Meffe and Carroll 1994).

The Role of Landscape Prioritization in the Designation of Reserves

Given the increasing competition between commodity uses and non-commodity uses of public lands, landscape prioritization is an important first step in the identification and designation of reserves. Many areas are unsuitable for resource extraction; likewise, some areas have less to offer toward maintenance of regional biodiversity than other areas. Ideally, new reserves would be located in landscapes with high biodiversity values that are otherwise unsuitable for sustained commodity production. In this case competition and conflict would be minimized. In all cases, identification of portions of landscapes that have the highest potential to contribute to regional biodiversity is the first, most difficult, and most important step in design of a reserve network. In an area the size of the Columbia River Basin there are a multitude of species, genetic variations, communities and ecosystems - which all comprise the native biodiversity of the region. Areas that offer high value habitat for one species often provide high value habitat for a diverse group of associated species. But these areas often do not have significant habitat value for other equally important species. Regional landscape prioritization must accommodate the habitat needs of all species which are to be conserved. This necessitates the consideration of a wide range of environmental and biological factors which are indicative of habitat quality for a wide range of organisms. Landscape prioritization involves the synthesis and integration of this information in a model that predicts the overall value of various segments of the regional landscape to a reserve network.

There are many criteria for landscape prioritization and reserve selection involving ecological, environmental, cultural, political and economic factors. Often the cultural, political and economic factors override biological factors in final reserve selection. Some of the ecological criteria to be considered include (Soule and Simberloff 1986, Meffe and Carroll 1994, Noss and Cooperrider 1994):

1. Reserves should provide optimal habitat for one or more species of concern.
2. Landscape units that have greatest species diversity and provide habitat for the greatest number of species of concern should be given highest priority.
3. Landscape units with high levels of endemism are of great value.
4. Landscape units that are relatively secure for long term conservation are desirable.
5. Natural communities (especially forests) that are fragmented due to development, extraction and human disturbance are lower priority than unfragmented natural communities.
6. Rare communities and successional stages (e.g. old forests) and communities that receive little protection within existing reserves are prioritized over communities that are widespread and/or well protected.
7. Landscape units where native flora is intact and relatively uninfluenced by alien species have high priority.
8. Undisturbed watersheds that provide high quality water to aquatic ecosystems and act as refugia for native fish and other aquatic organisms have high priority.
9. Natural wetlands (because of their key role in ecosystem dynamics and abundance of associated flora and fauna) have a high priority.

Reserve Design Principles

Once information has been gathered on biological and environmental characteristics of a region and a landscape prioritization process has been completed, a network of reserves, linkages and restoration areas can be designated. This task needs to consider the basic principles of reserve design described below and be soundly based on the biological, environmental, political and social reality of the landscape in question. The following issues need to be considered in reserve design. Reserve design in the ICRB should consider all of these issues, but there is no generic prescription that will provide an optimal solution (Lomolino 1994). All of the following issues are interrelated and must be considered in conjunction. For example, decisions regarding matrix management and proximity of reserves influences decisions on reserve size, shape, and ability to absorb disturbances.

Reserve Size

In most respects large reserves are better than small reserves. Large reserves encompass more species, due to the well known species/area relationship. The ability of a reserve to provide adequate habitat to maintain minimum viable populations for target species should be the primary consideration in reserve size (Soule and Simberloff 1986). Reserve size needed to maintain minimum viable populations is a function of home range size and population density of target species, habitat quality within the reserve, proximity and connectivity to adjacent suitable habitat, and surrounding matrix character and quality. Often, reserves are visualized as isolated islands, surrounded by hostile environments to target species. In reality this is sometimes the case, but elsewhere reserves may be surrounded by habitat adequate for migration and dispersal. Isolated reserves surrounded by hostile environments need to be significantly larger that reserves in a more friendly matrix.

Representation and Redundancy

Representation of the entire range of ecosystems and species is a key objective in design of a regional reserve network. The ICRB is a vast area incorporating many ecosystems. A reserve network that provides adequate representation of the important elements of biodiversity present in the region will necessitate many large and small reserves well distributed throughout the region. The historic abundance of vegetation types needs to be considered when designing a reserve system. Vegetation types that have declined dramatically in historic abundance due to human activities need special consideration. The Eastside Forests Scientific Society Panel Study (Henjum et al 1994) found that ponderosa pine (Pinus ponderosa) and western larch (Larix occidentalis) forests are far below historic levels and need to be prioritized for protection.

A fundamental requirement of the representation objective is that reliable information on the location, condition and historical abundance of natural communities and target populations exists. This can be a monumental task for an area the size of the ICRB. Significant work remains yet to be done in developing this basic information.

Redundancy in representation of the elements of biodiversity is of great importance, both to the overall ecological health of the region and in the long-term maintenance of biodiversity. This redundancy helps insure that the ecosystem services provided by many organisms will benefit the entire region. It also helps insure that local extinctions will not result in regional extinctions.

Heterogeneity within Reserves

Spatial heterogeneous areas further the maintenance of high biodiversity (Meffe and Carroll 1994). Overall biodiversity within a reserve is a function of alpha (within patch) and beta (between patch) diversity. More heterogeneous areas usually have higher beta diversity. Patch heterogeneity also accommodates disturbances better than homogeneous landscapes. Individual patches may undergo disturbances or succession rendering them unsuitable for dependent species, yet other patches in a heterogeneous landscape may have developed into suitable habitat. Patch heterogeneity may also be important in the metapopulation dynamics of small biota such as annual plants, invertebrates and small vertebrates (Meffe and Carroll 1994). Spatial heterogeneous reserves also provide for the diverse habitat needs for many species (e.g. grizzly bear - Ursus arctos) which require a variety of habitats at different seasons or at different life stages.

Ability to Absorb Disturbance and Climate Change

Since natural disturbances and climate change are inevitable, it is wise to design reserve networks so that they can absorb these changes without significant loss of target species and communities. This is best accomplished by incorporation of large landscapes with broad environmental gradients wherever possible. Broad elevation and precipitation gradients allow for species and communities to adjust to climatic change

(Graham 1988). Incorporation of large landscapes allow for natural disturbance processes to operate without jeopardizing all available habitat for target species. Ideally, reserves should contain a 'minimum dynamic area' - the smallest area with a natural disturbance regime which maintains internal recolonization sources and hence minimizes extinction (Pickett and Thompson 1978). Others have suggested that reserves should be large enough to incorporate landscapes many times the size of the largest disturbance (Shugart and West 1981, Baker 1992). Reserves of this size are rarely possible, but significant opportunities for large reserve complexes exist in the Columbia Basin (e.g. North Cascades, Columbia Mountains, Central Idaho Mountains). Multiplicity within a reserve network also dampens the long-term effects of disturbances which may affect individual reserve elements.

Reserve Shape

There has been considerable discussion about ideal reserve shape. There is some advantage to reserves designed with large area/perimeter ratios which minimize edge effects (Shafer 1990, Meffe and Carroll 1994). But others suggest that reserve shape does not have a major influence on reserve success (Shafer 1990). What appears to be most important is that reserves should not be long and thin allowing edge effects to dominate.

Proximity, Connectivity and Matrix Management

Provision for migration and dispersal of organisms between units in a reserve network critical to its success. The ability of organisms to migrate between reserve units is dependent on the proximity of the units, provision for habitat connectivity and management of the matrix in which the reserve units are situated. Obviously the closer the reserve units - the easier the migration. Provision for habitat linkages promotes migration and dispersal capabilities of many organisms provided the linkages are of sufficient width to minimize edge effects. Matrix management which provides habitat conditions suitable for migration and dispersal will greatly improve the ability of organisms to move between reserve units.

SUGGESTED LANDSCAPE PRIORITIZATION METHODS - ANALYSIS AND WEIGHTING OF BIOPHYSICAL FACTORS USING GIS.

We recommend the following methods for evaluating and prioritizing landscapes for reserve design in the ICRB. This discussion is derived in large part from methods employed in a landscape prioritization and reserve design effort recently employed in the greater North Cascades ecosystem by Sierra Biodiversity Institute and Greater Ecosystem Alliance.

Step 1 - Assembly of GIS Data Layers for Biophysical Attributes.

The first step in GIS based landscape prioritization of the ICRB is the assembly of a multitude of GIS data layers which accurately portray the important biophysical attributes of the study area influencing biodiversity values. The following list includes some of the base data that should be acquired or developed:

1. Vegetation data which accurately reflects the current condition of plant communities in the study area. Ideally, this data should categorize vegetation to the plant association group level and contain information on current vegetation condition as well as potential natural vegetation status. This data should cover both forested and nonforested plant communities with equal emphasis. Corresponding species level databases should exist which give additional detail on the composition of mapped plant communities.
2. Detailed forest cover data, which contains specific information on canopy cover, successional stage, age, size, site quality, and management and disturbance history of all forest stands.
3. Digital elevation data - for a regional analysis, 90 meter resolution data is adequate.
4. Detailed hydrography data with stream segments attributed according to the Strahler ordering system. Ideally this should be a network coverage.
5. National Wetlands Inventory data. This invaluable source of wetland data can be supplemented with additional locally collected data where available.

6. River Information System data - similar to the Washington River Information System (WARIS) program data.
7. Natural Heritage System data - specific information on element occurrences of all monitor, sensitive, threatened and endangered species.
8. Major watershed and sub-watershed boundaries.
9. LANDSAT thematic mapper satellite imagery covering the study area.
10. Detailed transportation system data compiled from all available sources.
11. Soil and geology GIS layers.
12. Range maps for all vertebrate species.
13. Population status maps for important sensitive, threatened and endangered species.
14. Status maps for aquatic species.
15. Human population centers and population density (from US Census data).

Step 2 - Derived Data Layers - Determination of Biodiversity Values

Analysis of the above data sources can yield derived data layers which reflect various dimensions of the biodiversity value or potential of the landscape. These data layers are assembled to provide input into a raster based GIS biodiversity value surface model. The following derived layers are important elements to this surface model.

<u>Distribution and Fragmentation of Native Forests.</u>
A GIS layer is developed which contains data on the distribution of managed and unmanaged forests. A simplified management intensity attribute code is developed from management history data. The best existing data sources are merged to create a unified forest cover layer which best reflects the current status of managed and unmanaged forests in the study area.

Habitat fragmentation of patches of remaining forest is evaluated through several measures. Patch size and area/perimeter ratios of remaining native forest patches are calculated. Native forest patches are weighted with large patches with low perimeter to area ratios receiving the highest rank. An edge density surface is developed for edges resulting from human created openings in natural forests. This is developed through a moving window analysis, with the analysis window size set by the average home range of the important edge sensitive species in the study area. The resulting surface is weighted so that areas of native forest with low edge density receive the highest weighting.

<u>Degree of Late Successional Forest Development.</u>
Forest condition data is analyzed to proved information on the degree of development of late successional forest conditions within stands in the study area. This grid is smoothed with a 500 meter mean filter to reflect the average degree of development of late successional forest characteristics in the landscape. The resulting surface is weighted to reflect the degree to which late successional forests contribute to regional biodiversity.

<u>Patch Size Evaluation of Late Successional Forest Stands.</u>
The above GIS layer on late successional forests is analyzed to calculate patch size, connectivity and proximity of late successional forest stands. A GIS grid is created which is weighted by stand size, configuration and proximity to other stands.

<u>Vegetation Rarity and Representation Evaluation.</u>
The distribution of plant communities is assessed across the study area. Rarity of each vegetation assemblages is evaluated. The degree of representation of each plant community within existing protected areas is also evaluated. A GIS grid is developed which reflects both the relative rarity and degree of protection each vegetation assemblage has in the study area. This is weighted so that rare, poorly represented communities receive the highest weighting and common, well represented communities receive low weighting.

<u>Road Density Analysis</u>

A continuous surface model of road density over the study area. The road density surface is designed to reflect the landscape level impact of transportation systems in the study area. The road density surface is then weighted using a negative exponential distribution weighting.

Road Proximity Analysis

A continuous surface model of road proximity is developed for the study area. This is weighted with a negative exponential distribution weighting. The resulting surface model gives higher value to areas in the interior part of larger roadless/undeveloped regions.

Roadless/Undeveloped Region Determination.

All roadless/undeveloped regions for the study area are delineated using the following guidelines and methods. Roadless/undeveloped regions represent lands over 200 meters from a road and over 400 hectares in size, that have not been significantly altered by past management activities. These regions are determined through analysis of a composite road coverage which is assembled from the best current data sources for the study area. A composite land use coverage is also assembled from the best current data sources for the study area. Significantly altered areas are deleted from the roadless region coverage. Small appendages, slivers and other less ecologically significant areas are eliminated from the final coverage. Roadless/undeveloped regions are then weighted by size using an exponential distribution weighting.

Wetlands

Wetlands are also evaluated to determine overall rarity and representation of wetland types within protected areas. All natural wetlands are given a relatively high weighting, with rare and poorly represented wetlands receiving the highest weighting. Some specific wetland types of known regional significance are also given very high weightings regardless of rarity.

Biological Effect of Major Streams and Rivers on Terrestrial Species.

A proximity to major stream and river grid is developed, where the first 100 meters adjacent to the watercourse is given the highest weighting. The weighting of the rest of the landscape is determined by a negative exponential distribution, with areas over 1 km from a watercourse receiving no weight.

Biological Effect of Elevation Distribution

Low elevation lands are generally more productive and biologically diverse than in higher elevation lands in adjacent areas. A GIS grid is created to reflect this phenomenon where the weighting in inversely proportional to elevation.

Density of Sensitive, Threatened and Endangered Species

A GIS grid is developed based on the average landscape density of element occurrence data of locations of sensitive, threatened and endangered species. This grid illustrates the relative distribution of such species across the landscape. Remote, unsampled areas receive a regional average weighting - to reduce the bias created by sampling intensity.

Aquatic Diversity and Status

The status of major aquatic organisms is evaluated on a sub watershed level. Native and anadromous fish, amphibians, and keystone invertebrates are evaluated where data is available. Sub watersheds with high aquatic diversity or the presence of sensitive/threatened species or stocks are given the highest weightings. Other factors which influence sub watershed weighting are: 1) fish habitat quality, 2) level of human disturbance, 3) sensitivity to disturbance (erosion hazards), 4) connectivity value, and 5) purity of fish stocks/hatchery influence.

Geologic/Geomorphic Rarity and Representation

A regional geology layer and a regional landform layer are developed. Endemic and unusual flora and fauna are often related to unusual geologic/geomorphic conditions. A rarity and representation evaluation of geologic substrate and landform is developed in a similar fashion to that described above for vegetation.

Site productivity, forest suitability and erosion hazard
Soil data for the study area is compiled. This data is analyzed to develop two GIS layers for use in reserve design. The first GIS data layer reflects the relative potential of individual landscape units to provide sustained commodity outputs, with areas of higher productivity receiving higher weighting. The second GIS layer reflects the relative erosion hazard of each landscape unit. These two data layers are used in the reserve design process to aid in locating reserves in areas where conflict with commodity uses is minimized, where possible.

Step 3 - Development of the biodiversity potential surface model.

Areas with high biodiversity potential are determined through an iterative and interactive process. An objective GIS based habitat prioritization model integrating all the biodiversity value layers describe above is developed. Weights and integration algorithms may be adjusted in an interactive environment to achieve sensible results. This is accomplished in a GIS grid environment. High values in this surface represent areas with high biodiversity values. Low values in this surface represent degraded areas with relative low biodiversity potential where restoration activities may be necessary to restore habitat. This biodiversity potential surface is the end result of the landscape prioritization process. It is then used in design of a reserve network.

METHODS FOR DESIGN OF A RESERVE NETWORK

The biodiversity surface model developed in the preceding section identifies areas with high potential to contribute to regional biodiversity. However, the design of a reserve network needs to consider this information in conjunction with all the design considerations and principles discussed earlier in this paper.

The sub watershed GIS layer can be attributed with the average biodiversity value present in the surface model. These sub watersheds can then be used as "building blocks in the designation of reserves, linkages and recovery areas - based on their biodiversity values. Integration of aquatic diversity areas (as described in this report (Scurlock 1995)) into the regional reserve network is key to protection of regional biodiversity.

Linkages between sub watersheds with high biodiversity potential that may be designated as reserves can be determined using the biodiversity potential surface and GIS grid techniques which find least cost flow paths (easiest migration routes for various species) between high value areas. Physical constraint and "obstacle" grids can be used to limit the potential options to those which reflect optimal linkages. These linkages can be fine tuned by conservation biologists to take factors into consideration which were not evaluated in the GIS model.

Final design of individual reserves and of the reserve network is best left to conservation biologists and landscape ecologists who can integrate the many design criteria described earlier in this paper and information on species requirements not incorporated in the GIS models. An interactive GIS environment can be developed to aid biologists in visualizing the consequences of design choices.

SUGGESTED MANAGEMENT OBJECTIVES AND GUIDELINES

General Management Objectives for Reserves in the ICRB

1. Maintain/enhance habitat quality for native ungulates and their predators
2. Restore native plant communities from damage associated with livestock grazing
3. Maintain/restore late-successional forests to historic abundance
4. Maintain/restore aquatic habitat for anadromous and resident fish and other elements of aquatic biodiversity.
5. Restore vegetation/landscape structure characteristic of natural disturbance regime
6. Maintain high quality habitat for wide-ranging mammals, including elk, mountain caribou, lynx, cougar, wolverine, grizzly bear, and gray wolf.
7. Maintain diversity of native flora and fauna.
8. Maintain viable populations for all native species.

General Management Guidelines for Land Designations in a ICRB Reserve Network.

Reserves

1. No new mining or road construction.
2. Thinning permitted in plantations and other previously logged areas in order to facilitate development of late-successional forest characteristics, restore natural forest structure and composition, and reduce fire hazards. Thinning permitted along some reserve boundaries to reduce fire hazard to adjacent lands.
3. Prescribed fire used as primary tool for restoring/maintaining forest ecosystem health in roadless regions, where appropriate. Prescribed fire encouraged along reserve boundaries to reduce fire hazards to adjacent lands.
4. Limited trail systems and other access (follow typical wilderness area standards).
5. No collection of plants or other natural objects for commercial purposes.
6. Eliminate exotic species, as feasible (without use of herbicides).
7. Fire suppression to be determined on a case-by-case basis, but generally discouraged.
8. Hunting to be determined on a species-by-species basis, but generally no hunting of predators or any other species sensitive to population declines.
9. Hiking, camping, environmental education, and non-manipulative research encouraged.

Restoration areas

1. Thinning permitted in plantations and other previously logged areas in order to facilitate restoration of natural forest structure and composition.
2. No new road construction or re-construction. Prompt closure of unnecessary roads with obliteration and revegetation of roadbeds. Gradual reduction of overall road density to no more than 1 kilometer of road per square kilometer.

Linkage zones

1. Some level of timber cutting permitted, but emphasizing "new forestry" selection logging techniques, long (200+ year) rotations, and other ecologically-based silvicultural systems that seek to emulate forest stand and landscape patterns created by natural disturbance regimes.
2. Restoration forestry and sustainable forestry experiments encouraged. Minimum levels of late-successional/old-growth forests to be determined for each proposed linkage in the ICRB, based on capability, vegetation associations, landscape context, and other factors.
3. Reduce or maintain road density at no more than 1 kilometer/square kilometer. New road construction is strongly discouraged, but when shown to be necessary, will follow strict guidelines that minimize environmental impacts. No road construction will be permitted that blocks movement of species through the linkage zone. Any current obstacles to animal migration posed by the existing transportation system will be removed or mitigated.
4. Strong protection of all riparian areas and other sensitive sites, to be identified by a landscape or watershed analysis conducted prior to any new management activity.

Matrix

1. Provide at least minimum levels of important ecological structures (e.g. large-diameter trees, down logs, etc.) and allow for natural processes to continue.
2. Practice sustainable resource production.

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