Developing a Conservation Priorities Tool for the North Pacific LCC

A final report prepared for
USFWS North Pacific Landscape Conservation Cooperative
Submitted by Ecotrust
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Project Summary

In September, 2011, The North Pacific Land Conservation Cooperative (NPLCC) awarded Ecotrust a grant to develop a conservation priorities tool intended to assist the NPLCC and other natural resource managers, individuals, and community organizations in accessing, understanding and visualizing a wide variety of data sets pertaining to aquatic and terrestrial species, anthropogenic threats and potential vulnerabilities to climate change for freshwater and forest ecosystems throughout the NPLCC geographic area. Over the course of the grant period, Ecotrust developed a custom, spatially explicit, on-line decision support tool that was designed to both visualize these data and to identify regional priorities at the scale of the HYDRO1k geographic database.

Ecotrust is a regional, non-profit organization with the mission to develop community-based approaches to sustainable watershed and natural resources management, including fish and water conservation and recovery. The NPLCC awarded Ecotrust this grant to complete the following activities:

- Develop an open-source Decision Support Tool, freely available online, where climate and natural resource conservation data can be readily visualized, explored, and used in conjunction with species-specific data in developing regional priorities.

- Develop a dynamic tool that gives users the ability to instantly identify climate change vulnerability and visualize the results of a range of assumptions by running analysis based on users' selection of priority species as well as aspects of climate change and other potential threats.

- Develop a tool that builds on a conservation priorities tool developed under a cooperative agreement with the US Fish and Wildlife Service (USFWS) that helps users identify regional freshwater conservation and restoration priority areas in the Pacific Northwest (Oregon, Washington and Idaho) given the potential impacts of climate change. Build upon this tool to include additional terrestrial species of interest and increase the geographic scope to include the entire NPLLC geographic area.

As of September, 2012, Ecotrust finalized the first version of this web-based planning tool. The tool and all supporting documentation, reports, methods, a data dictionary, and a tutorial are

included as a series of web pages: http://nplcc.labs.ecotrust.org/. The project as a whole included several discrete tasks as outlined in the work plan: 1) stakeholder engagement and user needs assessment; 2) review of existing data and analytical approaches; 3) compilation and standardization of data; 4) development of analytical framework and online tool; and 5) documentation and release.

Project accomplishments

The project completed all planned tasks, and each is briefly discussed below.

Task 1: Stakeholder engagement and user needs assessment

This task included extensive telephone and in-person meetings as well as conference attendance and participation of key staff in the NPLCC GIS sub-committee. Our initial conversation was with the NPLCC science coordinator and other partners where we discussed the importance of data visualization components in the tool to allow for understanding the disparate climate change data throughout the region. Subsequent conversations included phone calls and in person meetings with state, federal and local agencies as well as non-profits throughout the region. These conversations included (but were not limited to) the Southeast Watershed Coalition (Jess Kayser), the U.S. Forest Service, Tongass Fisheries Biologist (Sheila Jackobson), The Nature Conservancy (TNC) Alaska (David Albert), as well as representatives and staff from the USFWS Region 1 office, the Bureau of Land Management, Washington Department of Natural Resources, Oregon Dept of Fish and Wildlife and British Columbia Department of Fisheries and Oceans.

While these conversations were informative, no clear, overarching needs were identified because of the wide diversity of needs expressed by the constituents. As such, no formal needs assessment was finalized and we worked with the NPLCC to define a general purpose tool that could be used for data exploration and visualization in addition to a tool used to establish conservation priorities.

Task 2: Review of existing data and analytical approaches

We reviewed a wide variety of species distribution and habitat data for this tool, from wide-ranging northwest flagship species to those found in a handful of watersheds. We also reviewed data pertaining to climate change and other potential threats such as aspects of watershed condition. Review of species data included an assessment of data pertaining to birds, fish and mammals. We did not review data pertaining to vegetation, invertebrates or amphibians. Following is a brief discussion of the data we reviewed.

Birds

Limited detailed habitat data exists for many bird species across the NPLCC region. Although many datasets exist, the habitat they identify is too general to be of use (Avian Knowledge Network (AVK) 2011a; Avian Knowledge Network (AVK) 2011b; Ridgely et al. and BirdLife International 2011; U.S. Fish and Wildlife Service, Pacific Region 2004; Regional Ecosystem Office (REO) 1993). In order to represent critical bird species across the entire focal area, we used historic climate niche data to calculate habitat density by watershed (Geos Institute and

Leuphana University Lueneburg 2012). The initial release of the tool includes only these niche data for marbled murrelet and spotted owl.

Fish

Although fish habitat has been identified and mapped to a greater degree than either birds or mammals, past efforts to map fish habitat across the NPLCC region have been limited in geographic scope, often due to funding sources or administrative boundaries. However, the widest-ranging data we found for salmon, does cover the entire NPLCC region and provides value-added abundance data for each salmon species by watershed (Wild Salmon Center 2008). These values represent the total number of wild salmon return to a spawning area within the watershed. For non-salmonids, we analyzed linear habitat data to calculate each watershed's species-specific habitat density. For bull trout, we used data compiled by Streamnet (2010) for the U.S. portion of the greater Columbia River Basin. For Dolly Varden, Eulachon, and lamprey, we relied on linear habitat data in Alaska (Alaska Department of Fish and Game 2012).

Mammals

Many readily available spatial data on mammal habitat identify the geographic range, rather than presence or occupied habitat, of species. Most broadly, we relied on historical observations of mammals on southeast Alaska islands (MacDonald and Cook 2007). Using an existing spatial dataset of Alaska state boundaries (Alaska Department of Natural Resources, Land Records Information Section 1998), we identified islands where occurrences of American marten, Canada lynx, cougar, moose, wolf, and wolverine had been documented. For these species, only simple binary presence or absence was identified by watershed. For Dall's sheep and mountain goat, we felt that existing distribution data was detailed enough to rely on, and calculated the density of distribution area within each watershed (International Union for Conservation of Nature and Natural Resources 2010).

Furthermore, as part of the Tongass National Forest Land Management Plan conducted in 1997, habitat suitability models were developed for Sitka black-tailed deer and black and brown bears (Schoen et al. 1997; USDA Forest Service, Tongass National Forest. 1997). From each, we calculated the average winter (for deer) and general (for bear) habitat suitability value for each watershed.

Climate Change and Watershed Condition

Downscaled climate projections are available but are scattered and limited to varying geographic areas. Some states make this data available (Oregon Geospatial Data Clearinghouse: Average Monthly or annual precipitation, minimum and maximum temperature, 1971-2000). Regionally, the Climate Impact Group provides a wealth of information and spatial data for the Columbia River Basin. While difficult to find on their website, we obtained data on predicted air temperature, precipitation, and snow-water equivalent (SWE). In Alaska, both the University of Alaska (2011) and the Alaska Center for Climate Assessment and Policy (2011) maintain extensive Alaska satellite and GIS and downscaled climate prediction models.

Datasets useful in measuring watershed condition reviewed include land use and land cover, roads, population density, dams, hatcheries and environmental quality, among others. Some

states make this data available; Oregon's Geospatial Data Clearinghouse distributes an ecological systems dataset (Kagan 2010) as well as data on roads and railroads. Washington State makes land use, water quality assessment (WSDOE 2011), and transportation data (WSDOT 2010) available. National datasets for the United States include the Wildland Urban Interface (CONUS only) and the Protected Areas Dataset 1.1 (CBI 2010). The National Land Cover Database (MRLC 2011) has recently been updated for 2006, and includes land cover, land cover change, and imperviousness data. Additionally, Natural Resources Canada (2009) maintains geospatial data specific to land cover.

Task 3: Data Compilation and Standardization

Selection of species data for the tool was based on the relevance of the species, the quality of the data and the extent of the coverage. Data that did not cover the full range of species or at a minimum, the extent of selected geographies were omitted.

The diversity of species was consciously selected in order to ensure that resulting prioritization schemes would address the needs of species across the entire NPLCC geographic area.

For each species, watersheds were given a value reflecting their relative importance to that species. While detailed habitat data, such as Sitka black-tailed deer habitat suitability, is available for a few species, fewer and more general datasets are available for most other species. When assessing a wide variety of species, as in this project, this variability of data on their distribution and status, and the scale at which that information is available, can complicate analytical approaches.

Given this difficulty, this tool relies on different value data for each species. Examples of these data types are shown in tables 1 and 2, below. The metric for each species can be found in the detailed data dictionary (appendix A, attached to this report). It is important to note that these values are only compared within, and not across species.

Table 1: Bear habitat suitability thresholds.

Value	Ranking of relative habitat suitability
40 – 100	Highest
10 – 40	High
2 – 10	Moderate
0 – 2	Lower
0	Not suitable

Table 2: Deer habitat suitability thresholds

Value	Ranking of winter habitat value
50 – 100	Highest
26 – 50	High
16 – 25	Moderate
1 – 15	Lower
0	Not suitable

For climate change data we relied on three primary data sets: the Climate Impact Group spatial data for the Columbia River Basin on predicted air temperature, precipitation, and snow-water equivalent (SWE), the Alaska Center for Climate Assessment GIS and downscaled climate prediction models (SNAP) and habitat / niche response data from Geos Institute and Leuphana University Lueneburg 2012. Like the species data, these data were summarized to the HYDRO-

1k watersheds for the extents that they exist. Users are allowed to select the climate change attributes of interest within the tool to drive the prioritization (priority watersheds will avoid those areas more vulnerable to climate change) but only data available for the entire user-defined extent of each priority scenario is available for analysis.

Like climate change, a number of different aspects of watershed condition were compiled and standardized for input into the tool. These aspects include percent of watershed under agricultural production, the impacts of dams, hatchery density, human population, urban land cover, and a human influence index. A number of these data were compiled by the State of the Salmon Program (Wild Salmon Center, 2008) and therefore are found across the entire extent of the NPLCC.

Task 4: Development of analytical framework and online tool

Development of an automated, online, open-source analytical tool included both 1) specification and calibration of an automated model that allows for manipulation of key parameters and rapid (real-time) assessment of data as well as varying spatial extents; and 2) adaptation and extension of an existing online, spatially explicit, open source tool that facilitates stakeholder interaction (including alpha, beta and final releases). As mentioned above, this task consisted of utilizing the Madrona codebase and adaptation of the USFWS aquatic priorities tool. Construction of the automated model included: server-side modeling including conversion of sample data to input formats; calibration; and integration of results including asynchronous model execution, data translation, and reporting outputs. Customized development of the tool included: creation of a new instance of the Madrona codebase; client-side project specific UI adjustments; deployment on a production server; implementation (with new data layers, new input widgets, analysis module and tiled output); and cross-browser testing for functionality and data accuracy testing.

The majority of the work associated with adaptation of the USFWS aquatic priorities tool included creating a 2-d instance (compared to the 3-d Google earth plug-in utilized in the USFWS aquatic priorities tool) and manipulation of the underlying priorities model to dynamically calibrate for user-defined geographic extents and available data for those extents. The underlying model relies on a simulated annealing algorithm (we used the freely available and well vetted Marxan software) and data are clipped and re-calibrated on the fly based on the user-defined extent. Only data that covers the entire extent of the user-defined region are available for the analysis (and exposed to the user).

Because many datasets are compiled at the same extent, we identified predefined extents that when used, ensure the largest number of data sets will be available for consideration. These predefined extents are shown in table 3.

Table 3: Predefined extents of selected geographies.

Entire NPLCC
Greater Columbia River Basin, US
Alaska, Canada and Northern BC
Southeast Alaska
Southeast Alaska Islands
Pacific Northwest (OR,WA, ID)

Task 5: Documentation and release

The alpha version of the tool was released in April, and a beta version in May. After review, feedback was incorporated and a final version was released in September. The tool includes detailed metadata and documentation of individual data layers, the prioritization process, and the modeling approach, and we will soon license the tool under an open source license agreement (e.g. GPL). The source code has been made freely available. All documentation and a link to the source code and license agreement can be found on the tool website: http://nplcc.labs.ecotrust.org/. A detailed data dictionary that lists all data compiled for the tool can be found in Appendix A.

Problems or delays and their resolutions

Cross boundary compilation and standardization of data at regional extents proved to be far more extensive than originally anticipated, particularly compilation of data for the entire NPLCC extent. We envision this work to be on-going, with an evolving scope under the responsibility of which the NPLCC GIS sub-committee. With this in mind, we designed the tool to be as flexible as possible to facilitate incorporation of new data as it becomes available. Data merely need to be summarized to the analysis unit (HYDRO1k watersheds), and added to a single data tracking spreadsheet and they will be dynamically uploaded into the tool as well as dynamically symbolized at the HYDRO1k scale for visualization.

Another problem was the wide array of user needs that made a comprehensive user needs assessment difficult. This in turn affected the tool design and ultimate functionality. As such, based on input from NPLCC staff, we decided to incorporate a data visualization component that was not originally proposed as part of the scope. The data visualization component was intended to provide better access to all data and considered to be more broadly applicable to a wide array of audiences. However, time dedicated to developing this visualization component meant that we spent less time working with consultants to gather data for British Columbia and as a result this region remains an area where data needs to be developed further for incorporation into the tool. The line item budgeted for consultants was reallocated to support time of approved project staff for the development and implementation of the visualization component.

The co-PI, Alison Bidlack, resigned her position at Ecotrust roughly three quarters of the way through the project. However her new post as the director of the Alaska Coastal Temperate Rainforest Center afforded her the ability to stay involved and she continued to contribute strategic insight throughout the project.

The climate and watershed condition components of the tool, although well vetted, should still be considered as preliminary. These indices were developed using the best available information / methodology at the time of the release of the tool; however, as a significant amount of resources are devoted to improving understanding of these phenomena by the scientific community (in particular climate change), we expect that more accurate data will become available in the near future. As such, these indices should be used with these limitations in mind, and as new data become available, the tool should be updated to reflect these data.

As noted above, the species data collected are of dramatically different source scales and extents, and this should be taken into consideration when combining species of different scales in any analysis. Furthermore, because the development of priority scenarios is dependent on all data being represented at the extent of the analysis, user defined extents can result in limited available data for consideration. While users can define their own extents, we recommend that the predefined extents be used as a starting point, and that users then narrow the analysis by ”deselecting” watersheds.

A formal maintenance agreement was never formalized as part of the original grant. Subsequent funds need to be identified to ensure long term maintenance of the tool. If the tool experiences large amounts of traffic, a third party server host is recommended.

Financial Report

All work was completed within the designated budget. As noted above, a slight modification of line item budgets were approved. Ecotrust’s final financial report (SF425) is attached.

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NPLCC Prioritization Data Visualization Tool
Data Dictionary

Component	Factors	Source	Link	data type	raster resolution
Base Data	Watershed boundaries	Wild Salmon Center. 2008. Pacific Salmon Conservation Assessment: Watersheds. Vector digital data. Portland, OR: Wild Salmon Center.	http://www.wildsalmoncenter.org/toolkit/Cycle/PopAssess/Pacific/PSCA.php	Geodatabase	
Objectives: Species data	Salmon and steelhead abundance	Wild Salmon Center. 2008. Pacific Salmon Conservation Assessment. Spatial Database. Portland, OR: Wild Salmon Center.	http://www.wildsalmoncenter.org/toolkit/Cycle/PopAssess/Pacific/PSCA.php	Geodatabase	
	Dolly varden, Eulachon, lamprey linear habitat	Alaska Department of Fish and Game. 2012. Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes. Vector digital data. Alaska Department of Fish and Game.	http://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=data.contactForm	vector: line	
	Bull trout linear habitat	StreamNet, Pacific States Marine Fisheries Commission. 2010. StreamNet Generalized Fish Distribution, All Species Combined (July 2010). Vector digital data. Portland, OR: StreamNet, Pacific States Marine Fisheries Commission, July 7.	http://www.streamnet.org/mapping_apps.cfm	vector: line	
	Marbled murrelet climate niche	Geos Institute, and Leuphana University Lueneburg. 2012. Baseline and Predicted Future Climate Niches of Twelve Species Based on Three General Circulation Models and Two Emission Scenarios. Vector digital data. Medford, OR: Geos Institute. and DellaSala, Dominick A., Patric Brandt, Marni Koopman, Jessica Leonard, Claude Meisch, Patrick Herzog, and Henrik von Wehrden. 2012. Testing A Climate Change Adaptation Framework for the North America Pacific Coastal Rainforest: Report to Yale Science Committee. Draft. Ashland, OR: Geos Institute.	http://app.databasin.org/app/pages/datasetPage.jsp?id=3f460a2845e842908853c48328752fd8#tabId=detailsTab	vector: polygon	
	Northern spotted owl climate niche				
	Selected mammal island and mainland presence in Southeast Alaska.	MacDonald, S.O., and Joseph A. Cook. 2007. Mammals and Amphibians of Southeast Alaska. Special Publication Number 8. Albuquerque, NM: The Museum of Southwestern Biology, University of New Mexico. and Alaska Department of Natural Resources, Land Records Information Section. 1998. Alaska Coastline 1:63,360. Vector digital data. Anchorage, AK: Alaska Department of Natural Resource, Land Records Information Section US Geologic Survey, US Forest Service, Chugach US Forest Service, Tongass EVOS Trustee Council.	http://www.msb.unm.edu/publications/documents/SpecPub-MSB-N08-McDonaldCook2007.pdf	text	
				vector: polygon	
	Mountain goat distribution	International Union for Conservation of Nature and Natural Resources (IUCN). 2010. Digital Distribution Maps of The IUCN Red List of Threatened Species. Vector digital data. IUCN.	http://www.iucnredlist.org/technical-documents/spatial-data	vector: polygon	
	Dall's sheep distribution				
	Brown and black bear summer habitat suitability	Schoen, J., R. Flynn, L. Suring, K. Titus, and L. Beier. 1997. Habitat Suitability Model for Brown and Black Bears. Raster digital data. Tongass National Forest Land Management Plan. Juneau, AK: USDA Forest Service, Tongass National Forest.	http://home.gci.net/~tnc/HTML/Welcome.html	raster	50m
	Sitka black-tailed deer winter habitat suitability	USDA Forest Service, Tongass National Forest. 1997. Winter Habitat Suitability Model for Sitka Black-Tailed Deer. Raster digital data. Tongass National Forest Land Management Plan. Juneau, AK: USDA Forest Service, Tongass National Forest.		raster	50m
Constraints: Climate Data	Temperature change, WA & OR	Climate Impacts Group. 2009a. Delta Method Runs of Tmax monthly averages for July, August, using the A1B Scenario, 2080 - 2099. Raster digital data. Seattle, WA: University of Washington.	http://www.hydro.washington.edu/2860/products/primary_data/	raster	6097m
	Hydrologic regime state change, WA & OR	Climate Impacts Group. 2009b. Historic and Modeled Maximum Snow Water Equivalent. Raster digital data. Seattle, WA: University of Washington.	http://www.hydro.washington.edu/2860/products/primary_data/	raster	6097m
		Climate Impacts Group. 2009c. Historic and Modeled October-March Precipitation. Raster digital data. Seattle, WA: University of Washington.	http://www.hydro.washington.edu/2860/products/primary_data/	raster	6097m
	Temperature change, AK & BC	Scenarios Network for Alaska & Arctic Planning. 2012. Historical Monthly Average Temperature 2km CRUTS3.0/3.1. Raster digital data. Fairbanks, AK: Scenarios Network for Alaska and Arctic Planning.	http://www.snap.uaf.edu/data.php	raster	2km
		Scenarios Network for Alaska & Arctic Planning. 2011. Projected Monthly Average Temperature 2km AR4. 5-model Average A1B, 2100. Raster digital data. Fairbanks, AK: Scenarios Network for Alaska and Arctic Planning.			
	Precipitation change, AK & BC	Scenarios Network for Alaska & Arctic Planning. 2012. Historical Monthly Total Precipitation 2km CRUTS3.0/3.1. Raster digital data. Fairbanks, AK: Scenarios Network for Alaska and Arctic Planning.			
		Scenarios Network for Alaska & Arctic Planning. 2011. Projected Monthly Total Precipitation 2km AR4. 5-model Average A1B, 2100. Raster digital data. Fairbanks, AK: Scenarios Network for Alaska and Arctic Planning.			
	Change in probability of a winter 2-year flow event	Wenger, Seth, and Charlie Luce. 2011. Western US Stream Flow Metric Dataset: Modeled Flow Metrics for Stream Segments in Selected Basins of the Western United States Under Historical Conditions and Forecast Climate Change Scenarios. Database. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.	http://www.fs.fed.us/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml	vector: line	
	Change in stream flow timing				
	Change in mean summer flowrates				
	Climate Response: Pacific silver fir	Geos Institute, and Leuphana University Lueneburg. 2012. Baseline and Predicted Future Climate Niches of Twelve Species Based on Three General Circulation Models and Two Emission Scenarios. Vector digital data. Medford, OR: Geos Institute. and DellaSala, Dominick A., Patric Brandt, Marni Koopman, Jessica Leonard, Claude Meisch, Patrick Herzog, and Henrik von Wehrden. 2012. Testing A Climate Change Adaptation Framework for the North America Pacific Coastal Rainforest: Report to Yale Science Committee. Draft. Ashland, OR: Geos Institute.	http://app.databasin.org/app/pages/datasetPage.jsp?id=3f460a2845e842908853c48328752fd8#tabId=detailsTab	vector: polygon	
	Climate Response: Grand fir				
	Climate Response: Witch's beard				
	Climate Response: Lettuce lichen				
	Climate Response: Marbled murrelet				
	Climate Response: Northern spotted owl				
	Climate Response: Sitka spruce				
	Climate Response: Coastal redwood				
	Climate Response: Sitka black-tailed deer				
	Climate Response: Western redcedar				
	Climate Response: Western hemlock				
	Climate Response: Mountain hemlock				
Constraints: Watershed Condition data	Agricultural land use	Wild Salmon Center. 2008. Pacific Salmon Conservation Assessment. Spatial Database. Portland, OR: Wild Salmon Center.	http://www.wildsalmoncenter.org/toolkit/Cycle/PopAssess/Pacific/PSCA.php	Geodatabase	
	urban land use				
	Dam impacts				
	Hatchery density	Wild Salmon Center. 2008. Pacific Salmon Conservation Assessment: iHatcheries. Vector digital data. Portland, OR: Wild Salmon Center.		Vector: point	
	Human influence index	Wildlife Conservation Society (WCS), and Center for International Earth Science Information Network (CIESIN)/Columbia University. 2005. Last of the Wild Project, Version 2, 2005 (LWP-2): Global Human Influence Index (HII) Dataset (IGHP). Raster digital data. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC).	http://sedac.ciesin.columbia.edu/data/set/wildareas-v2-human-influence-index-ighp	Raster	814m
	Human population density	Center for International Earth Science Information Network (CIESIN)/Columbia University, United Nations Food and Agriculture Programme (FAO), and Centro Internacional de Agricultura Tropical (CIAT). 2005. Ridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates, 2010. Raster digital data. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC).	http://sedac.ciesin.columbia.edu/data/set/gpw-v3-population-count-future-estimates	Raster	4680m