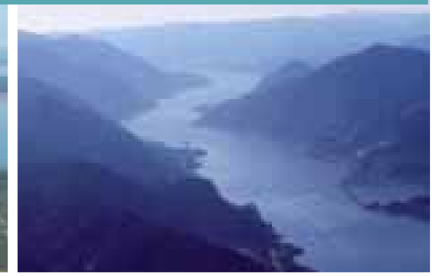
A Conservation Plan for the Columbia Land Trust



Analysis and Cartography by
CommEn Space

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Paper Abstract

The Columbia Land Trust (CLT) works to conserve land in the Columbia River region of southern Washington and northern Oregon. CommEn Space worked with CLT to develop a plan that will guide the land trust's conservation activities for the next five years. The plan ranks watersheds within an ecoregional context based on the conservation value for terrestrial biodiversity and salmonid species.

The biodiversity model assesses the relative importance of watersheds based on the amount of unprotected rare habitat types; the variety of rare habitat types; the number of rare, threatened, and endangered species; the diversity of bird, mammal, reptile, and amphibian species; and includes a representative set of all terrestrial vertebrates generated with the MARXAN model. Salmonid conservation priorities were determined using data from the Ecosystem Diagnosis and Treatment (EDT) model.

The conservation priorities were developed further by incorporating analyses of potential development threat, partnership opportunities with other organizations, and potential funding sources.

June 30, 2006

Columbia
LAND TRUST

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Overview

Background and Goals

The Columbia Land Trust (CLT) is a large land trust operating in the Columbia River region of the Pacific Northwest. Their service area runs from the mouth of the Columbia River east to the confluence with the Snake River, and 50 miles to the north and south of the mainstem. They work over a vast area—parts of two states, 26 counties, 153 cities and towns, 24 distinct habitat types, 388 terrestrial vertebrate species, 90 rare, threatened, and endangered species, 7 ecoregions, and 925 watersheds.

The CLT worked closely with CommEn Space to develop a conservation plan to guide their activities over the next five years.

The general goals of this planning process were to:

- Build regional understanding and perspective on habitat resources
- Identify high priority conservation areas to focus proactive conservation efforts
- Build & increase confidence in project selection criteria and processes
- Build in-house data and GIS capacity
- Create a tool to reduce uncertainty about where CLT will have the greatest impact on resource conservation

The specific questions that CLT sought to answer include:

- Where are the biodiversity hotspots?
- What is the geographic distribution of habitat communities within the region?
- Where are the identified priority habitats and species?
- Where are the priority salmonid protection reaches?
- What land is in Federal, State, or other conservation ownership?
- Where are the greatest development pressures?

The answers to these questions will help CLT to protect unique and declining habitat, communities, and species as well as facilitate ecologically relevant linkages between areas of habitat.

Study Area

We chose to conduct our analysis within an ecoregional framework to ensure that dissimilar areas were not compared to each other. Ecoregions provide broad, coarse-scale geographies with consistent ecological characteristics and are used by other organizations. Within the ecoregions, we chose the watershed as the unit of analysis because they are an ecologically significant unit and are also used by other organizations and agencies.

In the first phase of the project, we gathered a wide variety of habitat, physiographic, and socioeconomic data for an area slightly larger than the current CLT service area. We produced a series of basemaps to familiarize CLT with the data, and used this information to generate draft terrestrial biodiversity and salmonid assessment models, as well as a threat model.

The draft biodiversity model incorporated variables measuring bird species diversity, mammal species diversity, reptile & amphibian species diversity, rare plant and invertebrate locations (from the Washington Department of Natural Resources [DNR]natural heritage

Figure 1
The ecoregions within the conservation plan study area

data and Oregon Natural History data) and priority habitats and species locations (from Washington Department of Fish and Wildlife [WDFW]), wetlands, and anthropogenic disturbance. The draft salmonid model included variables measuring stream density, length of known salmon streams, number of salmon species present, percentage of tree cover within a 150' buffer, the percentage of tree cover throughout the watershed, the number and area of wetlands in the buffer, the number of road/stream crossings, and anthropogenic disturbance.

These preliminary results were presented at two expert workshops attended by agency scientists, tribal scientists, and conservationists from other organizations (such as TNC). We received hundreds of comments from these workshops, but several themes emerged consistently:

- More emphasis on floristic diversity
- We should not use DNR Heritage or WDFW PHS data to drive prioritization because of the "absence of absence problem"—these data show where species or habitats were found, but do not indicate areas that were searched where species or habitats were not found
- More emphasis on rare, threatened, and endangered species
- Need to capture irreplaceable conservation features such as bays and estuaries
- The salmon prioritization model should be supplanted by the Ecosystem Diagnosis and Treatment (EDT) model created by Mobrand Biometrics that was run within each subbasin planning under the Northwest Power Planning Council

The workshop feedback was translated into a series of questions which we used to direct our refinements to the biodiversity prioritization:

- Which watersheds contain the greatest amount of unprotected rare habitat?
- Which watersheds contain the greatest variety of regionally rare habitats?
- Where are the Rare, Threatened, and Endangered Species?
- Where are the areas of high bird, mammal, and reptile/amphibian species diversity?
- How many watersheds need to be conserved to get at least some habitat for every species?

For the salmon habitat prioritization, we obtained spatially explicit EDT model results from the WDFW for the subbasins that had completed the modeling process and were involved in the joint WDFW/TNC work in the Columbia River region. This data (and how we used it for the CLT conservation plan) will be addressed below.

Habitat Type Analysis

We used habitat type data generated by the Northwest Habitat Institute for Washington and Oregon as a proxy for floristic diversity and to establish a clearer picture of the conservation status of each of the twenty-four habitat types found in the CLT study area. For each habitat type, we measured the percentage of the study area covered by the habitat type, the area of the habitat type within public ownership (or under private conservation), and the conservation status of the public/protected areas.

We defined "rare habitat types" as those that cover 1% or less of the study area. For each watershed, we measured the percentage of the total remaining unprotected area of each rare habitat type, as well as the variety of unprotected rare habitat types.

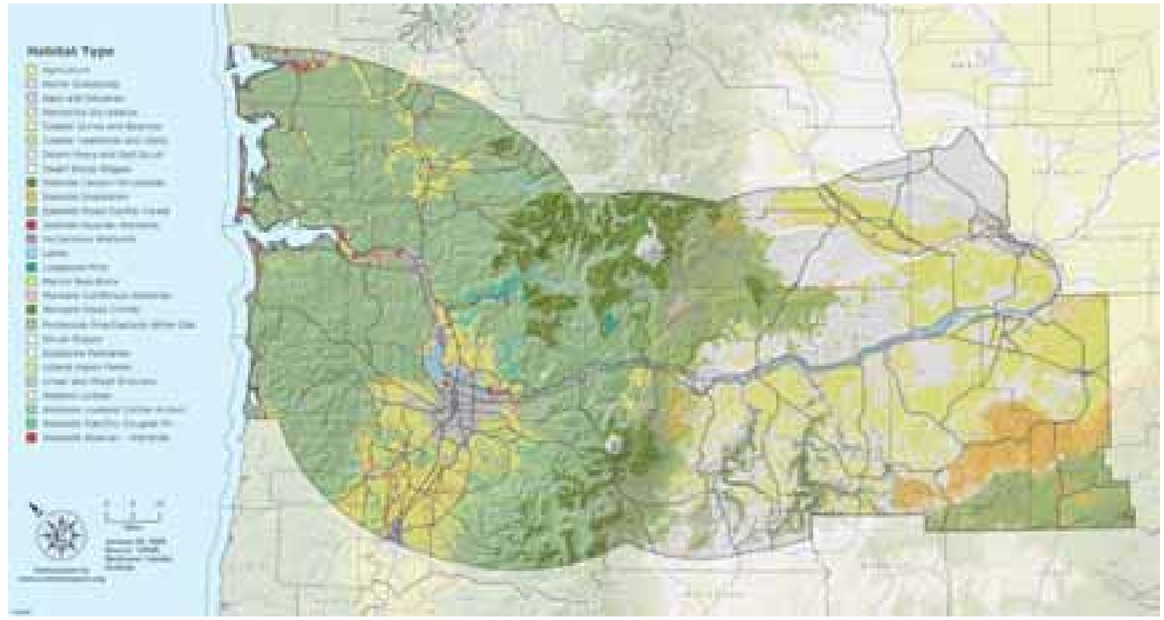

Figure 2
Habitat types mapped by the Northwest Habitat Institute

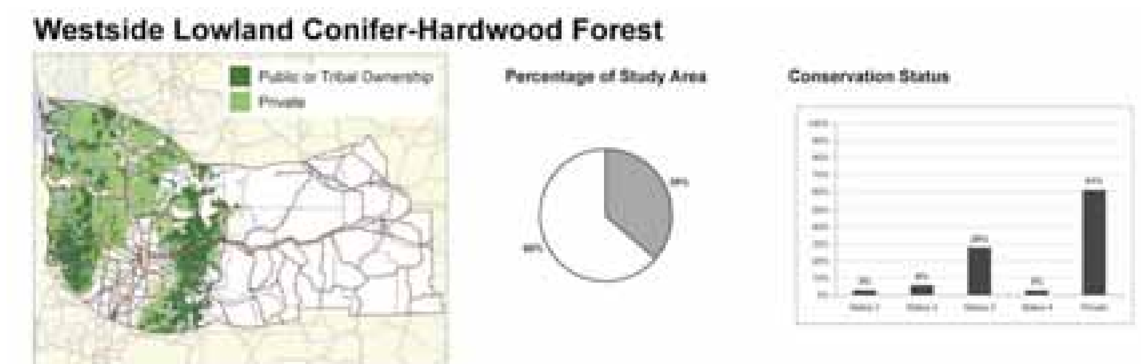

Figure 3
Example of habitat type analysis, this one for the Westside Lowland Conifer-Hardwood Forest

Gap Conservation Status

Conservation status was determined using the National Gap Analysis system, as follows (National Biological Survey Gap Analysis Program Handbook, version 1):

(1) An area with an active management plan in operation that maintains natural conditions and within which natural disturbance events are generally allowed to proceed without interference. The management objective has legal standing and cannot be altered at the discretion of the administering agency, organization, or individual. Examples; National Parks, Nature Conservancy Preserves, Audubon Society Preserves, Wilderness Areas, Forest Service Research Natural Areas.

(2) An area managed generally in a non-extractive way for its natural values, but which may receive uses that degrade the quality of the natural communities that are present. Management objectives are not legally mandated for biodiversity conservation, and such objectives may be subject to administrative discretion. Examples; State Parks, State Wildlife Management Areas with low intensity forest management.

(3) An area for which legal mandates prevent permanent conversion, but which is subject to extractive uses. Examples; non-reserved National Forest areas.

(4) Lands managed in ways that may preclude the holistic maintenance of native plant and animal assemblages. Examples: Department of Defense lands, or privately owned lands not having deeded covenants for biodiversity conservation or not owned by organizations having a principal charter to manage for the long-term maintenance of native biological diversity.

Species Richness Analysis

We used data from the Washington and Oregon Gap Analysis Projects to measure terrestrial vertebrate species richness. The National Gap Analysis Program (NGAP) is being conducted state-by-state and uses wildlife-habitat relationship models in conjunction with satellite-derived vegetation maps to predict the distribution of all terrestrial vertebrates. Although the dataset is predictive, it covers all terrestrial vertebrates, unlike observance-based wildlife datasets, and it is not limited by the "absence of absence" problem discussed earlier.

We clipped the individual species' distributions to the study area and cross-walked the Oregon species codes (TNC Elcode) to the Washington species codes (four or five letters composed of first two letters of genus and first two [sometimes three] letters of species). The Washington species distributions were converted to ESRI grids to conform to the Oregon data format and we used a series of Python scripts to measure the predicted area for each species within all of the USGS HUC 6 watersheds intersecting the study area. The end result was a table with individual watersheds as rows and species as columns. Additional fields were generated that sum the number of bird species, mammal species, herp (amphibian and reptile) species, and all species. In this way, CLT can display the predicted distribution for any individual species, the number of species by taxonomic group, or the total number of species by watershed.

Rare, Threatened, and Endangered Species

We researched the rare, threatened, endangered, candidate, and species of concern (RTE) at the Federal level and within Washington and Oregon. There are a total of 90 species that fall within our criteria for RTE species. We included a species in the analysis if it was listed at any level by any of the three jurisdictions, and used the predicted distributions from the Gap programs to measure the amount of habitat for each species within each watershed, as well as the total number of RTE species per watershed.

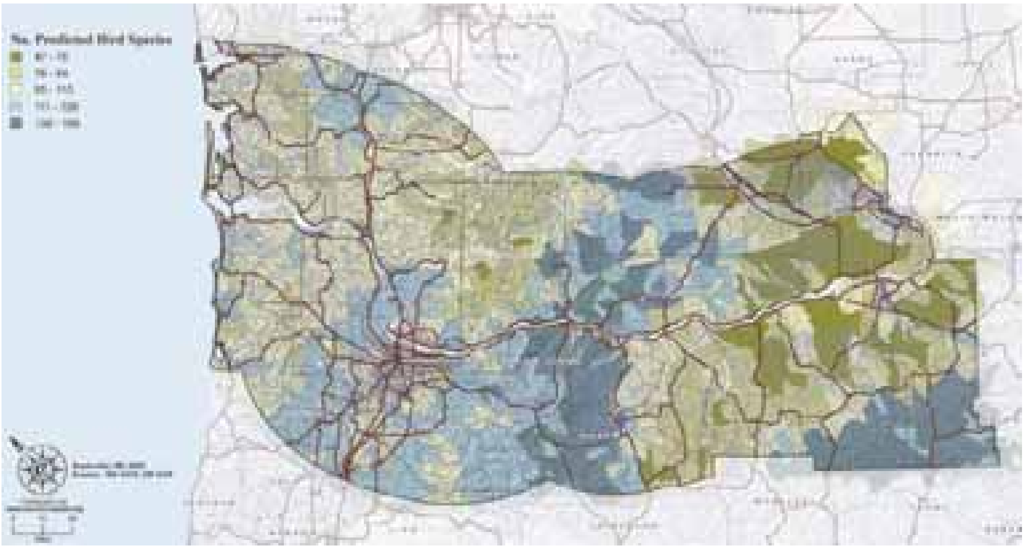

Figure 4

Raw number of predicted bird species per watershed

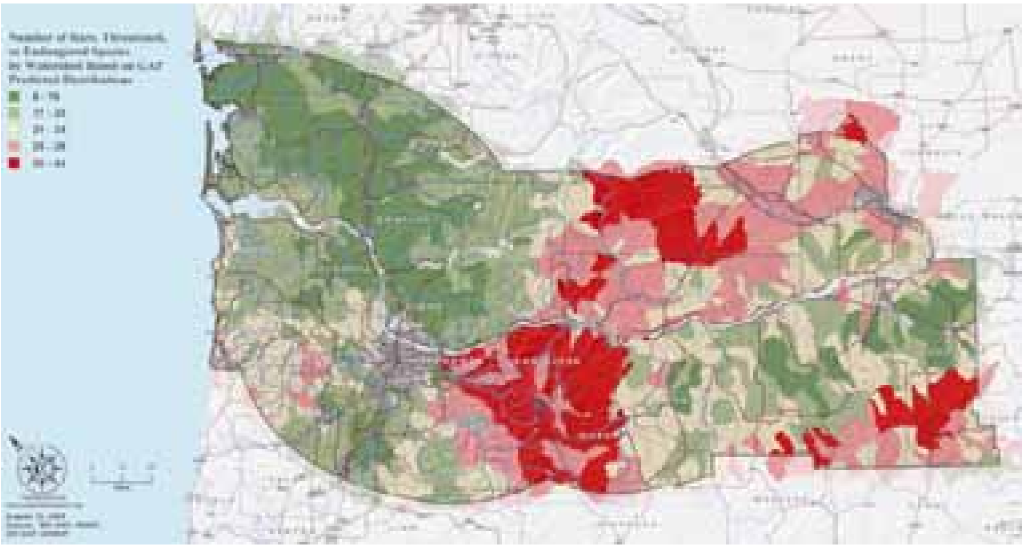

Figure 5

Raw number of predicted RTE species

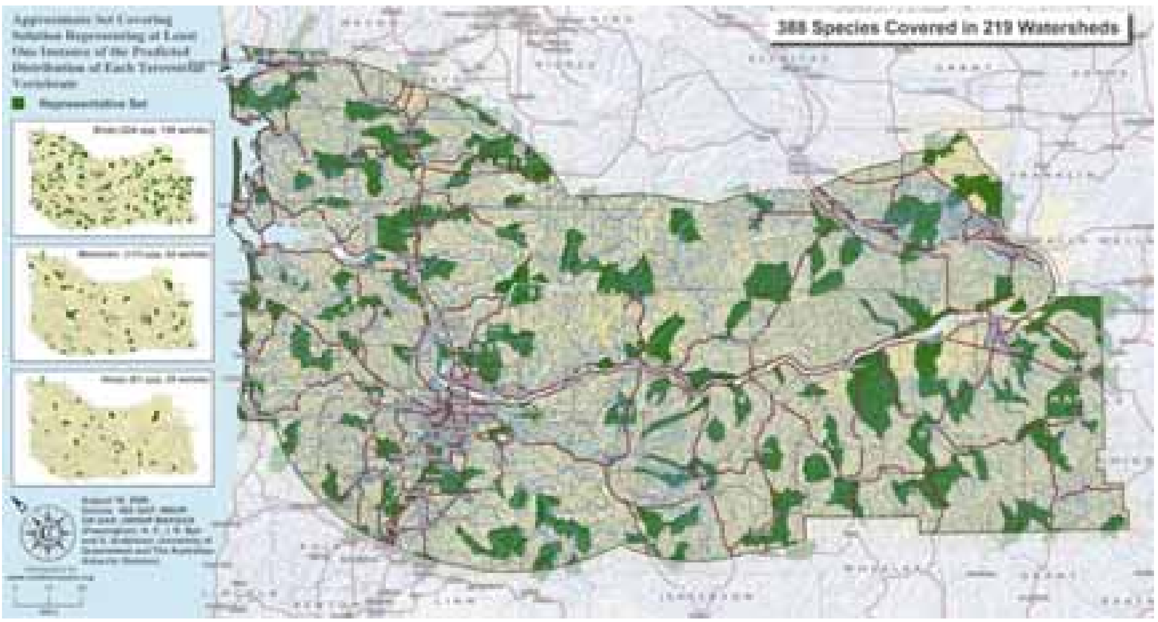

Figure 6

A representative set for terrestrial vertebrates

IRREPLACEABILITY AND REPRESENTATION

One of CLT's primary concerns was that our modeling approach avoid letting any species or habitat types "slip through the cracks." To address this concern, we modeled a representative set of watersheds that included at least one instance of every species—this is typically referred to as a "set covering problem." The objective was to ensure inclusion of at least some habitat for species that are not RTE, not dependent upon rare habitat types, and not in areas of high biodiversity. In this particular set-covering problem, the best solution includes at least some habitat for every species in the fewest number of watersheds. According to the Mathematical Computing Society,

> The idea is to select enough members in each of a specified collection of sets; that defines covering the sets. . . The matrix A has 0's and 1's, where the i-th row corresponds to the i-th set to be covered: A(i, j)=1 means element j is in set i; else, A(i, j)=0.

To minimize the number of watersheds required to achieve this objective, we created a matrix of 1s and 0s, where watersheds comprise the rows and species comprise the columns. If a species has habitat in the watershed, it was coded 1, and if a species has no habitat in the watershed, it was coded 0. We used the greedy heuristic in MARXAN (Ball and Possingham, 2000) to derive a representative set for each of the taxonomic groups individually. According to the documentation included with MARXAN,

> Greedy heuristics are those which attempt to improve a reserve system as quickly as possible. The heuristic adds whichever site has the most unrepresented conservation features on it.

Given more time and funding, we would ideally incorporate information on home range size and minimum viable population size for each individual species to ensure that watersheds received a score of 1 only when there was sufficient habitat to support at least one population of each species. However, that level of detail was beyond the scope of this project.

COMBINING VARIABLES TO RANK WATERSHEDS

We ranked watersheds within the study area by first identifying which watersheds should be included, based on CLT's criteria. We conducted the assessment in seven steps. Each step is useful individually, and combination(s) of these steps are helping CLT focus their priorities. First, we included watersheds that:

1. Have a high proportion of unprotected regionally rare habitat types
2. Have a high variety of rare habitat types
3. Have a high concentration of rare, threatened, and endangered species
4. Are high in terrestrial vertebrate richness
5. Are members of one or more representative sets (birds, mammals, or herps)
6. This process produced a set of 482 key watersheds, which constitute the basis for the prioritization

Within these key watersheds, the individual variables were combined to yield a score; however, we first had to scale the variables so their units could be compared. We did this by compressing or expanding the values for each variable to a scale of 0 – 100 using the generalized formula:

([FIELDNAME] – OLDMIN) * ((NEWMAX - NEWMIN)/(OLDMAX - OLDMIN)) + NEWMIN

The variables were scaled within the ecoregion to ensure that dissimilar areas were not scaled against each other, as mentioned above.

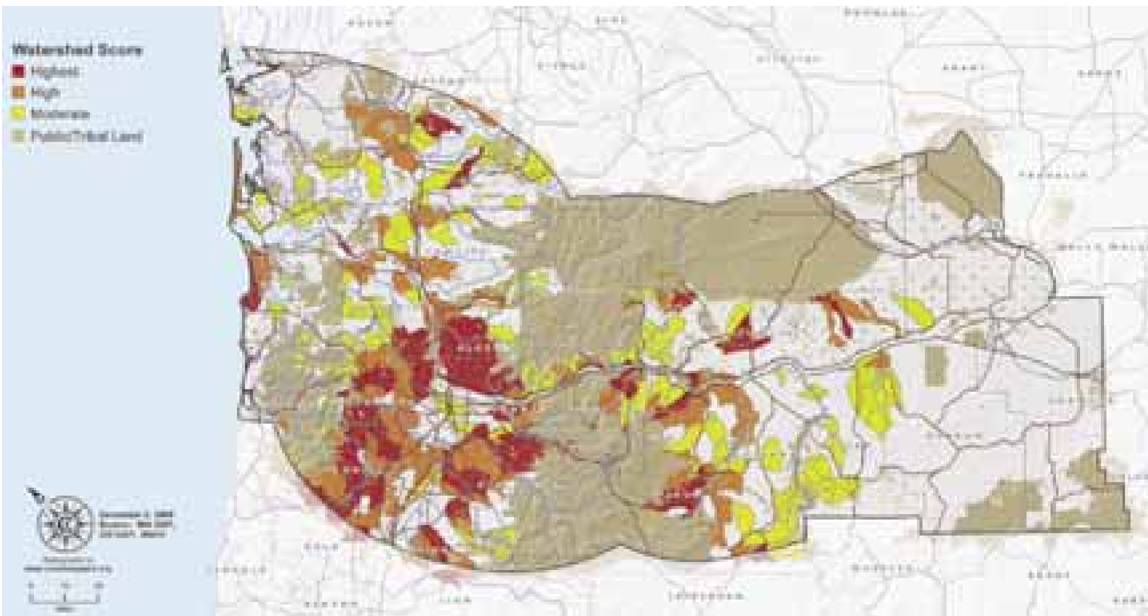

Figure 7
Priority watersheds based on watershed score

For example, bird diversity in the watersheds of the Coast Range ecoregion ranges from 78 to 118 species, while bird diversity in the watersheds of the Eastern Cascades ranges from 97 to 159 species. If we did not use an ecoregional framework, the most diverse watershed in the Coast Range would rate as only moderately diverse in comparison to the Eastern Cascades. Therefore, the formulas for these two ecoregions look like:

Coast Range
([birds_spp]- 78) * ((100 - 0)/(118 - 78)) + 0
Eastern Cascades
([birds_spp]- 97) * ((100 - 0)/(159 - 97)) + 0

The end result is that watersheds in the Coast Range with 118 species are re-scaled to 100, and watersheds in the Eastern Cascades with 159 species are re-scaled to 100, so that the most diverse watersheds in these two different ecoregions can now be compared. We performed similar calculations for the remaining variables, with the exception of the representative set, which is binary (either a watershed is part of a representative set, or it is not).

Once the variables were scaled, we combined them using linear summation to yield a raw priority score based upon species richness, RTE species presence, inclusion in a minimum set, proportion of rare habitats, and variety of rare habitats.

Salmon Habitat Priorities

Watershed prioritization for salmon conservation was based on the Ecosystem Diagnosis and Treatment (EDT) model created and run by Mobrand and made spatially explicit by WDFW. The model was applied using the river/stream reach as the unit of analysis, and the results identify areas within watersheds that contain the highest value for protection (not restoration suitability). The data contain 4 fields that are of interest:

Productivity: Future adults per current adult (they are indexed based on output)

Equilibrium Abundance: Closest to population number, this is the number of fish contributed by each reach

Diversity: The different life history possibilities for each particular species of fish; this measures the number of ways for a fish to make a living through time and space

Reach Protection: Sum of the 3 previous fields--this is the score used to rate the protection value of each reach. The higher the number, the better the habitat

Once we received the data, we determined which watersheds contained EDT data for each species. Because some reaches cross watershed boundaries, and we are prioritizing watersheds, we intersected the reach line segments with the watershed boundaries so that all reaches were split at watershed boundaries. Watersheds containing reaches that represent the "best of the best" habitat (2 standard deviations or higher), were selected for prioritization. Within these watersheds, the number and length of the best reaches varied tremendously, so watersheds were scored based on the total length of top quality reaches.

Unfortunately the EDT model has not yet been completed for portions of the CLT study area (notably coastal Oregon and Willapa Bay in Washington). As they become available, we will integrate these results into the conservation plan.

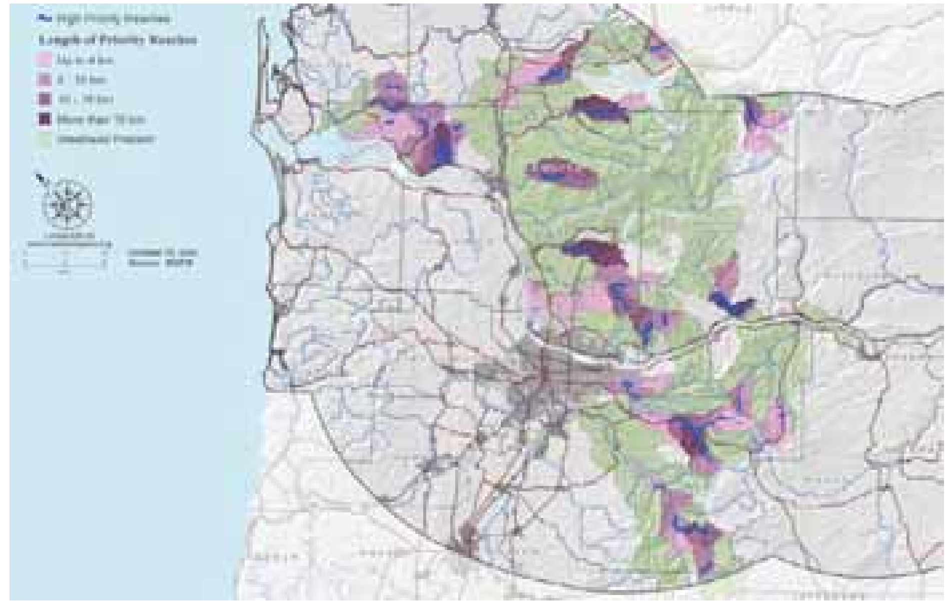

Figure 8
Priority reaches and watersheds for Steelhead conservation

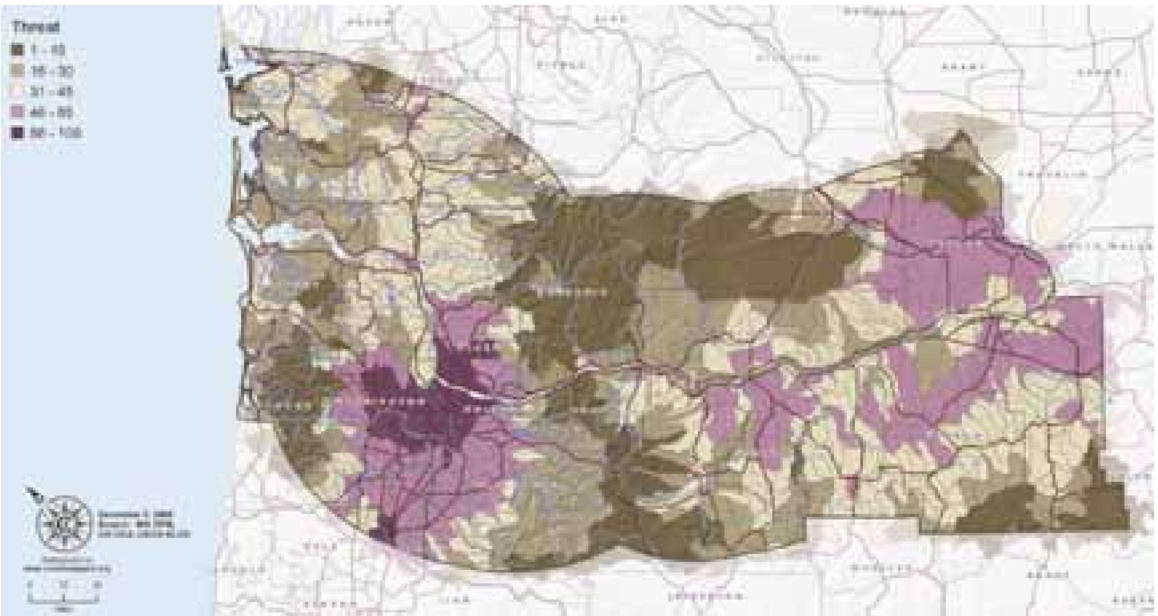

Figure 9
Composite threat score, showing watersheds with high road density, high landcover modification, low public/tribal ownership, and high projected population growth

THREATS ANALYSIS

In addition to identifying the watersheds with the highest priority for conservation of terrestrial vertebrates and salmonid species, one of CLT's primary conservation plan goals is to get a better sense of where the greatest development pressures are located. We created a simple model that incorporates:

- Road density
- Landcover modification
- Public/Tribal land ownership
- Projected population growth

Road density serves as a proxy for human activity--urban/suburban development, logging activity, and agriculture. We considered landcover to be modified if the natural vegetation has been converted to urban/suburban development, agriculture, clear-cuts, or mines (landcover data came from NOAA CCAP and USGS NLCD). Public/Tribal ownership reduces the chances that areas with high conservation value will undergo permanent landcover conversion (ownership data derived from CommEn Space's Public Lands Database and OSU's Natural Heritage Information Center). Projected population growth to 2025 indicates which areas are most likely to experience the greatest threats to habitat due to development and associated economic activities (data obtained from Washington office of Financial Management and Oregon Office of Economic Analysis).

These four variables were scaled (using the same methodology described above) and combined using linear summation to yield a threat score between 1 and 100 for each watershed in the study area.

Implementation and Next Steps

The results from CommEn Space's conservation planning efforts are currently being integrated into CLT's strategic plan. The biodiversity and salmonid prioritizations are useful for showing watersheds containing many conservation features, and the individual components are useful for highlighting specific conservation features (eg Westside Oak habitat). These analyses are being used in conjunction with on-the-ground knowledge, local expertise, partner organizations and funding opportunities. We have installed all of the data, models, and maps on CLT's GIS workstation at their office in Vancouver, Washington, and they are using the information daily to evaluate conservation opportunities and identify areas where they will proactively contact land owners. Currently, CLT is evaluating the top 50 watersheds to determine where they will work with CommEn Space to conduct subwatershed analyses to generate parcel-based conservation priorities. Ultimately, we envision building a web-based MapServer application that will make watershed-scale and subwatershed data and analyses widely available to all staff, board members, and advisors.

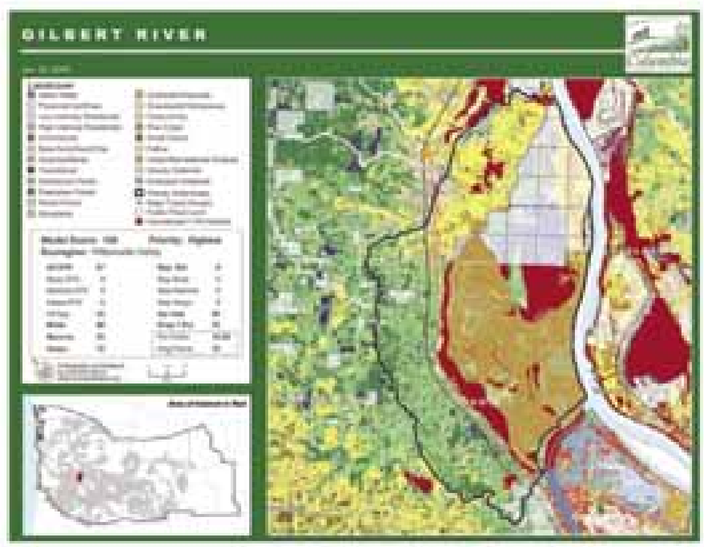

Figure 10
A page from the map book CLT is using to evaluate the top 50 watersheds

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Ball, I. R. and H. P. Possingham, (2000) MARXAN (V1.8.2): Marine Reserve Design Using Spatially Explicit Annealing, a Manual

Possingham, H. P., I. R. Ball and S. Andelman (2000) Mathematical methods for identifying representative reserve networks. In: S. Ferson and M. Burgman (eds) Quantitative methods for conservation biology. Springer-Verlag, New York, pp. 291-305.

The Mathematical Programming Society http://glossary.computing.society.informs.org/index.php?

DATA SOURCES

Washington and Oregon Current Wildlife-Habitat Types

Chris Kiilsgaard and Charley Barrett, Northwest Habitat Institute
Publication_Date: August 10, 1999
http://www.nwhi.org

National Gap Analysis Program

http://gapanalysis.nbii.gov

NOAA C-CAP

http://www.csc.noaa.gov/crs/lca/ccap.html

Washington OFM

http://www.ofm.wa.gov/pop/gma

Oregon OEA

http://www.oea.das.state.or.us

Download MARXAN from:

http://www.ecology.uq.edu.au/index.html?page=27710&pid=20497

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