Chapter 1: Overview of the Integrated Landscape Assessment Project

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Introduction

Fire suppression, vegetation management activities, wildfires, grazing, climate change, and other factors result in constantly changing vegetation and habitat conditions across millions of hectares in the Western United States. In recent years, the size and number of large wildfires has grown, threatening lives, property, and ecosystem integrity. At the same time, habitat for species of concern is often becoming less suitable, the economic vitality of many natural resource-dependent human communities is declining, and resources available for land management are limited. Techniques are needed to prioritize where natural resource management activities are likely to be most effective and result in desirable conditions. Solutions driven by single-resource concerns have proven problematic in most cases, as multiple ecological resources and human systems are necessarily intertwined.

To help resource managers prioritize management actions across large landscapes, the Integrated Landscape Assessment Project (ILAP) produced databases, reports, maps, analyses, and other information showing mid- to broad-scale (thousands to hundreds of thousands of hectares and larger areas) vegetation conditions and potential future trends, key wildlife habitat conditions and trends, wildfire hazard, potential economic value of products that might be generated during vegetation management, and other critical information for all lands and all major upland vegetation types in Arizona, New Mexico, Oregon, and Washington. The ILAP work involved gathering and consolidating existing information, developing new information to fill data holes, and merging vegetation model information with fuel classifications, wildlife habitat models, community and economic information, and potential climate change effects. Information resulting from ILAP highlighted priority areas for management, considering a combination of landscape characteristics.

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The ILAP was designed to allow resource managers, planners, analysts, and other potential users to answer many questions about the integrated effects of vegetation change, management activities, natural disturbances, and climate change on important natural resources across all major upland ecological systems in the four-state study area. Questions addressed by ILAP included, but were not limited to, the following:

1. What are the conditions and trends of vegetation and natural disturbances in forests, woodlands, shrublands, grasslands, deserts, and other ecological systems in Arizona, New Mexico, Oregon, and Washington?
2. What are the implications of vegetation change, management activities, and natural disturbance trends on key wildlife habitats, wildland fuel conditions, nonnative invasive plant species, and other landscape characteristics?
3. How might those trends play out in the future under alternative land management approaches or scenarios?
4. How will alternative vegetation management scenarios meet land management objectives and generate economic products that might offset treatment costs and benefit local communities?
5. What areas and management regimes might be most likely to produce high combined potential to reduce critical fuels, sustain or improve key wildlife habitat, and generate positive economic value?

To ensure that relevant and useful information was produced, ILAP worked with local collaborative groups in focus areas (fig. 1.1) to forecast the potential effects of alternative land management scenarios on important landscape characteristics. Questions addressed in these landscapes were developed in collaboration with local users, in particular the Tapash Sustainable Forestry Collaborative in central Washington and the Firescape-Sky Islands group in southern Arizona. Alternative landscape management scenarios were simulated for each area. Examples of the questions addressed in focus areas include:

1. Central Washington landscape area—How might the Tapash Sustainable Forestry Collaborative partners simultaneously achieve individual landscape objectives while sustaining or improving critical wildlife habitat, reducing wildfire hazards, and generating economic benefits for local communities?
2. Sky Islands landscape area—How could fuel treatments be used to move vegetation toward desired or reference conditions in the Sky Islands landscape and how much would that cost? What effects might climate change have on the effectiveness of fuel treatment programs and associated wildfire hazards?

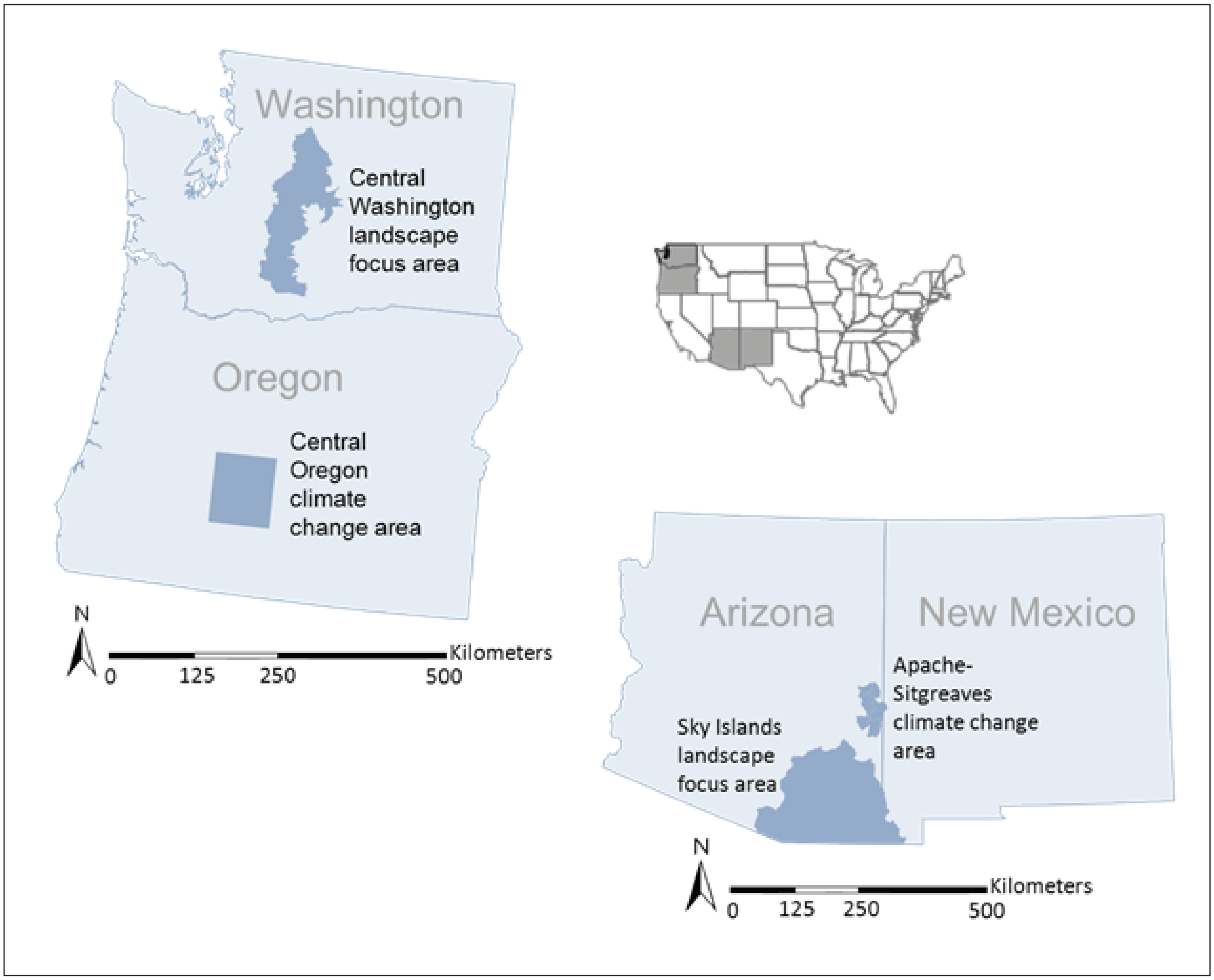

Figure 1.1—The focus areas and climate change areas within the Integrated Landscape Assessment Project.

In addition to working with collaborative groups at the local level, ILAP also worked to address issues that were important over larger regional landscapes. The Interagency Mapping and Assessment Project (IMAP) User Group served as the advisory group to ILAP. This group included regional and state land managers and planners from Oregon and Washington. They identified the east-side dry forests in Oregon and Washington as highest priority for ILAP to address, with these specific management questions:

1. What are likely trends in dry forest conditions in eastern Oregon and Washington under a fire suppression only and hypothetical resilience/forest health scenario?
2. Where are dry forests most at risk for loss of large, old trees?

3. What are the land ownership and management allocation circumstances (ownership-management hereafter) in these areas?
4. Which landowners might need to collaborate to achieve mutual forest management objectives?

Each of these landscape-level questions was addressed by ILAP through vegetation mapping and modeling and integration with newly developed information, as well as subsequent discussions with each of the collaborative groups in each focus area. The structure of ILAP is described below and represented in figure 1.2, and methods used for ILAP are outlined below and described in detail throughout this report.

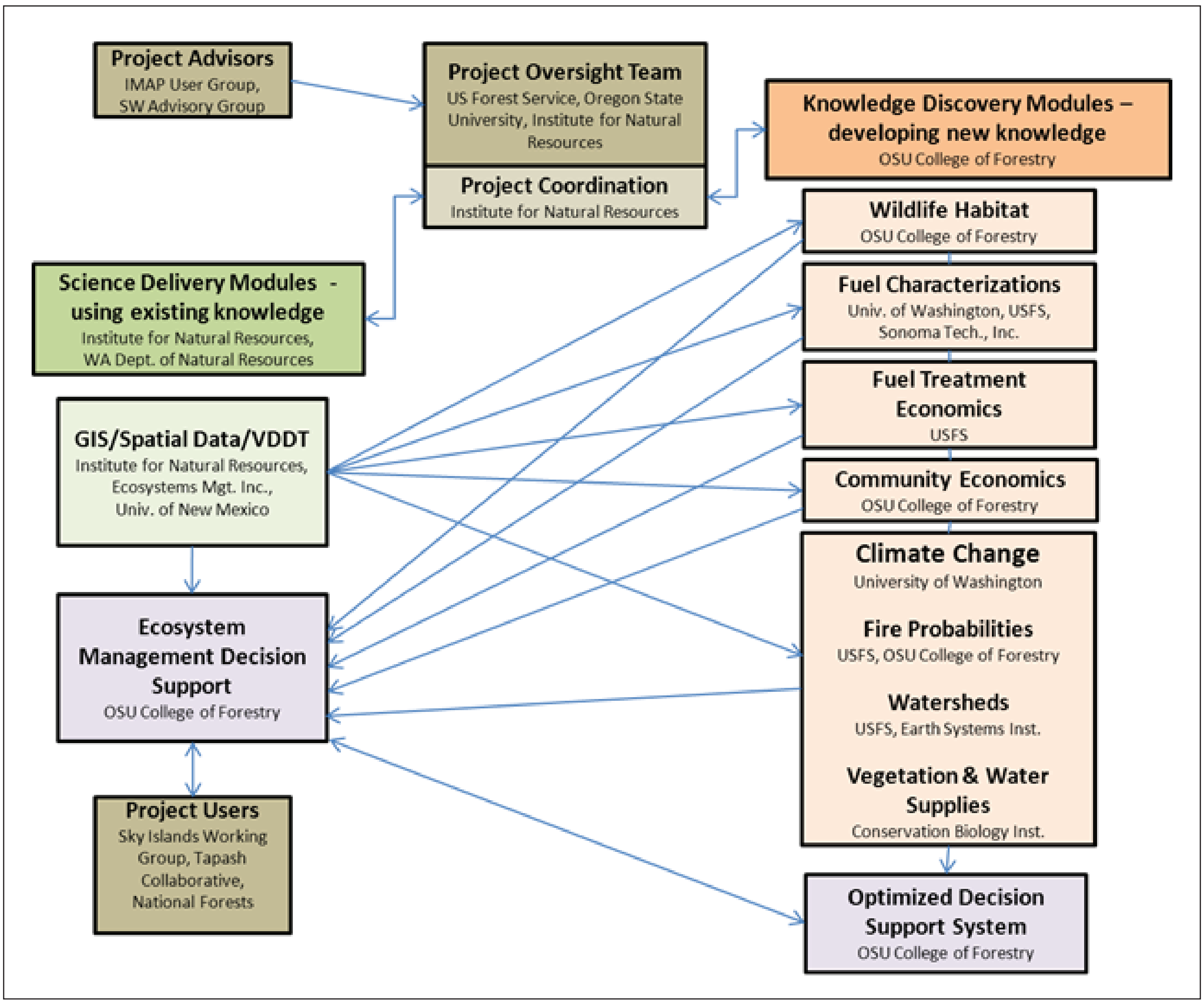

Figure 1.2—Organization of science delivery and knowledge discovery partners in the Integrated Landscape Assessment Project. IMAP = Interagency Mapping Assessment Project, OSU = Oregon State University, WA = Washington, USFS = U.S. Forest Service, GIS = geographic information system, VDDT = Vegetation Dynamics Development Tool.

Structure of ILAP

Partners and Oversight

The ILAP was a collaborative effort and incorporated expertise from several institutions and disciplines (fig. 1.2). An oversight team, composed of representatives from the major collaborators (the Institute for Natural Resources, Oregon State University College of Forestry, the U.S. Department of Agriculture Forest Service [USDA FS], Pacific Northwest Research Station, and the USDA FS Southwest Region) provided overall direction at monthly meetings. Other clients and partners include the USDA FS Pacific Northwest Region, Washington Department of Natural Resources, Oregon Department of Forestry, University of Washington, University of New Mexico, University of Arizona, The Nature Conservancy, and others. Two groups of project advisors, one from Oregon and Washington and one from Arizona and New Mexico, connected the project goals, objectives, and products to state and federal agencies, nonprofit organizations, private contractors, universities, and the interested public by providing comment, feedback, and review throughout the project. The project lead scientist and project coordinator oversaw the technical and outreach aspects of project work. Science delivery, as a whole, was jointly led by scientists from the Institute for Natural Resources and the Washington Department of Natural Resources. Each science delivery module (described below) had a lead investigator and production team, as necessary. Knowledge discovery modules (described below) were led by several universities and nonprofit organizations, and each module had a lead scientist, and as appropriate, a production team. User involvement was critical throughout the project, particularly in the development of management scenarios and review of draft products.

Science Delivery and Knowledge Discovery

The ILAP was organized into two broad themes that roughly followed each other sequentially—science delivery and knowledge discovery. Science delivery teams generally worked with existing methodologies to develop landscape-level information (primarily related to vegetation conditions), while the knowledge discovery teams developed and applied new methodologies to link the science delivery vegetation outputs with associated landscape-level information on wildlife habitat, fuel conditions, treatment economics, community impacts, and climate change impacts.

Science delivery modules—

The science delivery portion of ILAP consisted of two main modular components: geographic information system (GIS) data and state-and-transition models (STMs). These two modules worked together to create the following across the four-state area:

- Maps of potential vegetation that depicted the kinds and spatial extents of all major upland ecosystem types in the four-state area (riparian, aquatic, agricultural, urban, and barren areas were not modeled for this project).
- Maps of current vegetation characterizing current vegetation cover and structure conditions. These maps were summarized into state classes that matched STMs.
- Parameterized STMs used for simulation forecasting of future vegetation condition.

The potential and current vegetation mapping work, STM development, vegetation classification, and simulation forecasting are described briefly below and in detail in chapter 2.

The GIS data sets compiled by ILAP include more than 40 statewide spatial data sets detailing current and potential vegetation conditions, watershed boundaries, ownership-management categories, and others.

Geographic information system module—The GIS module processed the best available spatial data for use by the other ILAP modules. The GIS data sets compiled by ILAP include more than 40 statewide spatial data sets detailing current and potential vegetation conditions, watershed boundaries, ownership-management categories, and others. The team gathered data from various sources, merged and appended it, combined attribute data into consistent formats, and created detailed documentation. The GIS module delivered standardized data in raster/grid and vector formats from various hardware and software platforms. A data management process and protocol were put in place to facilitate the incorporation of any data updates or improvements and maintain and house original data sets over the long term.

Where existing maps were not available or contained insufficient detail, current and potential vegetation were mapped using imputation methods and geo-referenced plot data from various sources. Plot data for mapping came from the USDA FS Forest Inventory and Analysis (FIA) program (USDA FS 2012), the LANDFIRE plot database (www.landfire.gov; Rollins 2009), U.S. Department of the Interior Bureau of Land Management data, and various other sources. Current and potential vegetation were mapped using a combination of gradient nearest neighbor imputation (Ohmann and Gregory 2002) and random forest nearest neighbor imputation (Crookston and Finley 2008), which rely on a combination of remotely sensed information and other geographic data. The resulting spatial data are 30-m grids that contain information on key attributes of current vegetation and an assignment of potential vegetation across the four-state region.

The STM module collected, integrated, and as necessary, built new vegetation models for forest, woodland, shrubland, grassland, and desert vegetation types across the four-state study area.

State-and-transition modeling module—The STM module collected, integrated, and as necessary, built new vegetation models for forest, woodland, shrubland, grassland, and desert vegetation types across the four-state study area. Using a summarization of layers from the GIS data to establish initial (current) conditions, STMs were used to project future landscape conditions according to alternative vegetation management scenarios.

The STM approach represents vegetation types by state classes (boxes), each characterizing combinations of cover type (i.e., dominant species or functional group composition) and structural stage (i.e., vegetation cover, size class, and canopy layers) within a particular biophysical environment. Boxes are linked by arrows (transitions) that represent natural disturbances, management actions, or vegetation growth and development (fig. 1.3). The ILAP team sometimes augmented existing STMs used by various organizations for land management planning, restoration planning, and ecoregional assessments in Arizona, New Mexico, Oregon, Washington, and elsewhere (e.g., Evers 2010, Forbis et al. 2006, Hann et al. 1997, Hemstrom et al. 2007, Holsinger et al. 2006, Merzenich and Frid 2005, Weisz et al. 2009). In some cases, STMs consistent with the project framework did not exist and new models were constructed using similar existing models as templates. State-and-transition models were developed for units of potential vegetation within 18 modeling zones (see chapter 2, fig. 2.4), resulting in 275 STMs across the four-state study area. Transition probabilities in the STMs come from a combination of expert opinion, available literature, and empirical data analysis (see chapter 2). However, the structure of ILAP STMs allows relatively easy updating of transitions and probabilities from empirical data (e.g., annual insect and disease surveys) and

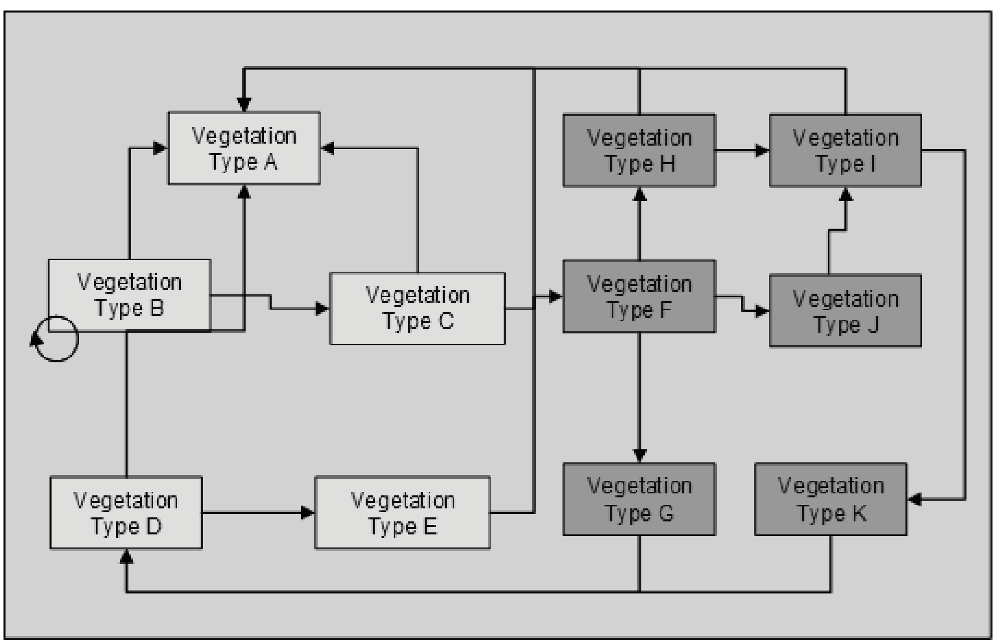

Figure 1.3—Generalized state-and-transition model (STM) diagram used in the Integrated Landscape Assessment Project. Boxes represent state classes, comprised of cover type and structural stage. Arrows represent transitions that simulate processes that can cause an area to move from one state class to another. One STM is built for each potential vegetation type.

ancillary models, such as the Forest Vegetation Simulator (Crookston and Dixon 2005, Stage 1997) and new inventory data.

Models were stratified and run on combinations of land ownership-management classes, potential vegetation, and watershed (fifth-code hydrologic unit [HUC5]; USGS and USDA NRCS 2011). Results forecast potential future amounts and distributions of important landscape characteristics, but vegetation data accuracy limit appropriate use to landscape scales rather than vegetation stands. The ILAP analyses were often summarized by watershed as an appropriate spatial scale. Alternative land management scenarios can easily be generated by changing assumptions about vegetation management treatments and rates by land ownership-management allocation. The resulting forecasts of vegetation conditions, management activities, and natural disturbances were linked to wildlife habitat characteristics, economic values, and other important attributes (see below and chapters 3 through 7).

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Knowledge discovery modules—
The ILAP was organized into nine knowledge discovery modules, each generating new information on a particular natural resource issue. Knowledge discovery modules are described briefly below and selected modules are described in detail in chapters 3 through 7.

Fire and fuel characterization module—The fire and fuel characterization module evaluated current and potential future fuel characteristics and fire hazard for forests and woodlands across Arizona, New Mexico, Oregon, and Washington. The module team built fuel beds (descriptions of burnable biomass extending from the forest floor to the canopy) in the Fuel Characteristic Classification System (Ottmar et al. 2007) from inventory plots for each vegetation state class in the STMs. The resulting fuel beds (over 14,000) were analyzed for fire potential and linked to STM output, allow clients and users to assess current conditions and trends in fuels and potential fire behavior over time under different management scenarios. See chapter 3 for further detail.

Fuel treatment economics module—The fuel treatment economics module estimated potential tree-based biomass (by diameter classes and tree species groups), timber volume, and aboveground, tree-based carbon pools by STM state class and potential vegetation type for all forests and woodlands in Oregon and Washington. The study used STM simulation outputs of the removed timber products from proposed treatments over the simulation period to perform cost-benefit analyses. The analyses considered harvesting costs associated with each treatment using the Fuel Reduction Cost Simulator (Fight et al. 2006), transportation cost to mill locations, products prices, and other economic factors. It provided data and methods to allow managers and others to assess the financial feasibility of proposed forest vegetation management treatments. See chapter 4 for further details.

Wildlife habitat module—The wildlife habitat module developed species-habitat relationships for 24 species in Oregon and Washington and 13 species in Arizona and New Mexico, linking habitat and nonhabitat classifications to STM state classes in forest, woodland, shrubland, grassland, and desert models. The team generated tools that estimate the amount of current and potential future habitat area for selected species across the four-state area. These species-habitat relationships can be used for mid- to broad-scale assessments of management and on potential wildlife habitat. See chapter 5 for further detail.

Community economics module—The community economics module addressed the question of whether large-scale forest vegetation treatment programs can stimulate economic activity and contribute to well-being in communities that have been negatively impacted by recent federal forest policy changes. The team produced indicators for each HUC5 watershed (and ownership-management allocation within watershed) that describe the potential for fuel treatment in those watersheds to produce benefits to communities for the forested landscapes in Arizona, New Mexico, Oregon, and Washington. See chapter 6 for further detail.

Climate change and vegetation module—The climate change and vegetation module used the MC1 dynamic global vegetation model (Bachelet et al. 2001) to inform vegetation change and wildfire trends in STMs for two focus areas: central Oregon and the Apache-Sitgreaves area in eastern Arizona (fig. 1.1). The result is a set of "climate-informed" STMs that can be used to determine likely shifts in vegetation structure and species composition and abundance with climate change, and can be used by land managers to weigh potential benefits or tradeoffs associated with alternative management approaches under a changing climate. Analyses were conducted for three climate change scenarios that bracket the range of projected climatic changes for the study areas. See chapter 7 for further detail.

In addition to the coupled model approach for two focus areas, the climate change and vegetation module team ran coarser scale (4-km grid) simulations for Arizona, New Mexico, Oregon and Washington. These simulation data cover the historical (1895–2009) and future (2010–2100) time periods for the entire four-state area, and an Envision software-based tool (Bolte 2007) was developed and constructed as a GIS plug-in that allows users to extract climatic, hydrologic, vegetation, and other data from these MC1 outputs.

Climate change and watersheds module—The climate change and watersheds module developed information on the current condition of all HUC5 watersheds that contain national forest lands in Oregon and Washington. The module used NetMap (http://www.netmaptools.org/; Benda et al. 2007) to generate estimates of erosion hazards, in-channel habitat conditions, and other important watershed characteristics. It also allows estimates of potential future changes in watershed condition under climate change by analyzing the likely effects of changes in precipitation amount and seasonality, along with changes to wildfire and vegetation conditions that might result under different future climates.

Climate change and fire probabilities module—The objective of the climate change and fire probabilities module was to provide refined insight into the potential variation of wildfire probabilities and vegetation dynamics that may occur with climate change. Wildfire probabilities and vegetation transitions are key to STM parameterization, but we know little about how variations in wildfire probability or shifts in vegetation composition may vary with changes in climate. This module used spatially explicit landscape simulation models to examine variation in wildfire probabilities and vegetation dynamics with climate change in a prototype area of the upper Deschutes subbasin in Oregon. The methods and results of these analyses will be described in a forthcoming report.

Ecosystem management decision support module—This module used the Ecosystem Management Decision Support system (Reynolds 1999, Reynolds and Hessburg 2005) to integrate information on current and potential future vegetation, fuels, wildlife habitat, and economic conditions into a combined, flexible assessment and prioritization tool. This tool will help managers and others explore and set priorities using color-coded maps, tables, and reports based on various combinations of characteristics that best reflect local values. The methods and results of this work will be described in a forthcoming report.

Optimized decision support module—The optimized decision support module developed methods that integrate fuels, wildlife habitat, and economic conditions into a spatial analytical decision support process. Weighting and prioritization are driven by direct user input or through an evaluative technique, such as the Analytical Hierarchy Process (e.g., Kangas 1992, Thomas 1990). Methods and results of this work will be described in a forthcoming report.

Access to ILAP Data and Information

The ILAP created a number of methods and outputs that were developed to help land managers and planners integrate and prioritize management activities. Through the Western Landscapes Explorer (www.westernlandscapesexplorer.info), the project's publications, models, maps, data, and tools will be archived and available online so that scientists and managers will be able to use and build upon the project's products. Land managers, planners, analysts, scientists, policymakers, and large-area landowners can use the project's tools and information for many applications, including:

- Watershed restoration strategies
- Land management planning across all lands
- Statewide assessments and bioregional plans

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The ILAP data and information are being used to support USDA FS Forest Plan Revisions, Collaborative Forest Restoration Program projects, and can be used to inform upcoming statewide forest assessments, statewide wildlife action plans, and ecoregional assessments. As this first phase of ILAP concludes, a strong foundation of landscape-level data, STMs, tools and expertise has been built for future landscape planning and assessments across a broad range of western landscapes.

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