Conservation Value: Focal Species and Connectivity in California's North Coast

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Legacy - The Landscape Connection

The Pacific Fisher, a rare small carnivore, was used as an indicator species for the mature forest habitat that once dominated this 5.5 million acre region. Six basic factors were used to assess the values of land for the conservation of biodiversity, and the largest concentrations of high value areas were used as "core areas" for the Fisher and other mature forest species. Connectivity between these areas was then assessed using road and habitat information. The result is a map of places that will be most important to protect if biodiversity in this region is to be maintained and restored.

Introduction

Legacy – The Landscape Connection is a 501(c)(3) non-profit consulting firm dedicated to the maintenance and restoration of the ecological integrity of the northwest California, using GIS as our primary tool. Although we work with many advocacy groups who take strong political positions regarding environmental protection, we do not engage in advocacy ourselves.

This Presentation as well as the full Special Element Analysis Report available online at: http://www.legacy-tlc.org/reportindex.html

Methodology Summary

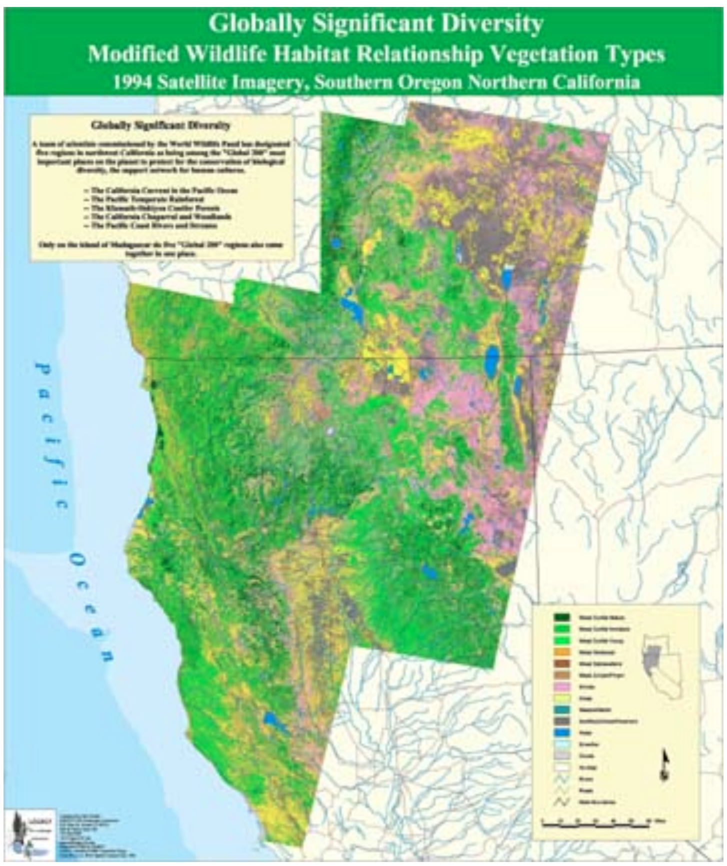
The study design and GIS work was carried out by Chris Trudel and Curtice Jacoby, using ArcView and ARC/INFO as provided to us (along with computers and a plotter) by two grants from ESRI's Conservation Technology Support Program. This study prioritizes the landscape and watersheds of the North Coast region of California according to seven variables. Some of these are combined to create a Conservation Value Assessment of terrestrial and aquatic "Special Elements," while others are used to create a generalized focal species model that we call "Habitat Security." Areas scoring high on these two factors were then combined with areas given high ratings by a focal species model for the Pacific Fisher that was developed by Carlos Carroll. Applying a minimum size criteria of 4,000 acres resulted in the designation of many places that we recommend as "Core Conservation Areas" for top priority protection as sources of cool, clean water, wildlife habitat, solitude, recreation, and open space.

Connectivity linkages for wildlife across the region were assessed using the Habitat Security model and "least-cost path" methods.

The theoretical basis for this use of Special Elements, Focal Species, Core Conservation Areas and Linkages is drawn from the basic texts of conservation biology, including works by E.O. Wilson, Reed Noss, Michael Soule', and John Terborgh, as well as recent planning for the Klamath-Siskiyou Conservation Assessment, the Sky Islands Wildlands Network, California Wildlands Project reports for the south and central coasts, the Southern Rockies Ecoregion Project, and the Maine Wildlands Reserve Network.

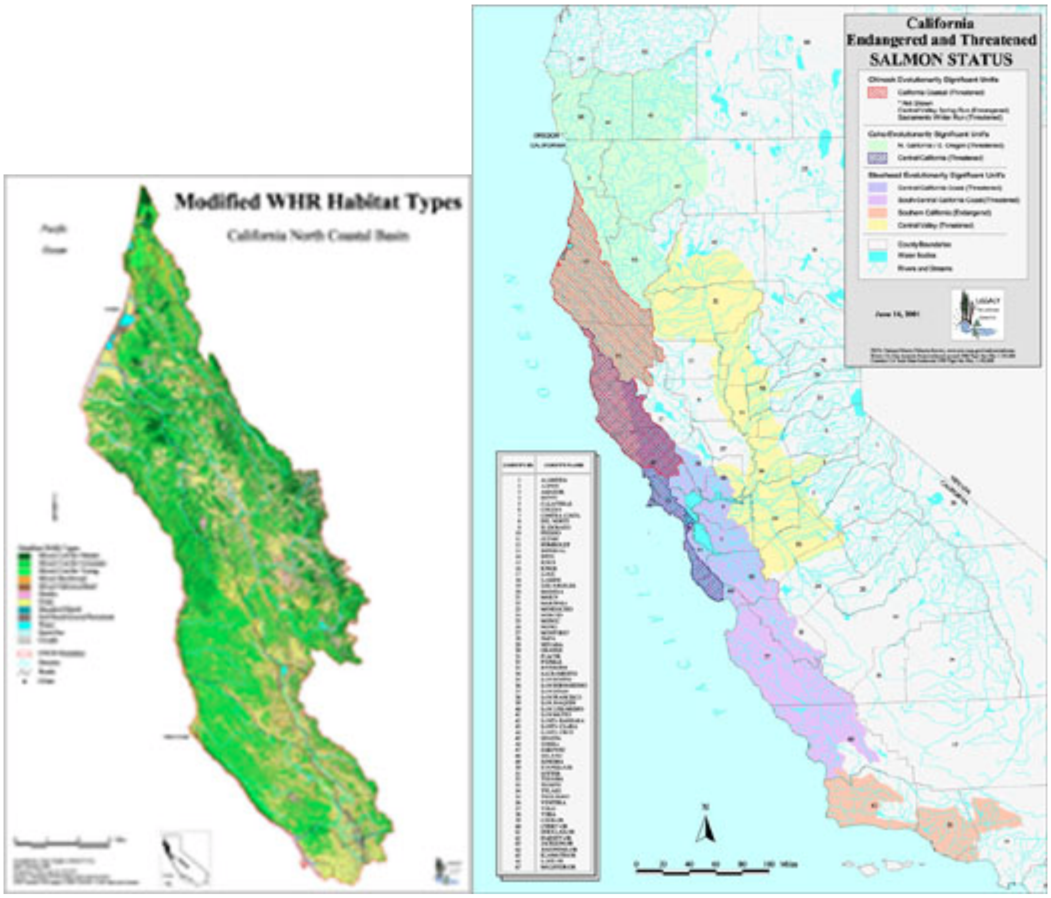
Study Area Description

California's North Coast region is the southern extent of the Pacific Temperate Rainforest, designated as a "Global 200 Ecoregion" by scientists convened by the World Wildlife Fund because of it's globally significant biodiversity and it's current vulnerability to degradation. The importance of this region is further enhanced by the fact that it is surrounded on all sides by other Global 200 ecoregions: the Klamath-Siskiyou Coniferous Forests to the northeast, the California Chaparral and Woodlands to the southeast, and the California Current to the west.



Because of the North Coast's vital role for salmon and steelhead, watershed boundaries are used by this study to define the region's exact boundaries: westward draining watersheds that are located south of the Klamath/Trinity River watershed, west of the Sacramento River watershed, and north of the San Francisco Bay watershed. Major river systems within the North Coast include (from north to south) Redwood Creek in Redwood National Park, the Eel River, the Mattole River, and the Russian River.

See how the shape of the region shown in this vegetation map of the North Coast ("Modified WHR Types") matches the shape of the watersheds designated as "Ecologically Significant Units" for Chinook Salmon shown on the next map of California Endangered and Threatened Salmon (colored red and dark purple below the green of the Klamath-Siskiyou region crossing the Oregon border).



The table below shows how the region is dominated by private land (79%). Roughly a quarter of that is owned by large timber corporations such as Pacific Lumber/Maxxam, Simpson, and Mendocino Redwoods. This makes the public holdings in the region especially significant, as existing protected areas there form the core of any conservation strategy. These include Redwood National Park, Humboldt Redwoods State Park, the Yolla Bolly and Snow Mountain Wilderness areas, and several candidates for Wilderness designation under pending legislation, such as the King Range National Conservation Area, Cahto Peak, English Ridge, Mount Lassic, Mad River Buttes, North Fork Eel, Red Mountain, Sanhedrin Mountain, and Yuki. One major Wild and Scenic River, the Eel, adds increased protection for water quality, and more stretches of the Eel and other rivers are eligible for such protection.

Ownership and Management Table Definitions

Highly protected areas, as defined here, include Wilderness Areas, National, State Parks and County Parks, conservation easements, and private reserves.

Moderately protected areas include federal lands protected under the Northwest Forest Plan for Northern Spotted Owls and other rare species.

Less protected lands include all other areas in public ownership.

Least protected lands are those in private ownership, including industrial timberlands.

Ownership and Management Type in California's North Coast Region

Ownership	Highly Protected	Moderately protected	Less protected	Least protected	Total	Percent of Total
Private, Non-industrial		15,207		3,266,840	3,282,047	61%
Private, Industrial Timber				996,059	996,059	18%
County		1,679			1,679	0%
CA State	109,222	21,568	48,751		179,541	3%
Federal Ownership:						
BLM	7,472	179,377	52,042		238,890	4%
Dept. of Defense		12,610			12,610	0%
National Park Service		67,697			67,967	1%
US Forest Service	108,183	0	232,007	364,586	704,776	13%
USFWS	2,577				2,577	0%
GRAND TOTAL					5,486,147	100%

Purpose and Need

- **Threats**

A single stressor has the ability to affect one or more of the habitats and species of the North Coast. The following stressors have been identified to be major factors contributing to the decline in integrity of habitats in the North Coast, and thus the decline in abundance of many species' populations.

1) Road building: Road building (primarily unpaved dirt roads) is widespread throughout the North Coast and often occurs on the steep terrain and erosive soils that characterize much of the region. Under typically high levels of precipitation, the logging operations which these roads facilitate contribute to slope failures and debris torrents that are made worse by the water diversions and blockages made by the roads. This has the potential for depositing massive amounts of sediment and debris into aquatic habitats. Excessive amounts of sedimentation prevent the successful reproduction of many fishes native to the North Coast, and has been identified as a major factor affecting their declines. The primary negative effects that road building can have on habitats and native species are thus: direct habitat loss, fragmentation, increased edge effects, erosion and sedimentation of aquatic habitats, loss of interior patch habitat, and increased vehicle and human access to remote areas.

2) Timber Harvest: This widespread land-use practice in the North Coast affects large parcels of land owned by timber companies. The effects that canopy removal by timber harvest can have on communities and native species are: increasing rates of erosion and sedimentation of aquatic habitats, loss of mature and old growth forests, loss of large woody structure (terrestrially and in aquatic communities), fragmentation, change in soil moisture regimes, increased precipitation runoff rates and thus increasing flooding potentials, increasing temperatures of aquatic habitats, and increasing the potential for exotic plant invasion.

a) Exposing slopes of land (that are often quite steep) to precipitation, and thus increasing rates of erosion and sedimentation into aquatic habitats.

b) Reducing the amount of riparian habitat that can buffer aquatic habitats from flooding and sedimentation.

c) Increasing temperatures of aquatic habitats, having a negative effect on native fish growth while favoring the growth of many exotic fishes.

3) Grazing: Grazing by livestock animals is prevalent within the North Coast and has multiple negative effects on native species including: riparian habitat degradation, competition with native herbivores, inhibiting or depressing regeneration of native plants (e.g. oaks), favoring exotic plant species (e.g. exotic graminoids vs. natives), increases human caused mortality for medium and large carnivores, increased erosion, and simplification of vegetative structure.

a) Degrades the quality of riparian vegetation and increases the potential for erosion and thus sedimentation into aquatic habitats.

b) Reduces the amount of riparian habitat that can buffer aquatic habitats from flooding and sedimentation.

4) Water Projects: Water projects include the presence of dams, channelization measures, and water diversions that have the following effects on native aquatic species:

a) Dams reduce the downstream volume of water in aquatic habitats thus reducing the amount of breeding and rearing (suitable) habitat available to species

b) Dams disrupt the natural hydrologic regime of aquatic habitats thus inducing rates of channelization with corresponding losses of riparian and suitable habitat

c) Dams prevent the passage of migrating fish species where adequate fish ladders are absent.

d) Channelization measures restrict natural meandering of watercourses thus reducing aquatic and riparian habitat and increased scouring of the current watercourse channel, reducing habitat quality.

e) Diversions reduce the downstream volume of water in aquatic habitats thus reducing the amount of suitable habitat available to species.

5) Urbanization: Urbanization includes the loss of natural habitat to a variety of development activities (conversion to homes, agriculture, pasture, etc.) that affect native species by: reducing the amount of habitat available to species (especially in lowlands, valleys, and the coastal plain), increasing fragmentation effects, increasing exotic species introduction, and increased pollution.

6) Pollution: Pollution includes many forms of degradation (e.g. chemical runoff, excess sediment loads, thermal) mainly caused by industrial and agricultural activities that affect native species by depositing large amounts of contaminants into aquatic habitats, degrading water quality enough to negatively alter the growth, reproduction, and survival of many species.

7) Mining: Two major types of mining occur in the North Coast: gravel and mineral mining. Gravel mining involves the removal of substrate from aquatic habitats faster than it can be replaced by natural processes which reduces the amount of suitable habitat available mainly to fishes. Mineral extraction occurs at various scales, targeting multiple types of minerals (e.g. nickel, gold) within the North Coast. The major effects of these types of mining include habitat destruction and hazardous chemical deposition.

8) Over-harvesting: This has occurred for conifer trees, fur-bearing animals, and salmon. It involves the removal of individuals from a population of species (trees, animals, fish) faster than they can be replaced by natural reproduction. This reduces the abundance of species and thus the number of individuals available to participate in reproductive activities required for the continued persistence of the species.

9) Estuarine Degradation: Pollution, urbanization, and dredging activities are the main activities that affect native aquatic species by decreasing the amount of suitable habitat available. Estuaries

represent critical stopover habitat for many species of waterbirds and play a variety of roles for multiple fish species.

10) Exotic Introductions: Exotic species (mostly plants and fish) have the following effects: competition with and replacement of native species reducing their growth, survival, and reproduction, and changing the structure and composition of natural communities.

11) Hatchery Effects: Many native aquatic species (primarily fish populations) are "enhanced" through hatchery activities that increase the number of individuals available to both recreation and reproduction, but effect native aquatic species by introducing fish that: increase competition with native stocks and reduce the genetic integrity of native stocks (Hatchery fish are usually produced from stocks that are not native to the aquatic habitat they are planted in. These individuals usually have a genetic quality that is inferior to those of the native individuals, and after successful interbreeding occurs, offspring are produced that are less capable of maintaining the species into the future).

12) Human Disturbance: Many habitats often receive large amounts of recreational pressure, such as rafting, catch-and-release fishing, and off highway vehicle (OHV) use. These disturbances can have dramatic (e.g. OHV degradation of sensitive dune communities) or subtle (e.g. snowy plover abandonment of beach and dune sites due to human disturbance) effects. Disturbance of individuals can cause abandonment of key sites or reduction in the amount of time they spend feeding, resting, and reproducing, potentially reducing their growth and survival.

13) Fire Suppression: This includes the direct suppression of fire as well as landscape alterations designed to decrease fire potential and intensity (e.g. fire and fuel brakes in chaparral). Fire suppression has different effects ranging from threatening the existence of entire communities, such as closed-cone cypress, to causing forests to become much denser with younger trees.

- **Applications for Legacy’s Wildlands Network Design**

The local, regional, and national groups that we work with use our information to guide their efforts in various ways:

-- identifying areas appropriate for sustainable forestry (Institute for Sustainable Forestry)

-- identifying priority areas for watershed restoration (Redwood Community Action Agency, Institute for Fisheries Resources)

-- placing land under conservation easements or "working landscape easements" (Northcoast Regional Land Trust, Jacoby Creek Land Trust)

-- aquiring land for conservation purposes (Save-the-Redwoods League, Sanctuary Forest, Ancient Forest International)

-- enforcing environmental laws through negotiation, appeals, and litigation (Humboldt Watershed

Council, Environmental Protection Information Center, Earthjustice)

-- passing Wilderness legislation (California Wilderness Coalition, California Wild Heritage Campaign, Friends of the River, Northcoast Environmental Center, South Fork Trinity River Land Conservancy, North Group, Redwood Chapter Sierra Club)

- **Methods Overview**

Seven basic variables were selected based upon available data and relevance (given ecological principles, past history, and current threats).

1. Mature conifer forests
2. Roads
3. Streams
4. Existing protected areas
5. Rare species locations (actual)

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6. Human population
7. Rare species habitat (predicted for the Pacific Fisher)

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<u>Phase One: Special Elements & Conservation Value Assessment</u>

The first five variables were used, singly or in combination, to map four terrestrial and four aquatic "Special Elements" that we believe are crucial to the maintenance and restoration of the region's ecological integrity, and thus are suitable measurements of conservation value.

Terrestrial Special Elements:

Every 2.5 acre patch within the 5.5 million acre region was ranked as very low, low, medium, high, or very high according to how it scored in terms of the following four terrestrial special elements:

- **Mature Conifer Trees**

Mature and old growth conifers previously dominated the region. Large old growth stands of redwood or douglas fir provided habitat for a vast array of species, many of which are now at risk.

<u>Data Sources</u>

Actual vegetation, summer 1994 Landsat Thematic Mapper imagery, Dr Lawrence Fox III and Steve Carlson, Humboldt State University, Spatial Analysis Lab, 1997 (Modified Wildlife Habitat Relationship (MWHR) Database v1.0a). This database contains 120 classes representing the actual vegetative conditions on the ground with a 30x30 meter grid cell resolution.

Methods

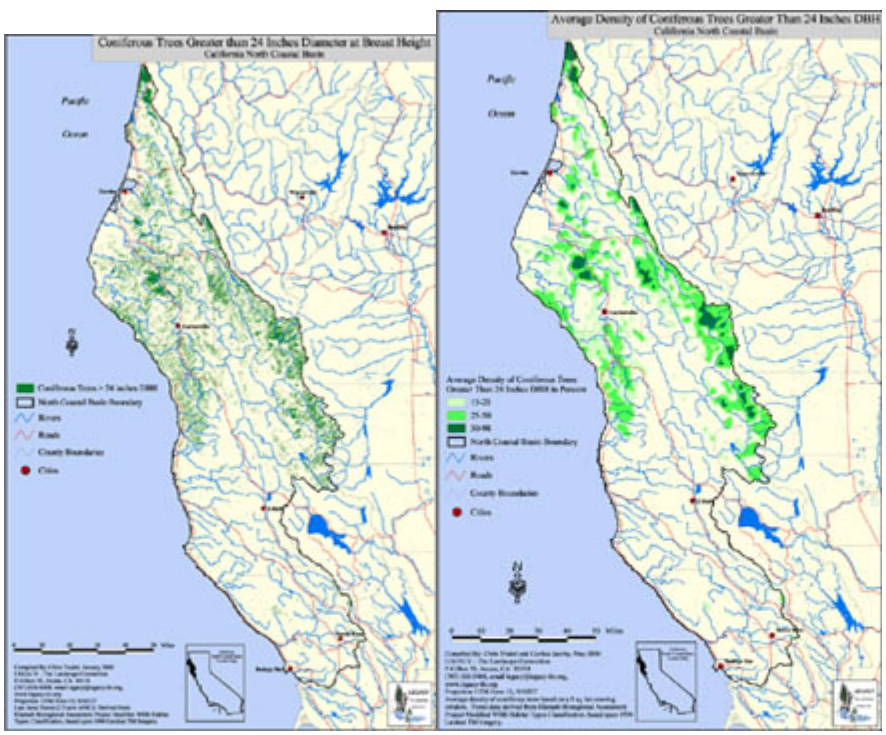
Mature and old growth conifers were defined by trees greater than 24" in diameter at breast height (DBH). The classification was done using Erdasä Imagineâ software and a hybrid of supervised and unsupervised classification techniques. MWHR, tree DBH, and canopy closure classes were all developed from homogenous training plots where the MWHR, tree DBH, and canopy closure classes were averaged for all trees within each 30x30 meter training plot. An initial review of the accuracy assessment shows a high degree of accuracy for the large size classes. One of the authors (Jacoby) conducted the ground-truthing for the northern part of the North Coast region.

Discussion

Because of the lack of and difficulty in obtaining forest age information we used forest size class as a surrogate to forest age. Although forests with a 24" DBH aren’t usually considered mature we decided to include this size class because these areas may contain mature forest characteristics as well as fallen trees, snags, and other legacies of older forests. If protected and allowed to mature, these forests represent the next generation of old growth forests.

Although the vegetation information used for this criterion is the most recent landscape level vegetation map available in a grid format with size and canopy closure classes, it is nonetheless 8 years out-dated and in need of updating to reflect losses, primarily from timber harvesting.

Maps of Mature Conifers and Density of Mature Conifers are compared below.



- **Density of Mature Conifers**

This Special Element adds the factor of density to the location factor described above, in recognition of the greater ecological value that larger patches of forest have when compared to the stands as small as 30 x 30 meters whose location is described by the first variable. This greater value is due to the loss of effective habitat through edge effects, and the benefits of greater patch size first described by MacArthur and Wilson.

<u>Data Sources</u>

1. Same as for Mature Conifers.

<u>Methods</u>

Density of mature trees was created by computing a focal mean GIS function on the mature conifer location data. A 100 x 100 cell ($3km^2$) moving window was used to calculate the mean density for each cell within the window. The resultant grid was then reclassified into high, medium, and low density classes.

- **Concentrations of Rare Species**

Concentrations of known locations of rare, threatened, and endangered species have been widely used for finding areas with high conservation value (Noss and Cooperrider 1994, Strittholt et al 1999). To ensure representation of the most imperiled species, a fine-filter approach was used to identify concentrations or hotspots of species richness and endemism.

<u>Data Sources</u>

1. CA Natural Diversity Database (CNDDB) - CADFG, 1999.

2. Spotted Owl Coverage – CA Department of Fish & Game, April 1995.

3. Marbled Murrelet Coverage - CA Department of Fish & Game, July 1996.

Methods

Global and state ranked threatened and endangered species were first looked at separately, then combined to create a concentration of global and state ranked rare species grid with 30 meter resolution, which was input into the composite special element model.

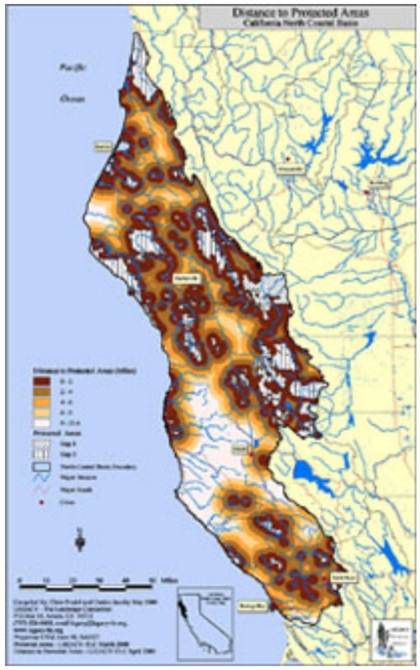
Before using the element occurrence point locations from the above data sources, some processing was required to assure that all available element occurrence (EO)information was best used, and that the EO information was as reliable as possible. First, all G1-G2 and non G1-G2 records from the CNDDB were selected and put into separate coverage's representing global and state ranked rare species. Second, all Northern Spotted Owl (NSO) detection's that were verified since 1980 and reliable and existing between 1990-1995 were selected from the Spotted Owl coverage and put into there own coverage representing reliable NSO occurrences. Because NSO's are a CA state ranked (S2 or G3) rare species and because of the lack of duplicate NSO records between the CNDDB and the Spotted Owl coverage we appended these 2 point coverage's into 1 point coverage representing state ranked rare species. Finally, all Marbled Murrelet (MAMU) survey stations and mapped points which were detected since 1980 were selected and put into there own coverage representing reliable MAMU occurrences. A more detailed description of further steps in this process is available on request.

Discussion

The source data contains areas of possible false negatives ("white holes") which may reflect a lack of survey effort, rather than the absence of at-risk species.

- **Distance to Existing Protected Areas:**

This Special Element is based on the conservation biology principal that reserves placed closer together are better than reserves placed further apart (Diamond, 1975). The existing protected areas described here include National Parks and Wilderness Areas that are permanently protected by the US Congress, as well as other less intact or less securely protected areas such as USFS Late Successional Reserves and California Department Of Fish and Game Lands.



Data Sources

A long list from federal and state agencies.

Methods

The polygon coverage of permanently protected and administratively protected areas (Gap 1 and Gap 2) was converted into a grid with 30 meter resolution representing protected and unprotected areas. The ArcGrid eudistance function was then used to calculate for each cell the euclidean distance to the closest cell representing a protected area. The resultant grid was then reclassified into 5 classes representing 2-mile intervals. Areas within 2-miles of an existing protected area recieved the greatest value of 5, while areas being > 8-miles from a protected area received the lowest value of 5.

- **Total Terrestrial Special Elements Conservation Value**

Scores for each of these four Special Elements were added together, as shown by the following map.

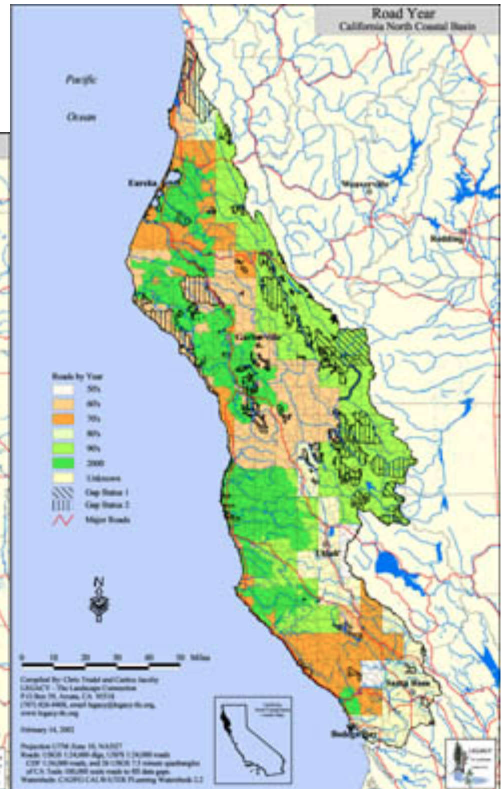
Aquatic Special Elements

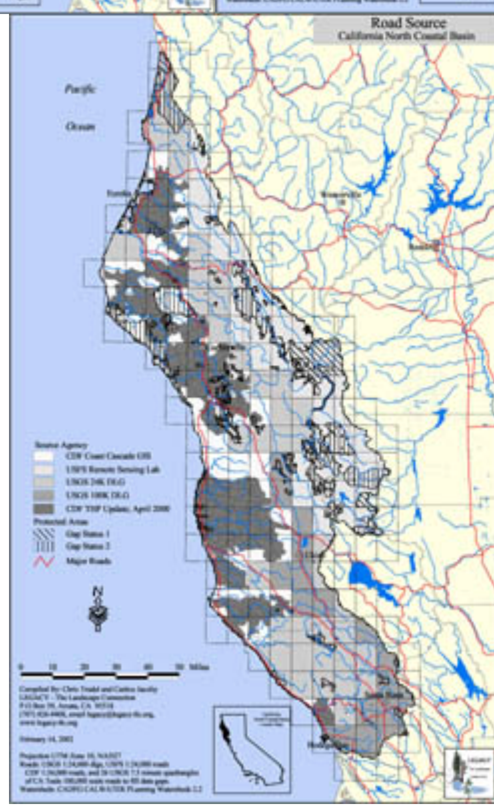
Sub-Watersheds are used as the unit of analysis to represent the needs of salmonids and other aquatic organisms. Aquatic species are dependent upon an abundant supply of high quality water. The watershed is used to define the sources of water and sediment. The presence of roads, streams, and mature forests are used to estimate the quality of aquatic habitat in each watershed.

Each of the [how many] small watersheds in the region (ranging in size from 10,000 to 30,000 acres) were ranked as very low, low, medium, high, or very high according how it scored in terms of the following four aquatic special elements.

- **Road / Stream Crossings**

It has been recognized that increased sediment delivery to streams is one of the major environmental impacts related to roads (Leathe and Enk 1985, Waters 1996:24). Potential impact from sedimentation is greatest where roads and streams cross, and thus increases as the number of intersections increases, decreasing the quality of habitat for aquatic organisms. Also, at road / stream crossings there is no buffer of streamside vegetation to prevent pollutants associated with roads such as heavy metals, salts, organic molecules, ozone, and nutrients from being directly delivered directly to streams (Trombulak 2000). Because sediment and pollutants are delivered to streams at the point that the road crosses the watercourse (Shaw and Thompson 1986, Case et al. 1994, Clarke and Scruton 1997), stream and road crossing density is an indicator of aquatic habitat condition. Culverts under roads are also easily blocked with branches and other debris, thus forcing run-off from a storm over the top of a road and washing it out, dumping large amounts of sediment into sensitive watercourses.





<u>Data Sources</u>

1:24,000 scale roads and stream data were compiled from various sources and assembled into seamless region wide data sets.

Roads

1. USGS 1:24,000 transportation DLG's.
2. USGS 1:24,000 manually digitized roads for a small portion of the redwood region, obtained from Jim Strittholt (Earth Design Consultants, Corvalis Oregon).
3. USFS Remote Sensing Lab 1:24,000 transportation data.
4. CDF 1:24,000 roads data as of May 2000.
5. California Teale 1:100,000 roads were used where 1:24,000 data was unavailable (24 USGS 1:24,000 quadrangles).

Streams

1. USGS 1:24,000 hydrology DLG’s.
2. USGS 1:24,000 manually digitized streams data for a small portion of the redwood region, obtained from Jim Strittholt (Earth Design Consultants, Corvalis Oregon). Missing the main stem of the Russian River.
3. USFS 1:24,000 streams data from Six Rivers and Mendocino National Forests.
4. California Teale 1:100,000 streams were used where 1:24,000 data was unavailable (11 USGS 1:24,000 quadrangles).

Watershed boundaries

1. CDF 1:24,000 California watershed boundaries, Calwater 2.2.

<u>Methods</u>

A point coverage representing stream and road intersections was created using the above data sources. The stream / road intersections were then intersected with the watershed boundaries and the total number of intersections were summed for each watershed. The summed values for all watersheds were then broken into 5 classes using the Natural Brakes algorithm in ArcView, and each watershed was given a value from 1-5 based upon its class. The lower the number of road /stream intersections in a watershed the higher the value.

Discussion

There will be more road/stream intersections than shown by the data for three reasons.

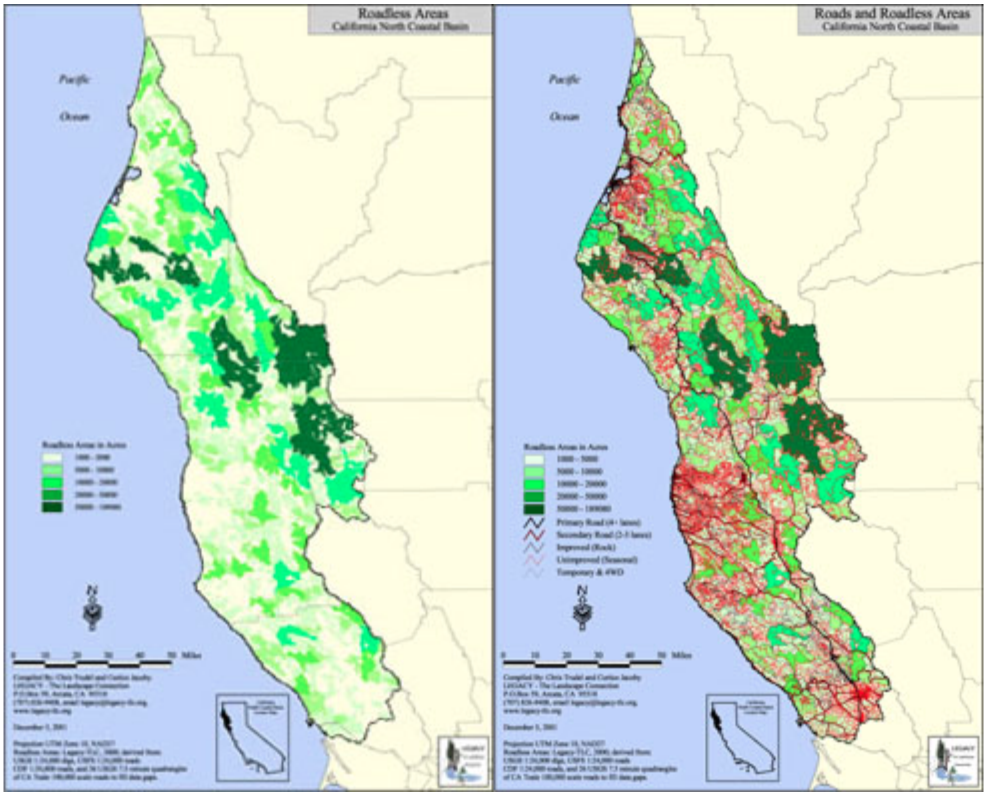
1. Some roads do not show up in the data because they have become overgrown or otherwise impassable, yet they still supply sediment to the streams.

2. Other roads have been built since the time of the USGS road surveys, some of which have not been updated for 40 years. In order to help understand how this problem effects our analysis, we have developed maps that describe the source and date of the road information.

3. Stream information for many areas reflects older survey protocols that did not map the location of seasonal streams. Rainy season flows make these small watercourses significant potential sources of sediment, especially when they flow through the small, easily-blocked culverts often used for "temporary" logging roads.

- **Roadless Areas**

The negative impacts of roads can also be assessed by measuring the percentage of a watershed that remains in large areas without them. Due to the multiplicity of non-mitigatable negative effects on aquatic ecosystems caused by roads, roadless areas are a key element in locating areas in need of protection. Roadless areas 500 acres or larger in size were mapped, and watersheds with a high percentage of their acres in areas un-scarred by roads were given high conservation value scores.



<u>Data Sources</u>:

The same roads and watershed data as for the road / stream intersection criterion.

<u>Methods</u>:

Roadless areas greater than 500 acres were mapped using methods modified from Strittholt et al. (1999). This technique utilizes a number of neighborhood operations using raster data (with 10 meter resolution) as opposed to older techniques that use vector data and a series of buffering commands. This technique was developed to take into account the sinuosity of the roads (which can be a problem when using buffer commands) and results in roadless areas having a corridor cut off width of 300 meters between roads.

Once the roadless areas were created, the ArcView Spatial Analyst Tabulate Area's function was used to create a database file with the area of each watershed that contained a roadless polygon. The database file was then joined to the watershed coverage attribute table and the percent of each watershed that remains roadless was calculated. The percent roadless area values were then broken into 5 classes using an Equal Area algorithm and each watershed was given a value from 1-5 based upon its class. Watersheds with the most un-roaded area were weighted the highest.

<u>Discussion</u>

Roadless areas will be smaller and perhaps fewer in number due to unmapped roads, as discussed above.

- **Mature Conifers along Streams**

Large, mature conifers contribute to aquatic conservation value in four major ways:

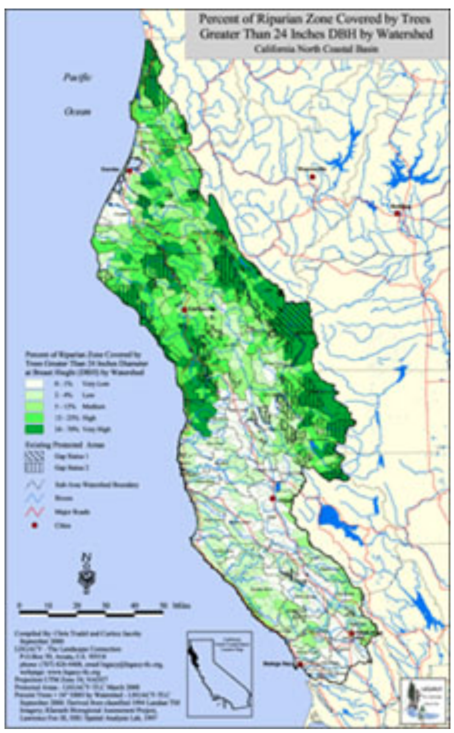
1. Cool stream temperatures are maintained to a greater extent by a canopy of mature trees that shades the water surface from the sun's warmth.

2. Surface erosion is also reduced by canopy cover.

3. Sediment from streamside landslides is reduced to a greater extent by the larger, deeper roots of mature trees that help to hold streambanks in place.

4. Fish habitat is created by large, slow-rotting conifers that fall into the stream.

Therefore, greater aquatic conservation value will be found in a watershed with a high percentage of its streamside zones covered by mature conifer forest that provides cooler, cleaner water, and better fish habitat. For this study, we defined streamside zones as extending 100 meters on each side of the stream, or approximately the distance of two "site potential" tree heights that the Northwest Forest Plan recommends be protected along fishbearing streams on federal lands in this region.



<u>Data Sources:</u>

Data sources include the same streams and watershed data as for the road / stream intersection criterion. And the forest information was taken from the Modified Wildlife Habitat Relationship (MWHR) Vegetation Data derived from 1994 30 meter resolution Landsat Thematic Mapper Satellite imagery classified by Fox et al. (1997).

<u>Methods:</u>

A polygon coverage representing a 100 meter streamside zone was created by using the ArcInfo buffer command on the 1:24,000 scale streams layer. Mature conifer trees ^{3} 24 " diameter at breast height in the vegetation grid were reclassified with into a new "large tree" class. Next, the large tree grid was combined with the stream buffer grid to create the large tree buffer grid. Using the ArcInfo Zonalstats command with the sub-watersheds as the zone and the large tree buffer grid as the value grid, the area of the streamside zone in each watershed in the ‘large tree class’ was then calculated.

Size of Mature Streamside Conifers

The average size of streamside conifers was used in order to provide a more refined measure of the impact of streamside conifer forests than the presence/absence data used above.

<u>Methods</u>

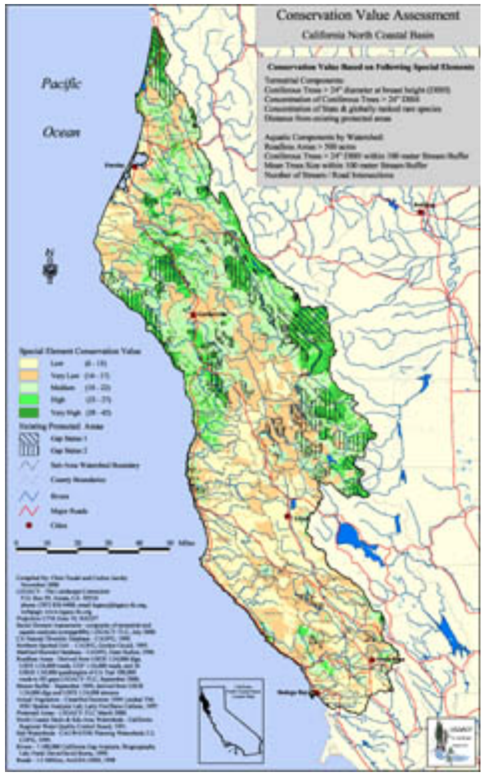
The average size of conifers with diameters larger than 24" at breast height was calculated within the same 100 meter stream buffers used above.

- **Total Aquatic Conservation Value**

Scores for each of these four Special Elements were added together with equal weighting, as shown by the following map.

Combined Terrestrial & Aquatic Conservation Value Assessment

Scores for the total Terrestrial and total Aquatic Special Elements were added together with equal weighting, as shown by the following map.



Phase Two: Core Conservation Area Design using the Special Elements Conservation Value Assessment

There were two steps to this phase of the process of selecting the most ecologically significant areas for recommendation as Core Conservation Areas:

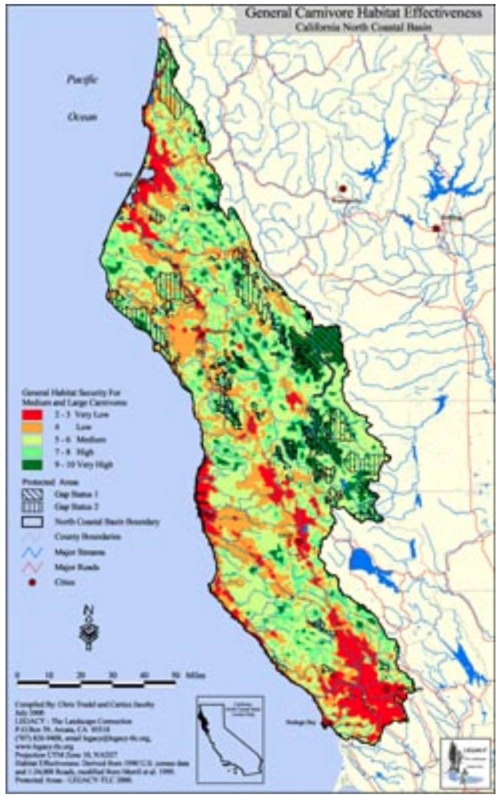
1. Find all areas that scored very high or high in total Terrestrial and Aquatic Conservation Value;

2. Designate as Cores those groups of very high and high scores that were greater than 4,000 acres in size.

This minimum size was selected as an adaptation to the fragmented forests of the North Coast of the 5,000 acre size cited in the Wilderness Act as the general minimum size for an area to be manageable as wilderness. It also reflects the principle that the larger the area, the more it will be able to sustain within it viable populations of creatures with large home ranges, as well as natural processes like fire and floods.

Phase Three: Generalized Focal Species Modeling – Habitat Security

As a measure of the kinds of disturbance by humans that are generally avoided by large carnivores (such as cougars) or large herbivores (such as elk), each 2.5 acre minimum mapping unit was rated from very low to very high according to road density and distance from human population. This process was based on a model that was developed by Merrill et al. in 1999.

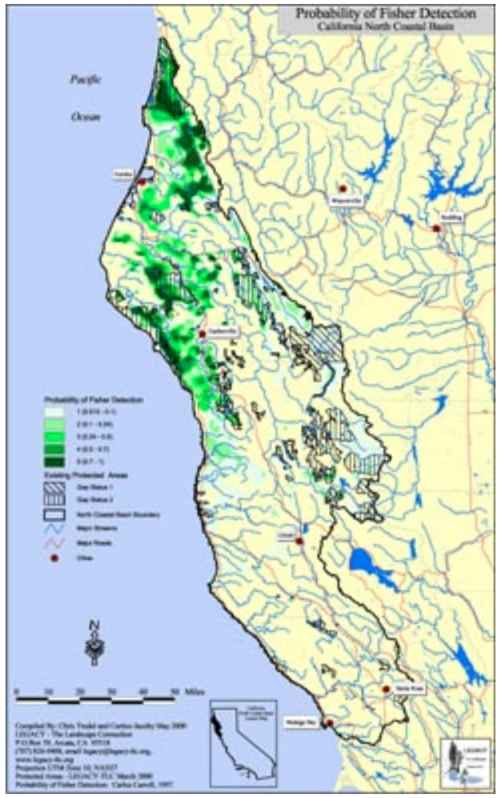


This Habitat Security variable was then used to define a new Core Areas in three ways.

1. **Existing Protected Areas/Habitat Security Areas** were created by the addition of acres scoring very high and high on Habitat Security, thus increasing the size of Existing Protected area clusters.
2. New **Habitat Security Cores** were formed solely by clusters of very high and high Habitat Security areas larger than 4,000 acres.
3. New **Habitat Security/Special Element** Cores totaling ?? acres were created by combining very high and high Habitat Security areas with smaller Special Element clusters less than 4,000 acres in size.

<u>Phase Four: Pacific Fisher Focal Species Modeling</u>

The Pacific Fisher is a mid-sized carnivore that was selected for use as a focal species because of it's association with mature and old growth forests, it's at-risk status (currently petitioned for listing under the ESA), and the availability of a ground-truthed model by Carlos Carrol predicting where Fishers would most likely be found, based on tree size, percentage of conifer trees, forest canopy closure, and annual precipitation.



This new Fisher Habitat variable was then used to define a new Core Areas in five ways.

1. **Existing Protected Areas/Fisher Habitat Areas** were created by the addition of acres scoring very high and high on Fisher Habitat, thus increasing the size of these protected area clusters.
2. **Existing Protected Areas/Special Element Areas/Fisher Habitat Areas** were created by the addition of acres scoring very high and high on Fisher Habitat, thus increasing the size of these protected area clusters.
3. **Existing Protected Areas/Habitat Security Areas/Fisher Habitat Areas** were created by the addition of acres scoring very high and high on Fisher Habitat, thus increasing the size of these protected area clusters.
4. New **Fisher Habitat Core Conservation Areas** totaling acres were formed solely by clusters of very high and high Habitat Security areas larger than 4,000 acres.
5. New **Fisher Habitat/Special Element Core Conservation Areas** totaling ?? acres were created by the addition of areas scoring very high and high on Fisher Habitat to areas scoring very high or high on Special Element Conservation Value.
6. **Fisher Habitat/Habitat Security Core Conservation Areas** were created by the addition of areas scoring very high and high on Fisher Habitat to areas scoring very high or high on Habitat Security.
7. **Fisher Habitat/Habitat Security/Special Element Cores** were created by combining very high and high Fisher Habitat areas with areas scoring very high and high on Habitat Securing and areas scoring very high or high on Special Elements.

Final results for Core Conservation Areas

Existing Protected Areas were increased in size ?? percent by the addition of ?? acres of Core Areas (of all kinds).

?? [how many] Core Conservation Areas (of all kinds) were found to total ?? acres. Addition of these to Existing Protected Areas, would increase acres protected by ?? percent.

Core Conservation Areas

Phase Five: Connectivity Mapping

The Habitat Security model was selected as a way to display the pattern of land minimally fragmented by roads that is also relatively remote from human activity. The following map shows areas of very high and high Habitat Security smaller than 4,000 acres could be used by wildlife as "stepping stones" between the larger Core Conservation Areas and Existing Protected Areas.

Cores plus Habitat Security outside the Cores

This general patterning of connectivity was then refined using the "least-cost path" method, as follows.

Cores plus Habitat Security with Landscape Linkages

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