Interdisciplinary Research Report
Modeling Trends in Forest Management, Exurban Development, and Biodiversity Conservation under Alternative Policy Portfolios in Northern Idaho

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Seemingly intractable conflicts over resource management practices and rapid population growth in the rural western United States have increased the social, economic, and ecological instability of the region with impacts on rural culture, productive capacity, and biodiversity (Franklin and Forman 1987, Hann et al. 2001, Johnson and Maxwell 2001, Haynes 2002). Loss of biodiversity across Idaho and the Interior Northwest has been attributed to simplified forest stand structure and habitat fragmentation by timber harvesting, road building, and exurban development (Spies 1998, Knight 1999, Hessburg et al. 2000). The trajectory of species endangerment in the U.S. demonstrates the necessity for proactive changes to conserve many species and their habitats, but current regulatory efforts appear insufficient for the task (Hadlock and Beckwith 2002). Regulations such as the Endangered Species Act have been the focus of conflicts between government agencies and private landowners over what landowners perceive as arbitrary and unconstitutional regulations that result in loss of economic production. In this culture of conflict, additional regulations will likely lead to little or no gain for biodiversity. Many authors have suggested that social, economic, and regulatory incentives are needed for conservation planning on private lands (Fischer and Hudson 1993, Hadlock and Beckwith 2002, Doremus 2003). In this project, our goal is to develop spatially-explicit predictions of the ecological and socio-economic future of the forest-dominated landscape of northern Idaho under various policy portfolios.

Maintaining the breadth of values that human dominated landscapes embody requires that production, development, and conservation values be identified, and that the synergies and trade-offs between those values inform long-term planning and management. Landscape-level research and planning can assist communities in making decisions about what values are reflected in the local environment (Linehan and Gross 1998). Approaches will be most effective if they include socioeconomic and ecological concerns and involve a socially inclusive planning process. A number of projects that use integrative landscape planning and modeling methods have recently been initiated in the northwestern U.S. (Hann et al. 2001, Hemstrom et al. 2001, Hulse et al. 2002, CLAMS 2003). Although these efforts include non-federal lands, policy instruments for conservation on private lands have not been assessed as part of these plans.

We are conducting this study in Latah and Benewah counties in northern Idaho. The two county study area has a diverse array of land ownerships, including private industrial and non-industrial forest, tribal, state, and federal government lands (Scott et al. 2002). Land use in this area is dominated by human activities, including agriculture, forestry, and tourism. Population growth and residential development are expected to increase in the coming years (Johnson and Maxwell 2001, Masnick 2001). The combination of ownership patterns, the diversity of land uses, and continued population growth presents a challenge for balancing conservation values with the region's existing production activities and changing demographics. We are working to address this

challenge by developing a spatially-explicit model of central northern Idaho's landscape that identifies the interactions among socio-economic and ecological factors.

Our specific objectives and hypotheses are:

1. Determine trends in land use and policies influencing these trends through literature review and preliminary field and interview data. *We hypothesize that trends in land use are influenced by population growth patterns and policies designed to deal with population growth.*
2. Predict landowner management plans and barriers to implementation of specified management activities based on the results of social surveys. *We hypothesize that landowner management plans and management barriers will be significantly influenced by current land use, parcel size, and spatial location of parcel.*
3. Model relationships between forest stand characteristics, landscape patterns, biodiversity, and functional indicators in the current landscape. *We hypothesize that amphibian genetic diversity and distribution, butterfly species richness and diversity, nitrogen dynamics, and tree growth rates will be significantly influenced by landscape pattern and forest stand characteristics.*
4. Map future scenarios of landscape composition and pattern at 10, 25, and 50 years in the future. *We hypothesize that current trends in land use change and exurban development will significantly increase landscape fragmentation at each time step, and that alternative future scenarios based on policy incentives will significantly alter patterns of landscape fragmentation and composition.*
5. Apply models of biodiversity and functional indicators to predicted landscapes. *We hypothesize that the predicted landscapes will significantly influence biodiversity patterns and ecological function.*
6. Identify synergies and tradeoffs between socio-economic and ecological factors within and among scenarios. *We hypothesize that scenarios that utilize a portfolio of policies oriented at overcoming barriers to specific land owner management decisions will enhance synergies between socio-economic and ecological patterns, while scenarios that are based on single issue policies will result in increased tradeoffs between socioeconomic and ecological patterns.*

Currently we have completed objective 1 and are analyzing the data from social surveys as described in objective 2. During fall 2004 we conducted 12 interviews with local experts from both counties. Local experts included representatives from the county planning, zoning, and assessor's offices, county cartographers, Soil and Water Conservation Districts, planning oriented non-profit organizations, and a few key landowners. Based on information collected in interviews and from the literature, we developed land use change (LUC) survey instruments, which were mailed to 827 property owners in the study region using a modified Dillman (2000) tailored design method. To ensure a diversity of landowner types (size and location), we stratified landowners by parcel size, and by owner mailing address. LUC questionnaires focused on land use history, barriers to implementing specified management practices, and future management plans for specific parcels of land. A second mail survey was mailed to an additional 762 property owners included a mapping activity (see Brown 2005) in which participants were asked to spatially locate social, economic, and environmental values on

a county map. Response rates of 54% and 50%, respectively, were achieved for each survey. Data entry is completed for the LUC survey; data entry for the mapping activity is ongoing. We will use data from the LUC survey to support objectives 2 and 4; mapping activity data will be used in support of objective 6.

We are completing the collection of field data for objective 3 during summer 2005. We are collecting data on vertebrate and invertebrate species commonly used as biodiversity indicators: amphibians and butterflies. We have collected presence/absence data for pond-breeding amphibians at 92 randomly-selected sites in the study area to develop habitat models. In addition, we have collected long-toed salamander tissue samples from 89 locations and spotted frog tissue samples from 80 locations to model the relationship between gene flow (connectivity) and landscape features. In fall 2004, microsatellite markers were optimized for both species. We collected butterfly diversity and density data from early April to late July in 2004 and 2005 at 16 sites in Latah County. We will model the relationships between butterflies and forest stand density and land cover types, and we will draw upon the literature and other regional data to better extrapolate these findings across the entire study region. We are also evaluating the effects of forest edges and adjacent land use upon two functional indicators within forests, forest growth rates and nitrogen dynamics. In 2004 we collected foliar samples for nitrogen analysis and increment cores for growth rates from 228 ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) trees within 27 sites throughout the two counties.

We are developing a land cover map of the current landscape of the study area to support objectives 3 and 4. The map will be based on a spectral classification of ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) satellite imagery that was acquired during August and September 2002. ASTER imagery has three spectral bands with 15 m spatial resolution (Abrams et al. 2003). In 2004 we collected 170 ground-truth points using a Trimble GeoXT GPS unit with sub-meter accuracy (Trimble Navigation, Ltd., Sunnyvale, CA). We will use these data to classify the imagery, along with 2004 National Agricultural Imagery Program digital aerial photos and detailed 2003 ground-truth data available for Moscow Mountain in Latah County. We have begun georeferencing the imagery and expect to complete the map by early fall 2005. To assist with objective 4, we have arranged to have a new PhD student at the University of Idaho, Melanie Johnson, work as a short-term fellow with our team in fall 2005. Her project will focus on mapping landscape change between 1984 and 2004 in the study area with the intent of informing models of future landscape change.

We will produce several peer-reviewed research papers that communicate the research conducted for this project. These will include at least three individually written papers (one from each IGERT fellow) focusing on disciplinary components of the project. Additionally, the three IGERT fellows will produce at least two co-authored interdisciplinary papers. The first will focus on the predictions of landscape change modeled during this project, and the second will focus on the ecological and socio-economic consequences of various landscape change scenarios in the study area.

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