

Improving the Efficiency of Timber Supply While Saving the Fish: The Umpqua Land Exchange Project

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Abstract: Western land development initiatives by the federal government led to a fragmented ownership in much of western Oregon. A project to examine the feasibility of voluntary land exchanges between public and private owners to increase ecological health of fish and other species in Umpqua Basin while maintaining timber supply has been initiated. A landscape model has been developed to quantitatively link geomorphic and management related variables to species habitat suitability so that solutions can be systematically assessed. A pilot study to develop and test the methodology has been completed and data compilation is in the final stages for the first 675,000 acre (2700 sq. km) analysis unit.

Keywords: Fisheries, habitat suitability, landscape analysis, forest planning, land exchanges, combinatorial optimization

1.1 INTRODUCTION

During most of the 19th century it was the national policy of the United States to promote settlement and development of the west by disposing of public domain lands to states and private persons or firms at no cost or at nominal cost. In some cases the federal government made outright grants of land to finance infrastructure development including military wagon roads, railroads, canals and other river improvements.

During the early 1860's, California business interests, hoping to profit from the growing commerce between California and the Pacific Northwest began lobbying Congress for a land grant to build a railroad between Davis, California and Portland, Oregon (University of Oregon, 1981). Following policies and practices established in earlier grants, Congress, in 1866, granted twenty sections (1 section = 2.6 sq km) for each mile (1.6 km) of railroad completed. The granted lands were to be selected from alternating sections with a strip 20 miles (32 km) wide on each side of the right-of-way. Under certain conditions lands outside of these boundaries could also be selected. The granted lands could be sold by the railroad company(s) as progress was made on actual construction and provided a basis for which companies could obtain capital to finance the work. More than 4 million acres (16,000 sq. km) were granted to the Oregon and California railroad (later absorbed into the Southern Pacific railroad), much of this land concentrated in southwestern Oregon.

There were, however, several conditions that the railroad had to comply with when the railroads sold the lands. These conditions included the maximum price that could be charged and who was eligible to buy the land. Although the railroad was built, the company was accused of violating the terms of the agreement for disposing of the lands and the lands remaining unsold by the railroad in 1915 were taken back under the Chamberlain-Ferris Act.

In 1937 Congress passed the O&C Act clarifying its intent that the reverted lands be managed by the United States Department of Interior for permanent forest production in conformity with the principles of sustained yield for the purpose of providing a permanent source of timber supply, protecting watersheds, regulating stream flow, and contributing to the economic stabilities of local communities and industries and providing recreational facilities. Since 1946 the majority of the reverted lands have been managed by the Bureau of Land Management (BLM), an agency of the Department of Interior. A smaller part of the reverted lands within the national forest boundaries, known as "controverted lands", have been managed by the USDA Forest Service since 1942. Under the O&C Act, the federal government makes annual payments in lieu of taxes to the counties in which the reverted lands are located. Since 1993 overall management direction for both the national forests and BLM lands was consolidated in what has become known as the President's Northwest Forest Plan although the individual agencies still carry out the on-the-ground administration.

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1.2 A FRESH APPROACH

The intervening private lands over much of the region are dominated by forests allocated primarily to commercial timber production. In 1994, Aaron Jones, a local industrialist and forest land owner, looking across the “checkerboard” of federal and private lands suggested there might be an alternative land ownership pattern that could both improve the efficiency of land management for all owners while saving the fish and other threatened wildlife. This alternative pattern would be created through voluntary land exchanges between private forest owners and the federal government. The idea drew the support of Oregon Senator Mark Hatfield, who sponsored legislation directing the USDA Forest Service as lead agency to undertake a study of land exchanges as a method of maintaining timber supply while improving the ecological health of the Umpqua Basin, an area of almost 3 million acres (12,000 square km) in southwestern Oregon. The actual study known as the Umpqua Land Exchange Project, is being conducted under the Foundation for Voluntary Land Exchanges. The Foundation is a nonprofit corporation located in Portland, Oregon. The project operates under the direction of a five person management committee: the President of the World Forestry Center, the State Forester, a prominent Pacific Northwest environmentalist, a Douglas County Commissioner (who currently also chairs the association of counties that contain the reverted lands), and Mr. Aaron Jones. Day-to-day management is provided by a Project Manager. Federal liaisons include the USDA Forest Service, the USDI Bureau of Land Management, the USDI Fish and Wildlife Service, the National Marine Fisheries Service, and the Environmental Protection Agency. The technical study is carried out by a team of 16 scientists, one acting as chair, including fishery biologists, wildlife biologists, foresters, botanists, hydrologists supported by remote sensing and geographic information specialists. The purpose of this paper is to discuss the process being taken by the science team, with emphasis on the fisheries component.

1.3 THE STUDY PROCESS

The science team decided a landscape approach would best serve the evaluation of ecological conditions across the Umpqua Basin. However, due to practical data collection and algorithmic realities, the Umpqua Basin was divided into five physiographic subregions. A pilot area of about 100,000 acres (400 sq. km.) was identified in the Coast Physiographic subregion for development of the assessment methodology (ULEP, 1998). A primary task for the science team involved developing a set of metrics to measure the health of various upland and

riparian species. After some study, a set of six fish and about 30 wildlife and other indicators were selected. The six fish species are the Coho salmon, Chinook salmon, Cutthroat trout, Steelhead trout, Umpqua Chub, and the Pacific Lamprey. These species were selected because they were considered “at risk” within the Umpqua Basin and because they are known, or believed to occur, within the pilot test area. For each of these indicators, a set of metrics was derived that provided a measure of the “fitness” of the indicator given a description of the physical and biological setting.

An important task was the identification of variables to determine “fitness” or habitat suitability on a zero to one scale. Ultimately two criteria were adopted for determining whether to use a particular fish variable: (1) either basin-wide data must be available for the habitat variables or if data sets were available for only a portion of the basin, it must be possible to reasonably estimate these characteristics in unsurveyed streams based on other available information, and (2) variables used as indicators of habitat suitability include only those that can be reasonably predicted into the future under alternative ownership patterns. It was recognized that these limitations in data and modeling capabilities have important ramifications.

First, several physical characteristics that are important determinants of habitat quality are omitted from the fish models. For example, water temperature, water chemistry, spawning substrate composition, and undercut banks all contribute to habitat quality but were not included in the models.

Second, certain biological factors that may influence habitat suitability such as presence of non-native species generally were omitted from the models.

Third, the models focus almost entirely on the juvenile rearing phases of the fish species. The life history of many fishes, particularly anadromous species, are extremely complex, with habitat requirements changing as fish move through various life stages. However, we did not attempt attributes such as the quality of the spawning habitat or incubation environments because 1) we were not aware of any spatially explicit model of gravel conditions that would allow us to project changing conditions over a 100 year modeling horizon, and 2) the development of new models for this purpose was beyond the scope of this project.

And fourth, because we chose to use the spatially explicit Oregon Department of Fish and Wildlife (ODFW) habitat inventory data, stream reaches that have not been surveyed must be accounted for in model simulations.

Our habitat suitability index (HSI) models are similar to models used by the US Fish and Wildlife Service (Raleigh et al. 1986, McMahon 1983) though significant differences exist. One of the most important differences is that published HSI models have focused almost exclusively on instream habitat or water quality attributes. Our models assign HSI values by integrating information relating to characteristics both within the stream and in the adjacent riparian vegetation as well as indicators of the surrounding watershed. At the site level, the fish-related variables include a set of variables for which strong relationships with fish production, abundance, utilization, or distribution are known or suspected. These variables can be divided into three groups. The first group includes variables operating at the scale of stream reaches or segments that exert pervasive influence on the structure and development of habitat types. Stream gradient, stream size, and valley type are three examples. These variables generally set the geomorphic context of the reach and are largely unaffected by human disturbances. The second group of variables includes attributes related to individual channel units (e.g., pools, glides, riffles, rapids, and cascades) or factors that control or influence the formation of those units (e.g., large woody debris). Because of differences in body morphology and physiological capacities, most fish species exhibit preference for certain macrohabitats or the microhabitats contained within them. Although partly controlled by gradient and geology, these variables also are affected by landuse practices, usually through modification of hydrologic processes, sediment regimes, and recruitment of large woody debris.

The third group of variables includes those related to the condition of the adjacent riparian stand and the specific functions that riparian vegetation provides (e.g., stream shading, potential recruitment of large woody debris). Again, these variables are strongly influenced by timber harvest and other landuse practices. Although not explicitly included in the fish models, it is assumed that other riparian functions such as bank stabilization, inputs of fine organic matter, nutrient cycling, and sediment storage are correlated to the shading and wood recruitment functions and hence, are represented by these modeled variables.

The mapping rules for all species, except the Umpqua chub, also incorporate four indicators of watershed integrity and cumulative watershed disturbance: an index of hydrologic maturity, an index of road-related erosion potential, an index of cumulative shade potential, and an index of cumulative large wood recruitment potential. These measures serve as coarse indicators of the potential influence of land-use activities on natural processes including hydrology, sediment delivery, stream shading, and large wood recruitment at the scale of subwatersheds (approximately 5-50 sq. km). Although there are

limitations to using these indicators as precise predictors of disruption to a specific watershed process, we believe that when taken in aggregate these variables likely provide a reasonable measure of human disturbance and ecosystem integrity within the watershed. The average index value for watershed variables is used as a multiplier to modify the habitat suitability value obtained for site-level component.

The inclusion of watershed indicators is based on the premise that the value of a particular stream reach is influenced not only by the immediate site conditions, but also by the overall condition of the watershed. If a particular watershed has experienced low levels of disturbance (as measured by an integration of several human-disturbance metrics) then the physical, chemical, and biological processes required to create and maintain habitats favorable to aquatic organisms are intact. A relatively intact riparian zone or stream segment within a highly disturbed watershed is assumed to have lower ecological potential than a similar area within a minimally disturbed catchment.

1.4 CURRENT AND PROJECTED LAND AND STREAM CONDITION

Coincident with the development of the habitat suitability models was construction of the existing vegetation and stream layers. Vegetation typing was done from a combination of 5 meter Indian Satellite Resource imagery and 1:31,000 scale black and white aerial photography. Existing and supplemental ground plot data was used to connect the vegetation typing to ground in order to provide a representative list of trees that would be found in each vegetation type including species, diameter, height, site productivity, and age. The combination of vegetation typing overlain with ownership boundaries divided the Coast physiographic, an area of about 675,000 ac (2700 sq. km) into about 18,500 parcels homogeneous in vegetation and ownership. Within each parcel, all perennial streams were identified from existing agency databases. Intermittent stream locations were also estimated through topographic analysis using digital terrain models. Streams were stratified into six stream classes. Approximately 56,000 stream reaches were identified. A road layer was also compiled.

The ORGANON growth and yield model (Hann et al. 1995) was used to project tree growth forward on each of the 18,500 parcels. Responses from an owner survey were used to spatially assign future harvests over each of 20 five-year periods for federal, state, industrial forest owners and nonindustrial forest owners. A coarse wood dynamics model (Mellen and Ager, 1998) was used to decay dead trees using tree mortality lists from ORGANON. Large wood contribution by species and

size into streams from adjacent riparian areas was estimated along all perennial stream reaches and an in-stream wood decay function was used to deplete wood within streams. Current State of Oregon Forest Practices regulations were simulated on private and state forest lands that control size of harvest opening, timing and planting of new forests. On federal lands, practices consistent with the federal Northwest Forest Plan were simulated.

Additional roads were added in areas where it was estimated that insufficient roads existed to access harvest areas. Road construction was assumed to take place during the same 5-year period that timber harvest occurred. Harvest values were calculated based upon topographic location, species, size, distance to processing facility, and road costs.

1.5 DESIRED FUTURE CONDITION AND SOLUTION METHODOLOGY

The desired future condition is to raise the habitat suitability indexes as high as possible and as quickly as possible assuming that the only variable that can change is the owner of each parcel. For each type of owner, it is assumed that the management goals are known and will be implemented. Since habitat suitability is assumed to be influenced by a combination of geomorphic and the management-related variables, the problem becomes one of allocating the “right” parcel to the “right” owner.

Certain other requirements must also be met to satisfy social and political goals: 1) the aggregate value of the public and aggregate value of the private lands cannot change, 2) the capacity to supply timber from each owner group must not be reduced, 3) the number of forested acres in the public domain cannot be reduced, and 4) the total acres of older timber in federal ownership must increase.

Allocating the “right” parcel to the “right owner” must not only consider the individual parcel, but the infrastructure needed for management. The current checkerboard ownership requires road access be provided to adjacent owners. Patterns that block up ownerships (that is reducing the checkerboard) provide for efficiency of management as well as more flexibility in reducing impacts of land management. Much of the public land has undergone a change of management direction over the last 10 years emphasizing restoration. However, requirements to provide access to intervening private lands may reduce opportunities to move existing roads away from riparian zones or to close or decommission roads. Similarly, blocked up ownerships provide benefits for private owners in more efficient transportation systems, and reduced surveying and monitoring requirements to make

sure the activities undertaken are on their own land.

This is a spatial allocation problem where the attributes are dynamic with time. To find a good or “best” solution is a combinatorial optimization problem. Complete enumeration of all possible solutions is usually not an tractable option for large problems of this type, and mathematical techniques to find the optimal solution are usually not available due to the number of decision variables and the properties of the solution surface. However, a great deal of progress has been made over the last two decades in the development of heuristic techniques for solving these problems. Popular approaches include Simulated Annealing, Tabu Search, and Genetic Algorithms (Reeves, 1993). In the pilot study, a hybrid gradient search technique was implemented using parallel processing. In the larger Coast Range analysis unit, a Simulated Annealing heuristic is being used.

1.6 STATUS AND FUTURE WORK

The science team completed its pilot study report in July 1998. Following the pilot study, an independent peer review was conducted to provide outside scientific review and a report published. Subsequently, elements of the peer review report were incorporated into the science team methodology. Satisfied with the methodology, the management committee gave approval to move on to the Coast Range analysis unit. The data set for the Coast range is in the final stages of review and exploration of alternative ownership patterns will begin July, 2000. If, as expected, superior ownership patterns are developed, an Environmental Analysis, culminating in an Environmental Impact Statement that could lead ultimately to land exchanges in the Umpqua Basin.

If successful, the methodology developed during this project may be useful in other areas where mixed ownerships exist as well in other management settings. For more information on this project contact the Foundation for Voluntary Land Exchanges, 4033 SW Canyon Road, Portland, Oregon 97221.

1.7 LITERATURE CITED

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