GEOGRAPHIC INFORMATION SYSTEMS IN THE MANAGEMENT OF WESTERN OREGON FORESTS

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Introduction

In today's socio-economic and political climate, the absolute necessity for rapid, sophisticated analysis to support management decisions about use of land and natural resources is abundantly clear. Perhaps nowhere is this more evident than in the temperate forests blanketing western Oregon where some 2.5 million acres, held by the Federal Government, is administered by the Bureau of Land Management (BLM), U.S. Department of the Interior (DOI). It is here where a Geographic Information System (GIS) has been built by the BLM to help formulate a new generation of Resource Management Plans, allocating finite natural resources and values among ever competing demands, and to guide future forest land decisions and operations into the next century. Believed to be one of the largest, most ambitious GIS undertakings in the United States to date, this is the story of the Western Oregon Digital Data Base and its role in the management of this priceless expanse of the public's domain.

GIS in the Management of Western Oregon Forests

The Estate: The people of the United States, especially those resident in western Oregon, are endowed with 2.5 million acres of some of the most productive rain forests on the North American continent. Administered by the BLM, a multiple-use agency of the U.S. DOI, the land ownership is largely fragmented in checkerboard patterns.[1] They are heavily timbered with vast remaining stands of prized old growth (200 years +) and mature (80-199 years) forests; shrouded in precipitation of up to 100 inches that inundates steep, occasionally unstable, slopes . . . and feeds streams and rivers of immense value to wild fish stocks, to community water supplies and to water based recreation. They are home to several plant and animal species classed as sensitive, threatened or endangered and to big game such as elk and deer. Some lands are valuable for mineral production — from common variety material to gold strategic metals. Some support unique and diverse associations of life forms. But most predominant is a rich mosaic of Douglas Fir forests — ranging from new plantations to those in a still primeval state —with a standing inventory of 50 billion board feet of timber.

The New Reality: For half a century or more, these lands have provided a sustainable source of raw material for lumber, plywood and wood fiber, supporting the economic fabric of scores of dependent communities. This traditional role is increasingly challenged by an ethic that places greater value on non-industrial forest attributes: recreation, wildlife, scenic vistas, wild and free flowing rivers or the solitude of an old-growth glade, an ageless, functioning ecosystem, untouched by road or chainsaws. The collision of these opposing values (economic use vs. preservation of amenities) have grown into bitter debates as how this public asset will be used and managed, now and into the future.

Douglas Fir, the dominant commercial tree species, is not shade tolerant. Visually dramatic clear-cutting is the normal method of harvest to insure successful regeneration over most of its range. These visual "scars" on the landscape, albeit temporary, help fuel public indignation in many quarters. The fallout from this conflict in values has increasingly spawned public assertions of agency mismanagement, administrative appeals, legal battles, court injunctions and increasing Congressional oversight. All tend to replace management by professional expertise with one by judicial fiat or short ranged political "fixes."

The Federal Oregon and California (O&C) Sustained Yield Act of 1937 was enacted to guide the activities on these western Oregon public lands under the BLM jurisdiction. The O&C Act states that the lands administered under the Act . . .

> shall be managed for permanent forest production, and the timber thereon shall be sold, cut, and removed in conformity with the principle of sustained yield for the purpose of providing a permanent source of timber supply, protecting watersheds, regulating stream flow and contributing to the economic stability of local communities and industries, and providing recreational facilities.

The Federal Land Policy and Management Act of 1976 (FLPMA) further emphasized the need for management practices on Federal land to comply with the principles of multiple use and sustained yield.

As part of the implementation of these acts, the BLM is required to calculate the allowable harvest level for its commercial timberlands. Timber management plans are recycled every 10 years for the next decade.[2] Formulation of a new plan involves extensive field re-inventory, evaluation of alternate planning scenarios, and appropriate levels of environmental analysis. Operational program features, such as the control of competing vegetation or other silvicultural treatments, are also evaluated and their applications included in the decision making process. This major planning effort requires tremendous quantities of data from many diverse sources. Lack of accurate data and precisely mapped resource attributes can have a devastating effect on the implementation of any future forest plan, especially in an arena of intense public scrutiny where credibility and confidence of information are supremely important (Dippon 1989).

Increasingly, data is recognized as a corporate asset that must be stored, manipulated, analyzed and preserved in a more secure and effective manner.

In this evolving social and information environment, it became obvious that the era of forest planning with maps of various vintages and scales, with mylar overlays and grease pencils, and determining acreage and lineal quantities by crude measurement, was obsolete. The need for a comprehensive information system with rapid sophisticated analytical capability became increasingly apparent: to generate alternative management scenarios and forest prescriptions; to evaluate their environmental and socio-economic affects; and to support sound management decisions in both planning and subsequent implementation of such plans.

Enter GIS, The Western Oregon Digital Data Base Project

This realization gave impetus to creation of one of the largest, most comprehensive GIS efforts undertaken in the United States to date.[3] Thus was conceived the Western Oregon Digital Data Base (WODDB) project. Initially, WODDB was not met with enthusiasm by the majority of the BLM staff in western Oregon. Many viewed it with disdain — a potential black hole that would siphon off funds, and people needed for more traditional, already under-funded, management functions. Despite this cool response, the BLM management in Oregon launched the project in 1985.

The first step generated digitized "base map" products on 7.2 million acres of Federal BLM, and intermingled lands in western Oregon from recent 1:40,000 aerial photography with about 1,500 panelled geographic control points (public land survey corners). Initial base map products consisted of six digitized layers at a scale of 1:4800: 1) topography at 20' contour intervals; 2) hydrography; 3) transportation networks; 4) cultural (other man-made) features; 5) broad representations of vegetative types to later register more detailed forest polygons, and 6) mathematically generated coordinates for the U.S. Public Land Survey System (PLSS) based on best available survey information. It was the PLSS system which provided the basis for ownership boundaries in the checkerboard ownership matrix and would tie all other themes to geographic coordinates within the accuracy of the public land surveys or resurveys.

Concurrent with building the base map products, it was necessary to ask what other spatial themes were required to populate the system. WODDB was to be issue oriented, not a collection of "nice to have" data elements. A team of line managers, planning coordinators, and resource specialists were assembled and tasked with the identification of management issues, present and future. In time, with public input, over 150 were identified. From these issues, many of which were spatial in nature and would need to be addressed in the next decadal plan, were established the critical WODDB data requirements. Thus, to the base map themes are registered additional core spatial layers, 74 in all, which depict Federal ownership; fragile lands withdrawn from timber harvest; stands of timber which can be aggregated by age, density, and species; soil classifications; critical wildlife and fishery habitats; streams by size and order, and sensitive viewsheds, to name a few. User input and user requirements were paramount in its design; in development of common data standards, spatial attributes and the analytical capabilities to answer a myriad of critical "what if" management questions by professional field managers and resource specialists. Many of the project's features were initially applied in a test area, four townships[4] in size, to insure its operational feasibility, compatibility, and most important, user acceptance. Required modifications and refinements were made before export to the BLM lands throughout western Oregon.

PC workstations and graphic terminals were provided to link the system user to six networked PRIME 6000 series mini-computers operating on MOSS GIS software.[5] "A unique mix of minicomputers, microcomputers, smart terminals, video processing, off-the-shelf and in-house software, color electrostatic plotting, project management software, local area network, and a support services contractor have made the project a reality" (Dippon 1989).

Five years and $17 million later, WODDB is functional. The skeptical attitudes once prevalent in much of the work force has mellowed to cautious optimism, even enthusiasm!

WODDB and Forest Planning for the 1990's

The BLM administers its lands in western Oregon through six District Offices. The lands are further subdivided into 12 Sustained Yield Units (SYU)[6]. Each District is in the process of concurrently developing new Resource Management Plans (RMPs) for lands under their jurisdiction; they will allocate resources to various uses which will provide the management framework for all forest land activities well into the next century. Not only must these plans address those core Federal statutes directly relating to these lands, they must also embody a host of other environmental and resource management legislation; laws dealing with clean water, clean air, protection of endangered species, preservation of antiquities and historic sites, land use zoning compatibility, mineral development and environmental impact analyses of Federal actions.

The forested landscape, for example, is delineated in a series of polygons derived from an in-place Operations Inventory delineated on 1:12,000 natural color aerial photography. Each polygon, 80,000 in all, is geographically registered into the WODDB data base and linked to supporting timber stand information resident in an alpha-numeric relational data base of which 30 distinct timber stand attributes are used in spatial analysis. This yields up to 2.4 million data interactions and reduces the need for a complex array of additional spatial themes. Furthermore, many if not most polygons, are subject to multiple dissection from a combination of other spatial features, 22 in total, which are impacting in character, e.g., fragile, unstable slopes; unproductive road prisms; streamside buffers of variable width; natural forest reserves; etc. In just one typical planning scenario, this will produce about 1.5 million potential spatial data displays. Both the spatial and relational data bases are not only linked together, but in turn, to an allowable cut model (known as "TRIM-PLUS") which is capable of establishing the sustainable yield of timber harvest based on: lands made available to timber production, site productivity, the profile of timber stands by age classes, planned rotation ages and intensity of management such as genetic tree improvements, thinning, fertilization and control of competing vegetation. This configuration has made possible a highly efficient analytical process within the WODDB system.

In an oversimplification, the WODDB vegetative themes capture, display, and compute acreages for:

The land base not suitable for tree growth, e.g., rock outcrops, sand dunes, water bodies, road beds, and other sites incapable of producing 20 cubic feet of wood per acre per year. These are noncommercial lands.

The land base that is capable of producing the requisite timber volumes but, by policy, are withdrawn from the timber base, e.g. steep, unstable or fragile sites that would be lost if logged and harsh sites that cannot be assured reforestation to prescribed standards within five years following harvest. By their nature, these sites cannot contribute to long term, sustained yield of timber.

The land base physically and biologically capable of timber production over several cycles or rotations. This is the potential commercial forest land base.

It is this last category that is the predominant focus for the Resource Management Plans and of most concern to the various affected publics; this should not, however, diminish the value of the other two land base categories for supporting other resource values and objectives. What lands will, and what lands will not, be allocated to sustained timber production due to concern for competing values? The more land withdrawn for other uses and values, the less the sustainable annual yield of timber.

Six distinct planning alternatives are being formulated, displayed, and analyzed for both the public and the BLM decision-maker. The range of options include one that places high emphasis on timber production and other economically important industrial commodities, to one at the other end of the spectrum that would preserve most remaining old growth and older mature forests and emphasizes preservation and enhancement of scenic, wildlife, wilderness, and primitive recreation values. The four other alternatives lie within these two "sideboard" scenarios for the widest possible mix of decision choices.

The application of six basic planning alternatives over 12 SYUs equate to 72 separate planning iterations, each evaluating the sustainable output of timber versus the output of other tangible and intangible resources. Add to this the analysis of a wide array of intensive silvicultural practices which contribute to forest productivity and variable rotation age options for final harvests over time. Each affects timber output, the economy, and the natural environment. Finally, superimpose various sensitivity and probability analyses, and a decision matrix of monumental proportions results. Each affects timber output, the economy, and the natural environment.

WODDB combined with its relational data bases and forest stand growth, and yield models not only provide this two dimensional look at planning options with direct resource trade-offs, one for the other, but also the GIS provides yet other dimensions. For example, overlaying hypothetical decadal timber harvest schemes into the GIS clearly displays the spatial relationship between harvest units over the 10 year period. Linkage to predictive models permit additional analysis of so called "cumulative affects" of these actions to the landscape, watersheds and water quality, even elk habitat. Manipulation of these harvest units allows the professional manager and resource specialist to locate timber harvest boundaries where there is minimum on-site and cumulative impacts to soils, water, endangered or threatened species, archeological and historic sites, visual corridors, and the like.

In the case of some resource values such as elk habitat, and harvest units, related actions can be designed in the GIS that synergistically enhance those resources as well as providing for permanent timber production.

In today's world, the BLM's decisions about the future of these public forests must be supportable, rational, and reflect a politically acceptable balance. At stake are jobs, communities and their tax base, clean air and water, resident and anadromous fisheries, the continued existence of species and natural ecosystems, mineral wealth and reduced dependence on other sources, and places to enjoy and recreate. Without GIS, this task would be questionable at best. WODDB is handling the interplay of a staggering quantity of spatial and relational data against all of the sophisticated variables required by this planning process to best optimize results.

After Planning, What Next?

The final planning decisions about the decadal future of the BLM administered lands in western Oregon are scheduled to culminate in 1992. Forest land operations and activities in 1993, and into the next century will be carried out within the framework of those planning decisions and attendant Environmental Impact Statements. WODDB will continue to be instrumental in the management of these forests as a day to day operational tool. A few examples are as follows:

Harvest Unit Selection: The selection and design of harvest units and their spatial relationships has already been discussed. Overlays of these proposed harvest units and connecting road construction routes with such attributes as topography, soils, and designated stream-side buffers will facilitate establishment of environmentally sound harvest unit boundaries, indicate logging systems to be employed, and define special mitigating measures to be practiced during and after harvest by the purchaser.[7] Use of three dimensional GIS displays will allow forest planners to design harvest units to improve visual design arts in sensitive viewsheds, minimizing the need to remove such forests from the commercial forest land base.

Prescribed Burning: Following harvest of all merchantable material, the remaining residue or logging "slash" is frequently disposed of by broadcast burning. This serves two purposes: reduction of fire hazard from subsequent wildfires, and preparation for the site for the next crop of trees. Predictive analysis of slash fuel loading and surrounding airshed data will assist in estimating release of airborne particulate matter and the planned timing of slash burning that best dissipates smoke plumes away from population centers.

Scheduling Seedlings: Reforestation is a vital link in the forest management process. As soon as possible, after site preparation, seedlings of two or three years in age from parent stock of local origin are hand planted. For Douglas Fir, this amounts to 35 distinct seed zones in 500' elevation bands ranging from 500' to 4500'. WODDB data as to which timber sales, present and planned, will likely be ready for reforestation two to three years away will enable more accurate forecasting of seedling needs, and influence seed sowing schedules in production nurseries. Conversely, if there are shortages of seed within specific seed and elevation zones, the data base can be queried and the out year timber sale plan adjusted to minimize harvesting in effected seed zones until sufficient seed and planting stock from that seed come on line.

Silvicultural Treatments: WODDB data base will be used to identify and schedule overstocked immature stands in need of precommercial thinning, normally prescribed at ten to fifteen years in age, in the most effective manner. Correlation of these young stands to specific soil types will also identify those most amenable to capturing the full growth enhancing effects of an application of nitrogen fertilizer. A query can also determine which of those stands meeting the above criteria occur in portions of the forest deficient in wildlife forage, since tree stand fertilization enhances the palatability and nutritional value of associated herbaceous plant species as a secondary effect. The net result would be providing big game wildlife benefits at no additional cost.

Commercial Thinning: Periodic WODDB queries will identify stands of timber that have attained mechantable size and are available for the first commercial thinning entry. Slope, soils, aspect, presence of critical plant or wildlife habitats and proximity of such stands to available road systems can be readily determined. These and other attributes resident in WODDB help define the economic feasibility, timing, logging practices, and density of removal of available commercial thinning options as they mature over time.

Road Maintenance: The permanent road network needed to serve this BLM forest estate is immense; it would crisscross the continental United States over five-fold. The maintenance of these roads for commercial timber, mineral, and general public transport is a major Bureauwide activity in western Oregon. Correlation of this transportation system with slope, unstable topography, soil types, aspect, hydrographic features, climatological data and projected use, will enable much improved direction and management of the BLM road maintenance activities.

Emerging Issues: In today's fast changing world, it is folly to believe that a plan, however well conceived, will remain static over 10 or more years time. GIS provides managers and specialists with data bases that can be readily updated, supplemented or turned quickly to solve new problems and issues.

A case in point followed the listing of the Northern Spotted Owl, an inhabitant of western Oregon forests, as a threatened species under the Federal Endangered Species Act.

A scientific panel was convened to develop a set of recommendations to help ensure the owl's preservation. The protective measures as developed and announced in 1990, were obviously very significant in terms of their potential impacts to timber supplies in Oregon and adjacent states. Recommendations included protection of large blocks of contiguous habitat from further disturbance, preservation of certain forest attributes around known owl activity centers beyond such blocks, and the maintenance or creation of a minimally acceptable forest-matrix for dispersal habitat in each nine square mile blocks of land (quarter townships). WODDB's first regional application was put to the test.

The system was used to graphically plot the scientific panel's recommendations as it affected all BLM-administered lands in western Oregon. It was also used to evaluate existing forest conditions around activity centers and dispersal habitat, and to calculate the potential loss of sustainable annual timber production on the 2.5 million acres of the BLM lands should the panel's recommendations be implemented in whole or in any of its individual parts. Due to the draconian impact on the Pacific Northwest's timber industry and economy, these plots and analyses were in urgent demand by Federal and State officials at all levels, by many members of the U.S. Congress, and by the news media. WODDB's "maiden voyage" as an operational, analytical tool was a complete and total success. What would have taken several months to do manually by redirecting large numbers of staff to the task was accomplished on GIS computers in a matter of weeks with a small core of skilled, dedicated people.

And to the Future . . .

Expectations as to what role public forest lands are to play in society continue to evolve and to change. This means that public policy-making will continue to be a very dynamic process into the future, with continued attempts to formulate solutions to issues, old and new. The land management agencies will be deluged even more with requests for answers to "what if" type questions from policy makers at all levels and our many publics. Sense can be made of what is inherently a chaotic process only if the agencies have the capability to provide reliable information, on a replicable basis, and in a timely manner, on what is certain to become an increasingly complex milieu of resource interactions. GIS technology is not a nicety or an interesting accessory, but rather it is an absolute necessity for any management entity expecting to function in today's climate, especially a public one.

Thanks to WODDB, the BLM western Oregon is poised for the future. It will fundamentally and unalterably change the agency and the way it conducts business; and will enable managers and specialists to meet the often politically charged public land management challenges, opportunities and decisions that lie ahead. The final result must be the optimization of uses and values from a finite base of land and natural resources for its stockholders, the American public.

Disclaimer

Reference herein to any specific product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement by the United States Government or the Department of the Interior, Bureau of Land Management. Questions relating to the WODDB project should be directed to the Public Affairs Office, Oregon State Office, Bureau of Land Management, PO Box 2965, Portland, Oregon 97208-2965, U.S.A., telephone (503) 280-7027.

Notes

1. Originally, an 1866 Federal land grant to the Oregon and California (O&C) Railroad in alternate sections of one square mile each as an incentive for railroad construction. The lands were later revested back to the United States in 1916.

2. For the past several decades, sustainable timber production levels from the BLM land has been well in excess of one billion board feet annually, enough to construct over one hundred thousand single family houses each year.

3. Raw core data is now estimated at 6 gigabytes and climbing; system capacity to operate the GIS is now at 25 gigabytes, and is soon to be expanded to 53 gigabytes.

4. A "township" is a six mile by six mile unit of the United States Public Land Survey System containing 36 one square mile "sections."

5. "MOSS" is an acronym for Map Overlay Statistical System, a public domain family of software developed and maintained by the United States Government.

6. A SYU is a legally defined specific geographic area where the management is predicted on providing long term sustained yield for local timber markets. Districts may have one to four SYUs under their jurisdiction.

7. Understand that the BLM does not actually log its timber. Instead it sells its timber on the open market by competitive bid and enters into a sale contract with the successful bidder. The purchaser then harvests the sale units under the contract's terms and conditions which may run for up to three years duration. Particular mitigation concerns relate to minimizing soil erosion, soil compaction, maintaining water quality and providing a suitable site for effective reforestation.

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