Integrated Landscape Assessment Project Final Report

Institute for Natural Resources

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THE INSTITUTE FOR NATURAL RESOURCES

Created by the Oregon Legislature through the 2001 Oregon Sustainability Act, the Institute for Natural Resources' mission is to provide access to integrated knowledge and information to inform natural resource decision making and develop solutions in the context of sustainability.

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Photo by Miles Hemstrom

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Disclaimer

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The contents of this report reflect the views of the authors who are solely responsible for the facts and accuracy of the material presented. This report does not constitute a standard, specification, or regulation.

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Executive Summary

The Integrated Landscape Assessment Project (ILAP) was a multi-year effort to produce information, maps, and models to help land managers, policy-makers, and others conduct mid- to broad-scale (e.g., watersheds to states and larger areas) prioritization of land management actions, perform landscape assessments, and estimate cumulative effects of management actions for planning and other purposes. ILAP provided complete cross-ownership geospatial data and maps on current vegetation, potential vegetation, land ownership and management allocation classes, and other landscape attributes across Arizona, New Mexico, Oregon and Washington. State-and-transition models (STMs) were developed to cover all major upland vegetation types in the four states. These models incorporate vegetation succession, management actions, and natural disturbances to allow users to examine the mid- and long-term effects of alternative management and disturbance scenarios. New STM linkages to wildlife habitat, fuel treatment and community economics, above ground carbon pools, biomass, and wildfire hazard were developed and integrated at landscape scales. Climatized STMs were developed for focus areas in Oregon and Arizona to examine potential effects of climate change on potential future vegetation conditions.

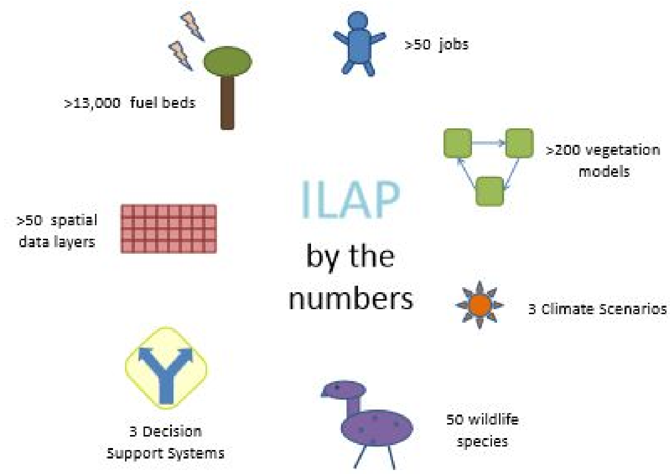
The Pacific Northwest Research Station in conjunction with Oregon State University spent several years and considerable effort developing and supporting the Interagency Mapping and Assessment Project (IMAP), an interagency collaborative effort to transfer landscape assessment tools to land managers and others. As part of the American Recovery and Reinvestment Act, this 10-year IMAP collaborative effort was expanded to create the Integrated Landscape Assessment Project (ILAP) which was charged to identify and analyze areas within the states of Oregon, Washington, New Mexico, and Arizona that could inform economically viable fuel reduction and restoration activities.

Over the course of the past three years, ILAP has produced consistent, integrated vegetation data sets and models for millions of acres across the American Northwest and Southwest, allowing decision makers to explore possible changes in landscape conditions under different management scenarios across all lands. ILAP's all-lands focus makes it particularly applicable, given that the complexity of natural resource management has grown well beyond ownership boundaries. ILAP has become known as an innovative tool for informing management decisions across all major upland vegetation systems at a watershed scale. Through user-friendly maps, graphs, and tables, ILAP creates a decision support framework for comparing different management scenarios. This kind of "what if" exercise provides a unique opportunity to understand the interactions among biophysical, social, and economic factors that determine the dynamic of a landscape.

ILAP was selected as one of eight exemplary, collaborative research and development case studies and presented at the Agriculture, Food, Nutrition, and Natural Resources R&D Roundtable on March 15, 2011 in Washington, D.C.

At a Glance: Outputs & Outcomes

Funded with $5.5 million from the American Reinvestment and Recovery Act (Recovery Act), the Integrated Landscape Assessment Project (ILAP) was developed to create jobs and produce consistent, integrated data and models to assess possible changes in vegetation, habitat, and economic conditions under different management scenarios. More than 50 short-term jobs were created to develop models, run analyses and do the outreach needed to make sure ILAP information can be used by land managers, planners, and analysts from public agencies, private industries, tribes, NGOs, collaborative groups, and others working in Oregon, Washington, Arizona and New Mexico.



ILAP offers a way to help people understand and visualize the long-term consequence of various management approaches across large landscapes. Projections of vegetation, habitat, fuel, and economic conditions from ILAP can help people to select the management actions that come closest to achieving landscape-level objectives, such as reductions in forest and rangelands burned, restored old forest conditions, or the long-term sustainability of existing mills or proposed biomass facilities. What started as a collaboration between the U.S. Department of Agriculture Forest Service, Institute for Natural Resources, Oregon State University College of Forestry, and the Washington Department of Natural Resources has grown substantially to include many other federal, state, private, and academic institutions.

Jobs

More than 50 jobs created or retained; 36 at Oregon State University

77% of $3.6 m directly supported created or retained jobs lasting 1 to 2.5 years

56% in Corvallis, Oregon; 44% of jobs in Portland, Oregon

52% of new hires were women

Jobs created and retained: *GIS analysts, modelers, science writers, researchers, outreach specialist*

Electronic Access to Information

ILAP Website – www.oregonstate.edu/inr/ilap

The Western Landscapes Explorer *(here)*

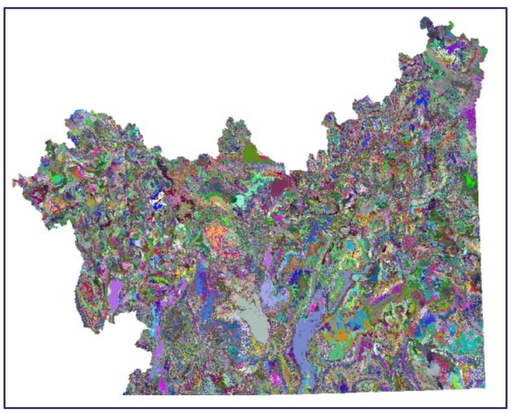
Access to data and models through an ILAP ftp site

Twenty-two archived ILAP webinars *(here)*

Pachyderm instructional site

Internal ILAP SharePoint site

Science Delivery: Data and Modeling Outputs



More than 50 GIS datasets compiled and standardized across four states
Lookup tables and outputs (indicators)
Local, region-wide, and statewide maps
Metadata
Plot data
Added functionality to NetMap for Oregon & Washington
More than 200 forest, woodland, and arid land state and transition models (STM)

Publications, Reports, and other Documents

Draft USDA General Technical Reports
Peer reviewed publications
INR Newsletter
Fact sheets
Booklet *(here)*
Maps
Terra Magazine article: *Bird's Eye View* *(here)*
U.S. Forest Service, Science Update – *Landscape Models: Helping Land Managers Think Big* *(here)*
ILAP Data Collaboration Guidelines

Analyses

- Informing four National Forest Plan revisions in Washington, Oregon, Arizona and New Mexico
- Assisting National Forest watershed restoration planning in Oregon
- Supporting wildlife area ecological integrity monitoring in Washington refuges
- Informing forest health restoration economic assessments for the state of Oregon
- Examining forest resilience and forest products around mills with high risk of closure
- Analyzing future climate, land management and wildlife habitat impacts in southern Oregon and coastal Washington

Scenarios and Scenario Development

To perform a landscape assessment using ILAP models and data, scenarios are identified in consultation with a stakeholder group either in person or via an online meeting. The ILAP project team usually starts running analyses with the "Fire Suppression Only" scenario, which was the only scenario applied across the 4-state project area. From there, stakeholders would identify 2-3 other management scenarios of interest that could be analyzed for a large landscape area of interest (areas that were often greater than 5 million acres in size). Many types of management scenarios can be evaluated using the ILAP models and data across landscapes of varying sizes. Although it was the initial project intent, the ILAP team was not able to assess current management across all 4-states because of the difficulty in getting this information from each of the land managing entities. To date, eight forest management scenarios have been evaluated for local landscapes that include, but are not limited to, the Sky Islands, Arizona; Eastside forests of Oregon/Washington; Central Washington; Southern Oregon; and Coastal Washington.

1. Fire suppression only
   No active management is undertaken, except that current levels of fire suppression will continue

2. Current management
   Incorporates current levels of mechanical treatments and prescribed fire for each ownership/management allocation class.

3. Old forest resilience
   A restoration scenario that analyzes a thin-from-below treatment, leaving all trees larger than 21" in diameter, also includes prescribed fire suppression

4. Prescribed fire only
   Only active management treatment is prescribed fire

5. Mechanical treatments only
   Only active management is mechanical treatments

6. Historic range of variation
   Incorporates historic fire return intervals; represents baseline conditions

7. 2x, 4x and 8x prescribed fire and mechanical treatments
   Ramps up current treatment levels to see when and if fuel reduction targets are reached

8. Early seral stage management
   Active management targets early seral stages

Presentations, Workshops, and Conferences

Numerous presentations at conferences, and briefs were conducted with federal, state, non-governmental, private landowners and consultants in the Northwest, Southwest, and nationally.

PATH Conference

Great Northern LCC and Climate Change

Biodiversity without Borders

Ecological Society of America Conference

Society of American Foresters, 2010, 2011, 2012

Society for Conservation Biology

Rural Voices for Conservation Consortium

American Forest Resources Council (AFRC)

International Association for Landscape Ecology (IALE)

The National Landscape Conservation Cooperatives Conference

ILAP arid lands workshop

LandCarbon-ILAP workshop

Education

- Graduate level seminar series in the OSU College of Forestry
- Completion of Master's degree (Greaves)
- Team Professional Development:
    - Fieldtrips to Oregon and Arizona
    - Training: MC1, PATH, Telsa
- Training non-ILAP analysts

Award

In March 2011, ILAP was selected as an exemplary, collaborative research and development case study at the Agriculture, Food, Nutrition, and Natural Resources R&D Roundtable. The eight recognized case studies were selected for their potential to raise the profile of agriculture, food, nutrition, or natural resources research and draw attention to the value of federal investment in the sciences.

About ILAP

Overview

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 tight. 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, since ecological 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. 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 will highlight priority areas for management, considering a combination of landscape characteristics.

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 area. Questions addressed by ILAP included, but were not limited to:

1. What are the broad-scale 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, non-native 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 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 – What would it take in the way of fuel treatments to move toward desired or reference conditions in the Sky Islands landscape and how much will it cost? What effects might climate change have on the effectiveness of fuel treatment programs and associated wildfire hazards?

Creating and Retaining Jobs

One of the core objectives of the Recovery and Reinvestment Act was to create new jobs and save existing ones. Throughout the ILAP enterprise, Recovery Act funding created and retained over 50 jobs. ILAP was a $5.5 million project, with $3.6 million being awarded to the Institute for Natural Resource at Oregon State University and the OSU College of Forestry. Of the $3.6 million award to Oregon State University, 77% of the funds directly supported 36 created or retained positions. Forty-four percent (44%) of the positions were located in Portland Oregon (Multnomah County), with the remaining 56% located in Corvallis, Oregon (Benton County).

With the downturn of the economy, the Institute for Natural Resources was able to hire people for the ILAP Science Delivery Team who had exceptional technical skills (GIS analysts, modelers, science writers, researchers, and outreach specialists) and were either out of work, in temporary positions, or threatened with the loss of a job. INR created 12 new, full-time (FTE) positions, and one new position at .80 FTE. Two hundred and thirty (230) people applied for approximately six GIS-related positions, 50 for six modeling positions, and 13 for one project coordinator position. One person hired through INR on ILAP stated:

> "*Both my [spouse] and I would be unemployed right now and we'd be sweating, because we have a small child and a house payment*."

Another ILAP hire said:

“I was looking for jobs for about eight months for a position where science and management interface.”

INR-ILAP faculty and staff were hired for appointments that lasted one to three years. Throughout ILAP, retention of staff remained very steady. In only one case did an INR-ILAP staff find other employment before their contract with INR ended, that employee moved to a new position within approximately six months. In all but two cases, INR was able to extend INR-ILAP employment beyond the initially committed time period. All employees who no longer work for the INR’s science delivery have all successfully found other employment, for example with the California Department of Fish and Wildlife, the Washington Department of Natural Resources, the Arizona Department of Fish and Game, and the Puyallup Tribe, to name a few.

The OSU College of Forestry’s ILAP new hires were primarily graduate students hired at .49 FTE. With the exception of 2 individuals, these graduate students were mostly Master’s level student, who worked with the leads of each of the Knowledge Discovery Team modules. Eighty-three percent (83%) of all new hires, the Science Delivery Team modules and Knowledge Discovery Team modules combined, had an FTE of .49 or greater. Fifty-two percent (52%) of all new hires were women.

ILAP Organization

ILAP was a collaborative effort and incorporated expertise from several institutions and disciplines (Figure 1) – creating and retaining more than 50 jobs.

An oversight team, composed of representatives from the major collaborators (the Institute for Natural Resources, Oregon State University College of Forestry, and the U.S. Department of Agriculture Forest Service (USDA FS) Pacific Northwest Research Station) provided overall direction at monthly meetings. Other clients and partners include the USDA FS Northwest Region, USDA FS Southwest 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 another from Arizona and New Mexico, connected the project goals, objectives, and products to state agencies, federal agencies, non-profit 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 had a lead investigator and production team, as necessary. Knowledge discovery modules were led by several universities and non-profit 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.

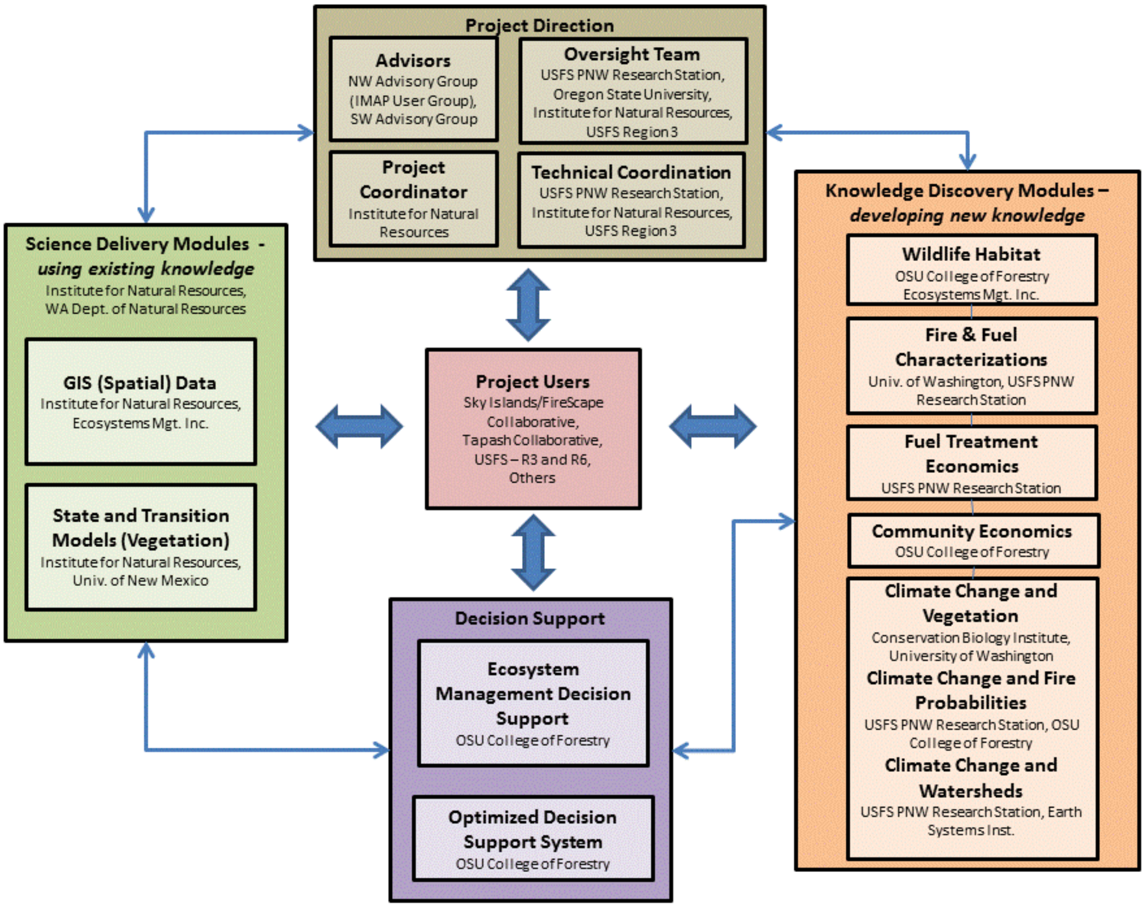


Figure 1. ILAP organizational chart

Project Direction

The **Oversight Team** assisted the Project Coordinator in ensuring the successful completion of the project, and its deliverables by: providing governance through the development or review of broad project policies and guidelines; shaping expected project outcomes; making and articulating critical decision points; assisting the Project Coordinator in resolving conflicts and/or issues within the project team; providing input on broader project activities (i.e., outreach, etc.); and representing and/or advocating for the project, when and if needed.

The **Project Coordinator** in partnership with the two OSU Principal Investigators was responsible for coordinating the activities of the science delivery, knowledge discovery, and decision support module teams to successful project completion, as well as leading and conducting project-related outreach.

Three **Project Advisory Teams** were established to represent the northwest (Oregon and Washington); the southwest (Arizona and New Mexico); and the national office of the USDA Forest Service. The project advisors assisted the ILAP Project Coordinator in ensuring the usefulness of project products by: advising on need and use of products; evaluating interim and final project products (including data and models, integrated analysis, and web tools); shaping expected project outcomes, providing input on broader project activities (i.e., outreach, etc.); representing and/or advocating for the project, when and if needed; and participation and/or advocating for roll-out/tech transfer.

Science Delivery Modules

Geographic Information System (Spatial Data) Module

Team members: Joe Bernert (INR) team lead, Jenny Dimeceli (INR), Myrica McCune (INR), Matt Noone (INR), Michael Polly (INR), Kuuipo Walsh (INR), Lindsey Wise (INR), and Melissa Whitman (INR).

Spatial data team built on and consolidated existing spatial data from the Interagency Mapping and Assessment Project (IMAP), USDA Forest Service Region 3 (R3) forest planning work, and LANDFIRE efforts. The spatial data team produced consistent mid-scale vegetation data, potential vegetation data, watershed boundaries, and other necessary data for all major forest and woodland in all four states. Data was designed to provide initial conditions for state and transition models that run on strata of watersheds (Huc5) and classes of land ownership/land allocation.

Table 1. ILAP data products for each state

	ILAP Data Products – GIS datasets	Oregon	Washington	Arizona	New Mexico
Boundaries (vector, raster)					
1	ILAP USFS Region 6 boundary	●	●		
2	ILAP USFS Region 3 boundary			●	●
3	ILAP modeling region boundaries	●	●	●	●
Ownership Theme					
4	Primary Public Ownership	●	●	●	●
5	Management/Allocation Composite	●	●	●	●
6	ReGAP Land Ownership/Stewardship	●	●	●	●
7	Northwest Forest Plan	●	●		
8	Wildland Urban Interface (WUI)	●	●	●	●
9	Mask of non-forested areas	●	●	●	●
Potential Natural Vegetation					
10	Potential Vegetation Type (INR)	●	●		
11	Potential Natural Vegetation Types (INR)			●	●
12	Tree Association Map (SSURGO/STATSGO)	○	○	○	○
13	Plant Association Groups (USFS)	○	○	○	○
14	Biophysical Setting (LANDFIRE)	●	●	●	●
Existing Vegetation					
15	Gradient Nearest Neighbor composite	●	●		
16	RF Nearest Neighbor composite for forest/woodlands			●	●

17	RF Nearest Neighbor composite for arid lands	●	●	●	●
18	Local Detailed Stand Data	○	○	○	○
19	Existing Vegetation Cover (LANDFIRE)	●	●	●	●
20	GAP/ReGAP Land Cover	●	●	●	●
21	NLCD Land Cover	●	●	●	●
22	Existing Vegetation Height and Type (LANDFIRE)	●	●	○	○
23	Canopy Cover (NLCD)	●	●	●	●
Watersheds					
22	5th Field Hydrologic Unit Codes (HUCs)	●	●	●	●
Topographic Data					
23	Elevation (30 meter)	●	●	●	●
24	Slope in degrees	●	●	●	●
25	Slope in percent	●	●	●	●
26	Aspect in degrees	●	●	●	●
27	Aspect in radians	●	●	●	●
28	Cosine transformation of aspect in radians normalized	●	●	●	●
29	Hillshade	●	●	●	●
30	Topographic position index, summarized with a radius of 150 meters	●	●	●	●
31	Topographic position index, summarized with a radius of 300 meters	●	●	●	●
32	Topographic position index, summarized with a radius of 450 meters	●	●	●	●
33	Landform Classification	○	○	●	●
Soils Data					
34	Available water capacity	●	●	●	●
35	Bulk density	●	●	●	●
36	Texture (Clay, Sand, Silt and Rock)	●	●	●	●
37	Hydrologic Soil Group	●	●	●	●
38	Depth To Bedrock	●	●	●	●
39	Hydrologic Runoff	●	●	●	●
40	Drainage Index Potential (based on lithology)	●	●	●	●
41	800m Texture (Clay, Sand, and Rock) by Layer 0-50cm, 50-150cm, >150cm	●	●	●	●
42	pH	●	●	●	●
43	Erosion Potential	○	○	●	●
Geology					
44	Underlaying Geology Source Material	○	○	●	●
Wildfire					
45	Burn Severity (MTBS)	●	●	●	●
46	Burn Area Perimeters (MTBS)	●	●	●	●

48	Fire Regime Condition Class (LANDFIRE)	○	○	●	●
49	Historical Fire Regime Groups (LANDFIRE)	○	○	●	●
50	Fire Succession Classes (LANDFIRE)	○	○	●	●
Masks					
51	Forest mask	●	●	○	○
52	Non-forested areas mask	●	●	○	○
53	GAP Forest/Non-forest mask with canopy adj.	●	●	○	○
54	Arid lands mask	●	●	○	○
Climate					
55	Average Annual Precipitation	○	○	●	●
56	Average Annual Temperature	○	○	●	●
57	August Max Temperature	○	○	●	●
58	December Min Temperature	○	○	●	●
59	Percentage Precipitation in June to August	○	○	●	●
60	Percentage Precipitation in June to August	○	○	●	●
61	Topographic Moisture	○	○	●	●
62	Coefficient of variation mean monthly precipitation of December and July	○	○	●	●
63	Coefficient of variation mean monthly precipitation of December through July	○	○	●	●
64	Mean precipitation from May-September	○	○	●	●
65	Growing season moisture stress: ratio of temperature to precipitation from May-September	○	○	●	●
66	Mean temperature from May-September	○	○	●	●
67	Difference between August Maximum Temperature and December minimum Temperature	○	○	●	●
68	Topographic Moisture Potential from Ecological Systems footprint	○	○	●	●
Imagery Mosaic (2006)					
69	Thematic Mapper Band 1 reflectance	○	○	●	●
70	Thematic Mapper Band 2 reflectance	○	○	●	●
71	Thematic Mapper Band 3 reflectance	○	○	●	●
72	Thematic Mapper Band 4 reflectance	○	○	●	●
73	Thematic Mapper Band 5 reflectance	○	○	●	●
74	Thematic Mapper Band 6 reflectance	○	○	●	●
75	Tasseled Cap transformation for Brightness	○	○	●	●
76	Tasseled Cap transformation for Greenness	○	○	●	●
77	Tasseled Cap transformation of Wetness	○	○	●	●
78	Normalized Difference Vegetation Index	○	○	●	●
79	Normalized Difference Moisture Index	○	○	●	●

● – Statewide data layer compiled; ● – Statewide data layer to be compiled by end of project; ○ - Statewide data layer will not be compiled during project, or may only cover portion of study area(s); Blank - no data is available or not applicable

State and Transition (Vegetation) Modeling Module

Team members: Emilie Henderson (INR) team lead, Simon Bisrat (INR), Theresa Burcsu (INR), Megan Creutzburg (INR), Treg Christopher (INR), and Rich Gwozdz (INR).

The modeling team built on and consolidated existing state and transition models (STMs) from the Interagency Mapping and Assessment Project (IMAP), USDA Forest Service Region 3 (R3) forest planning work, and LANDFIRE efforts, among others. The modeling team produced consistent mid-scale models for all major forest, woodland, grasslands, shrublands, and other major vegetated environments for each of the modeling regions within the 4-state project area. Models were designed to run on strata of watersheds (Huc5) and classes of land ownership/land allocation.

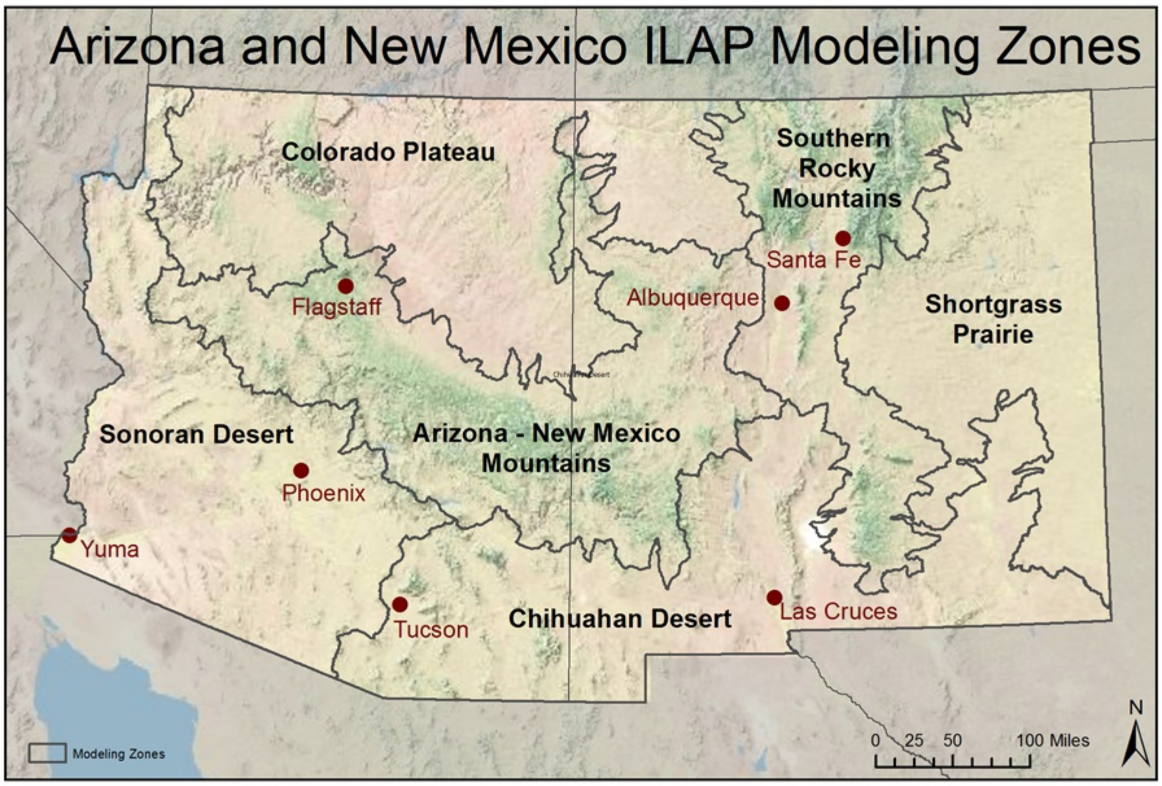


Figure 2. ILAP Southwest STM modeling regions

Figure 3. ILAP Northwest STM modeling regions

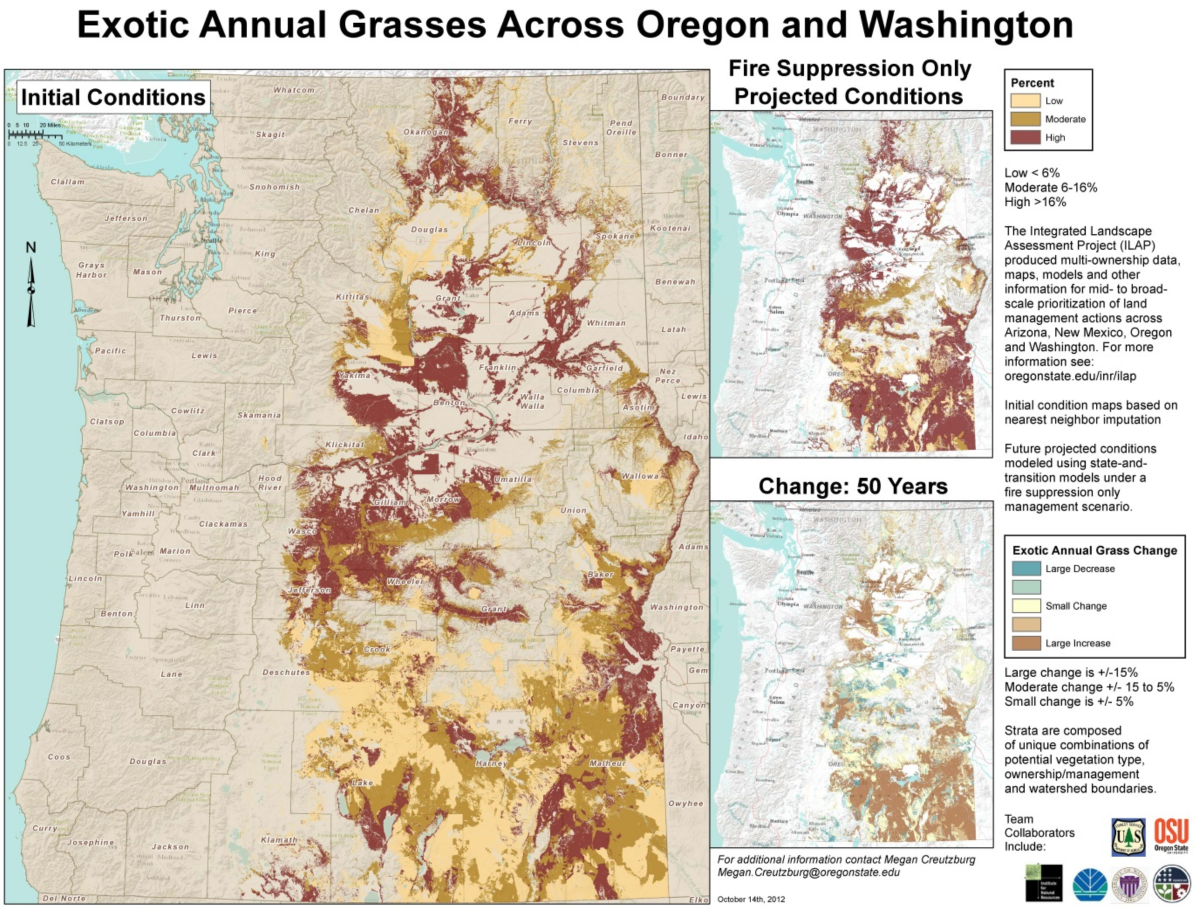


Figure 4. Example of ILAP STM arid land output maps for Northwest region

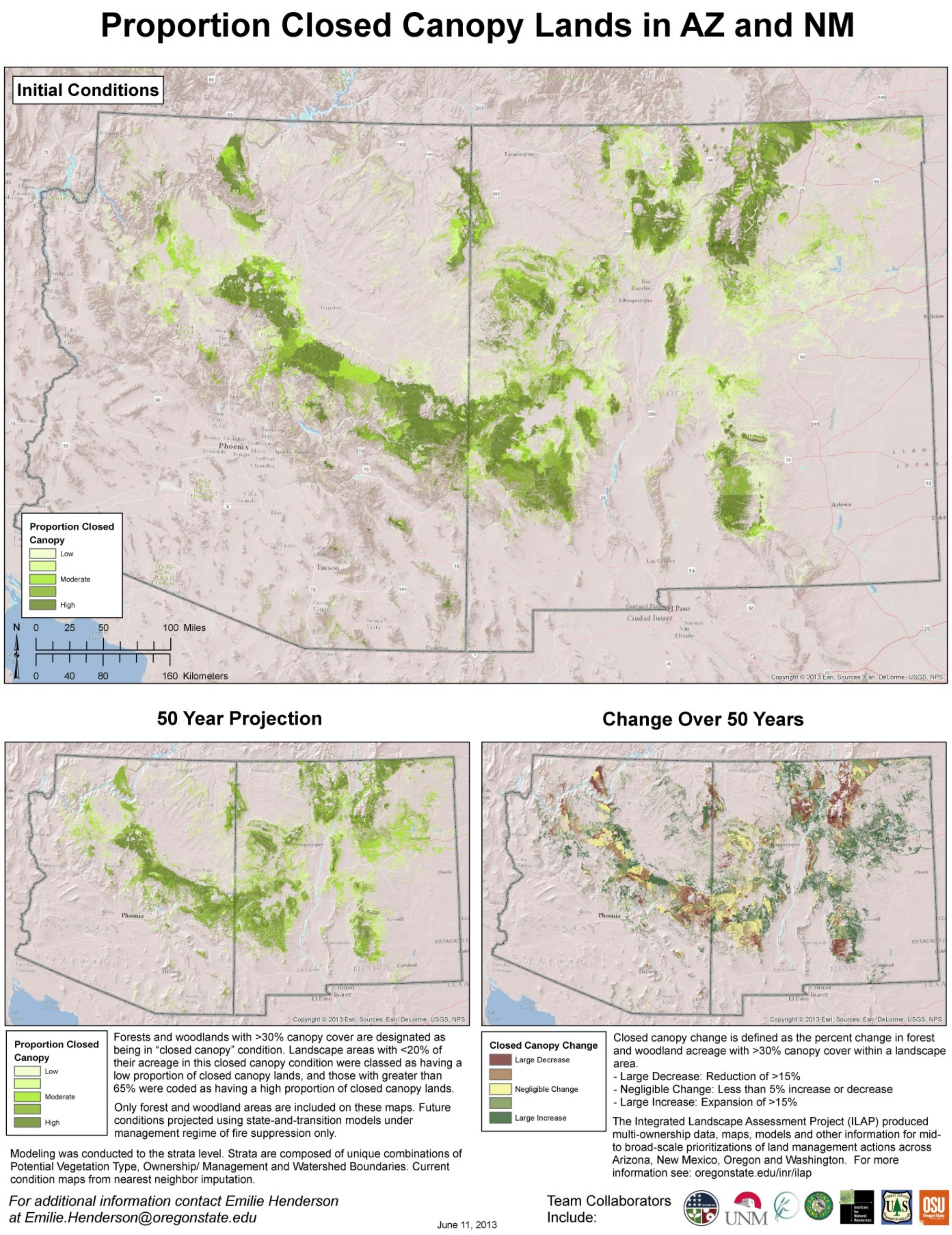


Figure 5. Example of ILAP STM forest and woodland output maps for Southwest region

Knowledge Discovery Modules

The Knowledge Discovery teams were established to develop new knowledge and methodologies to inform watershed-level prioritization of fuel and other management treatments in Arizona, New Mexico, Oregon and Washington. The Knowledge Discovery modules include: fire and fuel characterization, wildlife habitats, fuel treatment economics, community economics, climate change (three teams addressed landscape-level changes in fire probabilities, water supply, and watershed conditions), and decision support (one team applied EMDS—Ecosystem Management Decision Support and another team applied an optimized decision support system (ODSS) to an ILAP focus area). The Knowledge Discovery modules developed linkages to the outputs from the Science Delivery modules to support integrated landscape assessments that inform broad-scale prioritizations of fuel and other management treatments for use by planners, land managers, and policy-makers. The table below indicates the extent of the data for the 4-state project area that was developed for each of the ILAP modules.

Table 2. Extent of data developed for each of the ILAP knowledge discovery modules

*ILAP Module**	*Oregon*	*Washington*	*Arizona*	*New Mexico*
Fire & fuel characterizations	●	●	●	●
Wildlife habitat	●	●	●	●
Fuel treatment economics	●	●		
Community economics	●	●	●	●
Climate change-vegetation	●	●	●	●
Climate change-watershed	○	○		
Climate Change – fire probabilities	○			
Decision Support - EMDS	●	●		
Decision Support - ODSS	○			

**solid dot indicates full coverage and an open dot indicates partial coverage*

Only a few of the modules developed the data and models to evaluate all lands (forest, woodlands, and arid lands). The table below indicates the extent of the data for the different land cover types by region, where northwest includes OR and WA and the southwest includes AZ and NM.

Table 3. Extent of data for the different land cover types by region

*ILAP Module**	*NW forest & woodlands*	*NW arid lands*	*SW forest & woodlands*	*SW arid lands*
Fire & fuel characterizations	●		●	
Wildlife habitat	●	●	●	●
Fuel treatment economics	●			
Community economics	●	●	●	●
Climate change-vegetation	●	●	●	●
Climate change-watershed	○	○		
Climate Change – fire probabilities	○			
Decision Support - EMDS	●	●		
Decision Support - ODSS	●			

**solid dot indicates full coverage and an open dot indicates partial coverage*

Fire and Fuel Characterization Module

Team members: Jessica Halofsky (UW) team lead, Stephanie Hart (UW), Morris Johnson (USFS), Joshua Halofsky (WDNR), Miles Hemstrom (USFS-PNW/INR).

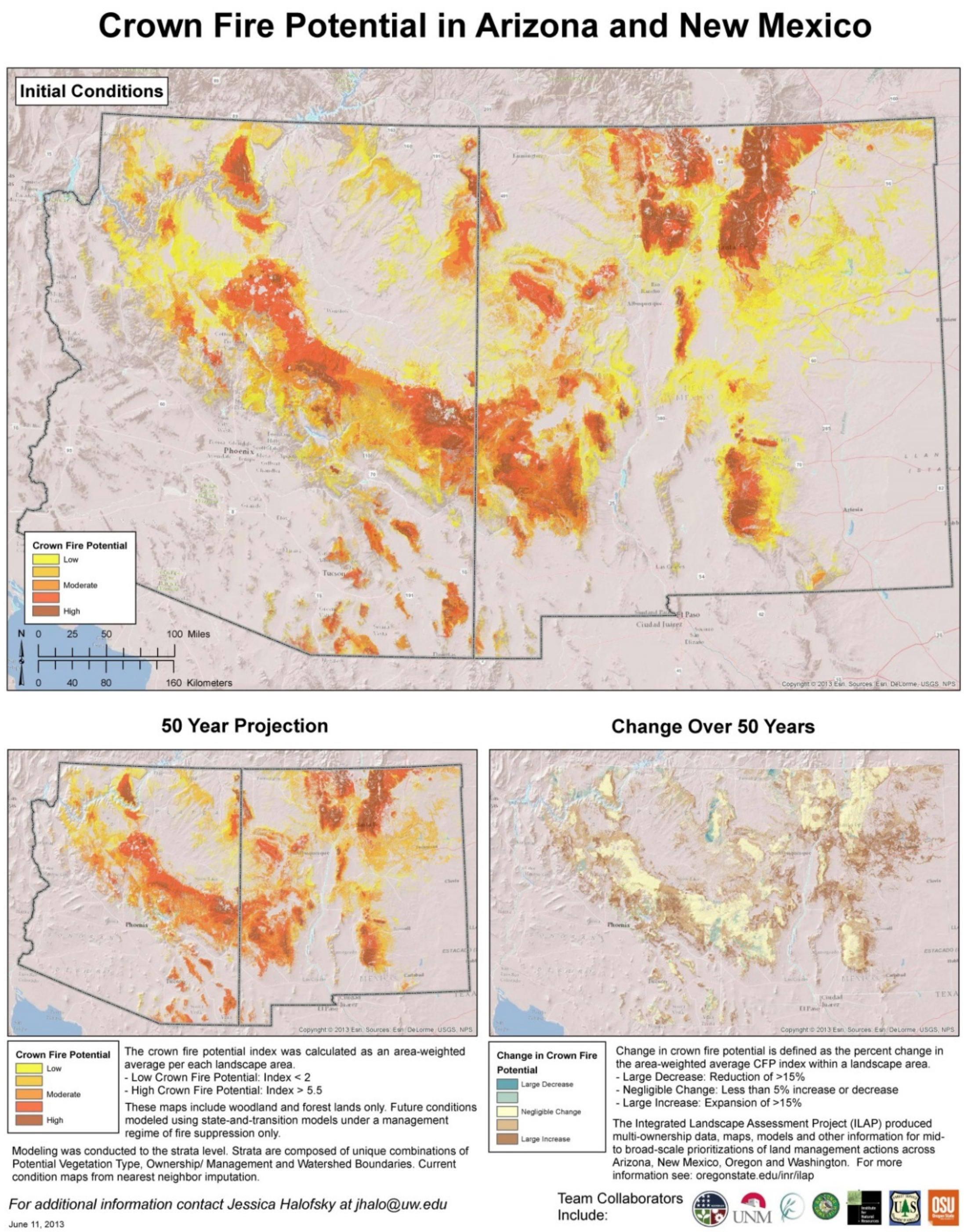


Figure 6. Example of ILAP fire and fuel characterization output map for Southwest region

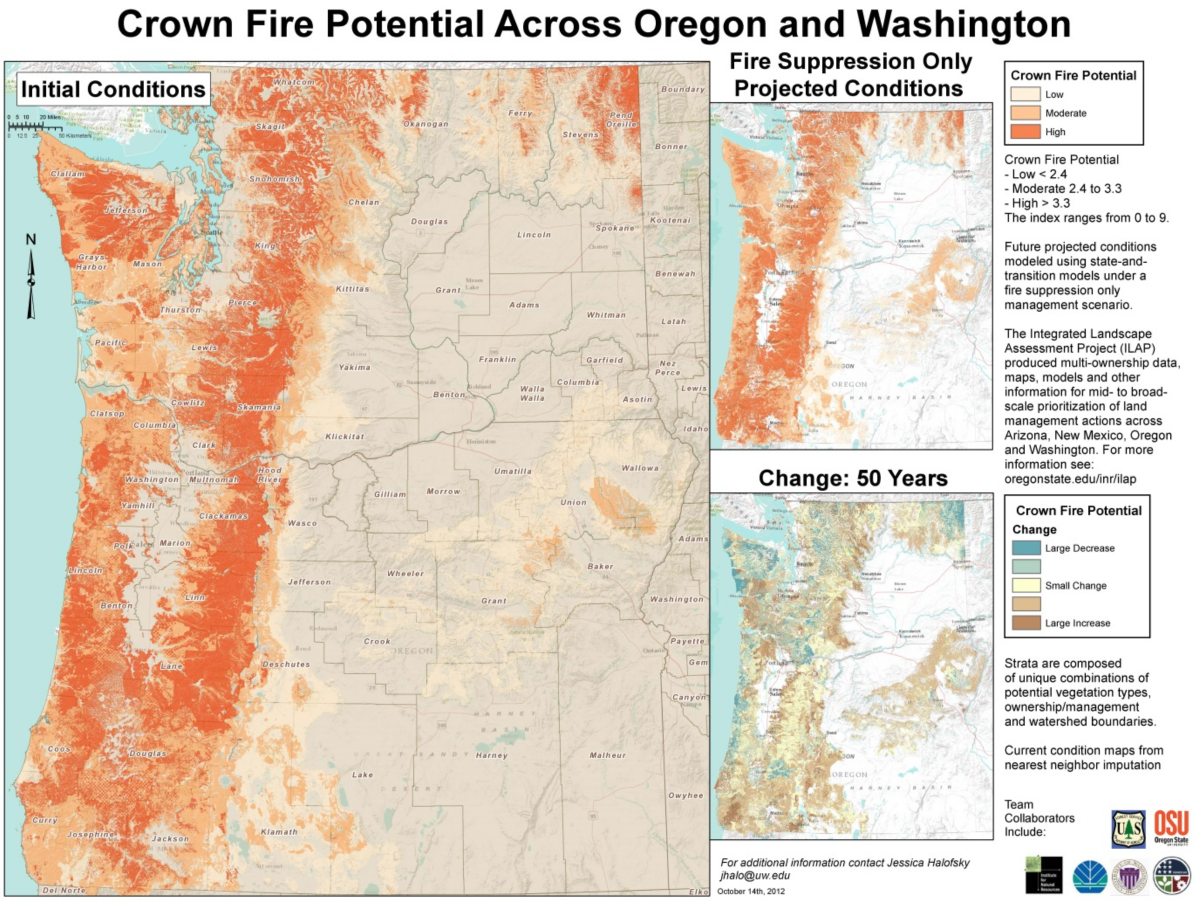


Figure 7. Example of ILAP fire and fuel characterization output map for Northwest region

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 (FCCS) from inventory plots for each vegetation state class in the STMs. More than 14,000 fuelbed plots were analyzed for their fire potential and linked to STM outputs, allowing clients and users to assess current conditions and trends in fuels and potential fire behavior over time under different management scenarios. Prior to ILAP, the STMs did not directly assess fire hazard for different vegetation states. The specific methods for developing the STM-FCCS relationships are documented in Halofsky, et al., 201x (Chapter 3).

Assumptions made for the fuel characterization analysis:

- FIA and CVS inventory plots represent the range of forested conditions found in Arizona, New Mexico, Oregon and Washington.
- Inventory plot information can be used to adequately characterize fuel conditions.
- The plots selected for each state and transition model state class are representative of that state class.

- State classes are unique in terms of fuel properties.
- FCCS gives accurate information on the fire potentials of fuelbeds.
    - o The default weather and topographical variables used to analyze fire potentials are representative of the conditions that would occur in our study area in the future.

Wildlife Habitats Module

Team members: Anita T. Morzillo (OSU) team lead
Oregon and Washington: Blair Csuti (INR), Pamela Comeleo and Michael Calkins (OSU)
Arizona and New Mexico: Stephanie Lee, Kurt Menke, Bill Dunn, Bruce Higgins, and Nancy Nicolai (EMI)

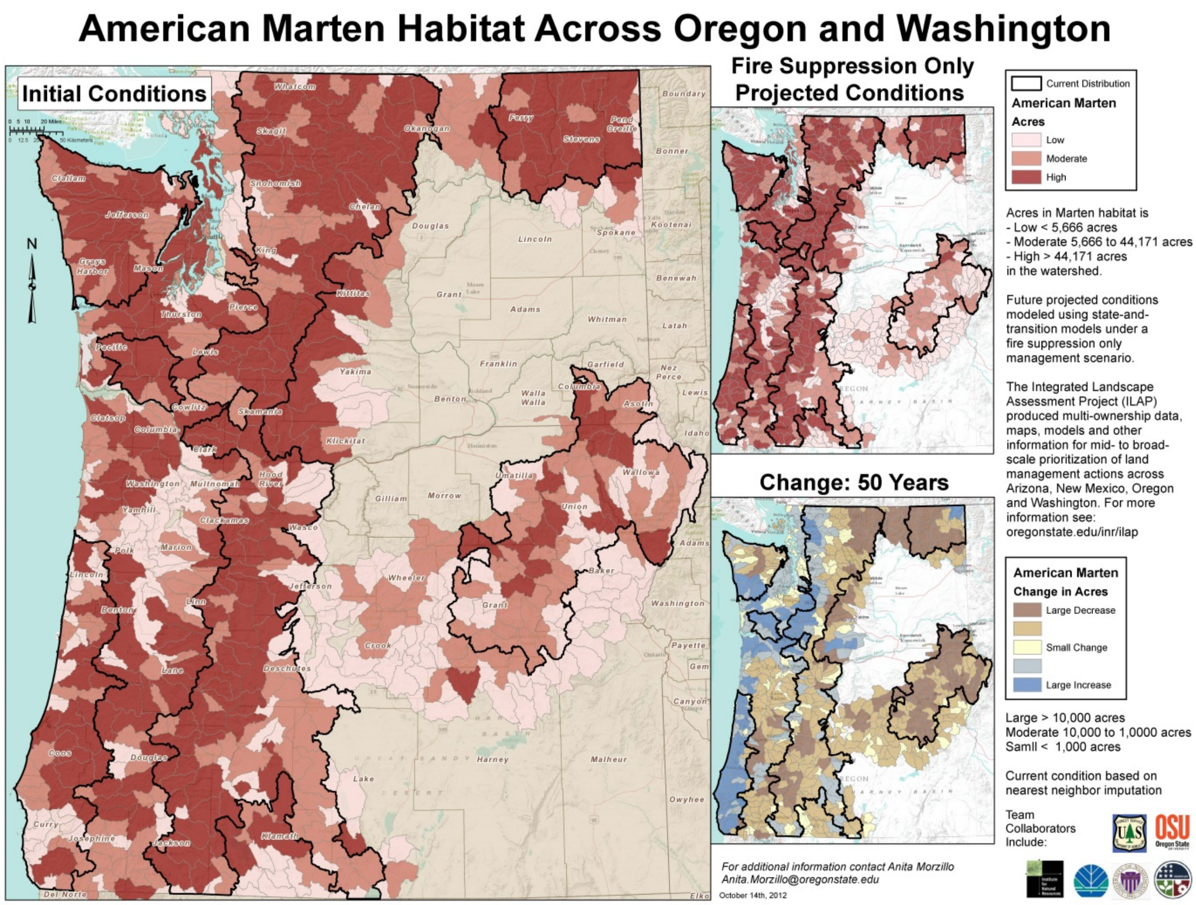


Figure 8. Example of ILAP wildlife habitat output map for Northwest region

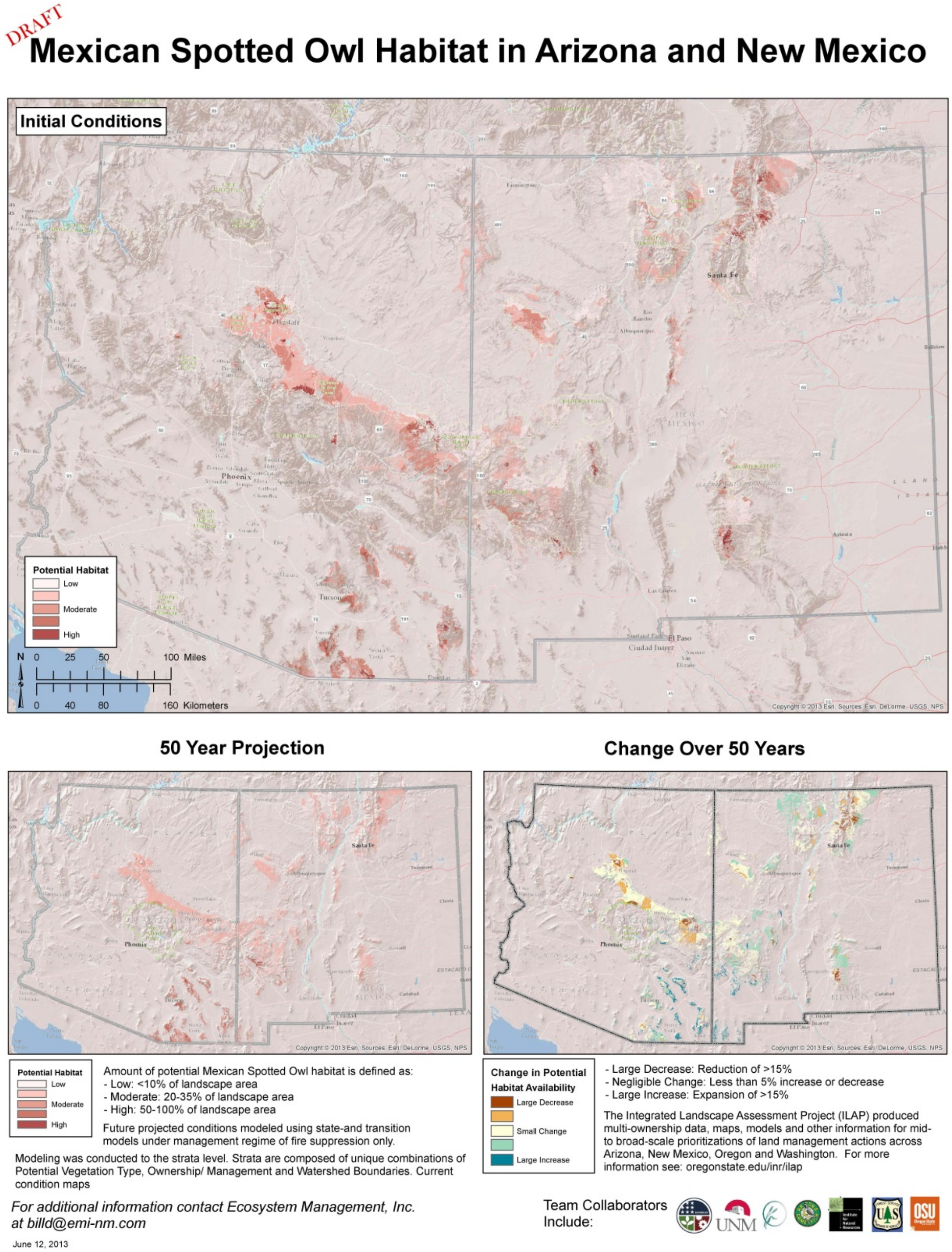


Figure 9. Example of ILAP wildlife habitat output map for Southwest region

The wildlife habitat module developed species-habitat relationships for 24 species in Oregon and Washington and 39 species in Arizona and New Mexico, linking habitat and non-habitat classifications to STM state classes in forest, woodland, shrubland, grassland, and desert models.

Table 4: List of the wildlife species evaluated for Oregon and Washington

American marten	Lark Sparrow	Pygmy rabbit
Ash-throated flycatcher	Lewis's woodpecker	Red tree vole
Black-backed woodpecker	Loggerhead shrike	Sharp-shinned hawk
Cassin's finch	Northern goshawk	Snowshoe hare
Fisher	Northern harrier	Swainson's hawk
Flammulated owl	Northern spotted owl	Western bluebird
Gray wolf	Olive-sided flycatcher	Western gray squirrel
Greater sage-grouse	Pileated woodpecker	White-headed woodpecker

Table 5: List of wildlife species evaluated for Arizona and New Mexico

Aplomado Falcon	Gray Vireo*	Texas horned lizard
Arizona Black-Tailed Prairie Dog	Grey-Checkered Whiptail*	Tucson Shovel-Nosed Snake
Baird's Sparrow	Guadalupe southern pocket gopher	White Sands woodrat*
Burrowing Owl	Gunnison's prairie dog	White-Sided Jack Rabbit*
Canyon spotted whiptail	Lesser Prairie-Chicken*	Yellow-nosed cotton rat*
Chuck walla	Loggerhead Shrike	Zone-tailed Hawk*
Desert bighorn sheep*	Merriam's shrew	Gray Footed Chipmunk
Desert pocket gopher	Mountain Plover*	Jemez Mountains Salamander
Desert tortoise	Northern Sagebrush Lizard*	Mearn's southern pocket gopher
Ferruginous Hawk	Plains harvest mouse	Mexican Spotted Owl*
Franklin banded gila monster	Rosy boa	Northern Goshawk*
Giant spotted whiptail*	Sand dune lizard	Organ Mountains chipmunk
Grasshopper Sparrow	Swainson's Hawk	Sagebrush Lizard

**List of species for the methods section of the GTR.*

OSU College of Forestry worked on the specific wildlife species habitat relationships for the northwest, while Ecosystem Management, Inc. worked on the wildlife species-habitat relationships for the southwest. Each of the wildlife species were associated with vegetation state-classes that were mapped and modeled by the ILAP science delivery teams. With this information, the ILAP models can produce estimates of the current and potential future habitat area for selected species across the four-state area. However, the species-habitat relationships still need to be validated for the southwest, before using for mid- to broad-scale assessments of management and other effects on potential wildlife habitat. The specific methods for developing the wildlife species-habitat relationships are documented in Halofsky, et al., 2013 (Chapter 5). Each of the wildlife species were associated with a specific potential vegetation state-classes that were mapped and modeled by the ILAP science delivery teams.

Assumptions and considerations

In order to link wildlife habitat characteristics to state-and-transition model output, some simple assumptions were made. These assumptions include (but are not limited to):

- State class characteristics used to construct state-and-transition models must be able to represent particular wildlife habitat characteristics for selected focal species across Oregon, Washington, Arizona, and New Mexico. With this assumption, variables for analysis were limited to state class variables derived from state-and-transition model output.
- Because of the structure of state class variables, many fine-scale habitat features (e.g., snags, proximity to water, feature juxtaposition) cannot be evaluated at the 5th-field watershed scale.

Important points to consider about interpretation of the wildlife habitat results:

- Habitat is the unit of observation. Habitat is the potential for necessary resources to exist for a species based on a linkage between state class variables and habitat characteristics. Habitat is not equal to occurrence and does not ensure occurrence of a species in any given location.
- Information at the 5th-field watershed scale does not account for distribution of habitat. This information is limited to habitat within each watershed as an aggregated amount.
- Interpretation of results is limited to variables that were measured by state-and-transition models. Therefore, many fine-scale attributes important to wildlife cannot be used to interpret these data.
- Confidence in habitat assessments varies greatly. Risk of error as a result of habitat distribution effects varies based on the proportion of watershed that is classified as habitat, uncertainty with distribution of habitat within the watershed (because aggregated to 5th-field scale), and the life history (e.g., home range) of a particular species.
- The quality control steps for the southwest species were not performed due to lack of time and resources.

Fuel Treatment Economics Module

Team members: Xiaoping Zhou (USFS-PNW) team lead, Miles Hemstrom (USFS-PNW/INR), Joe Bernert (INR).

The fuel treatment economics module estimated potential supply of timber and woody biomass by product classes and tree species groups. Above-ground forest carbon storage was also estimated by STM state class and potential vegetation type for all forests and woodlands in Oregon and Washington. STM simulation outputs of the removed products were used from proposed treatments over the simulation period to perform cost-benefit analyses. 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. The specific methods used by the Fuel Treatment Economic Module are described in Halofsky, et al., 2013 (Chapter 4).

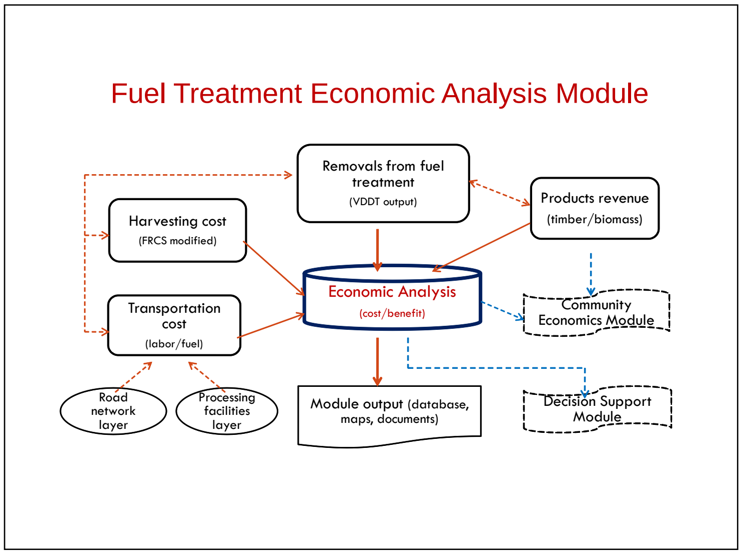


Figure 10. Workflow for ILAP Fuel Treatment Economics module

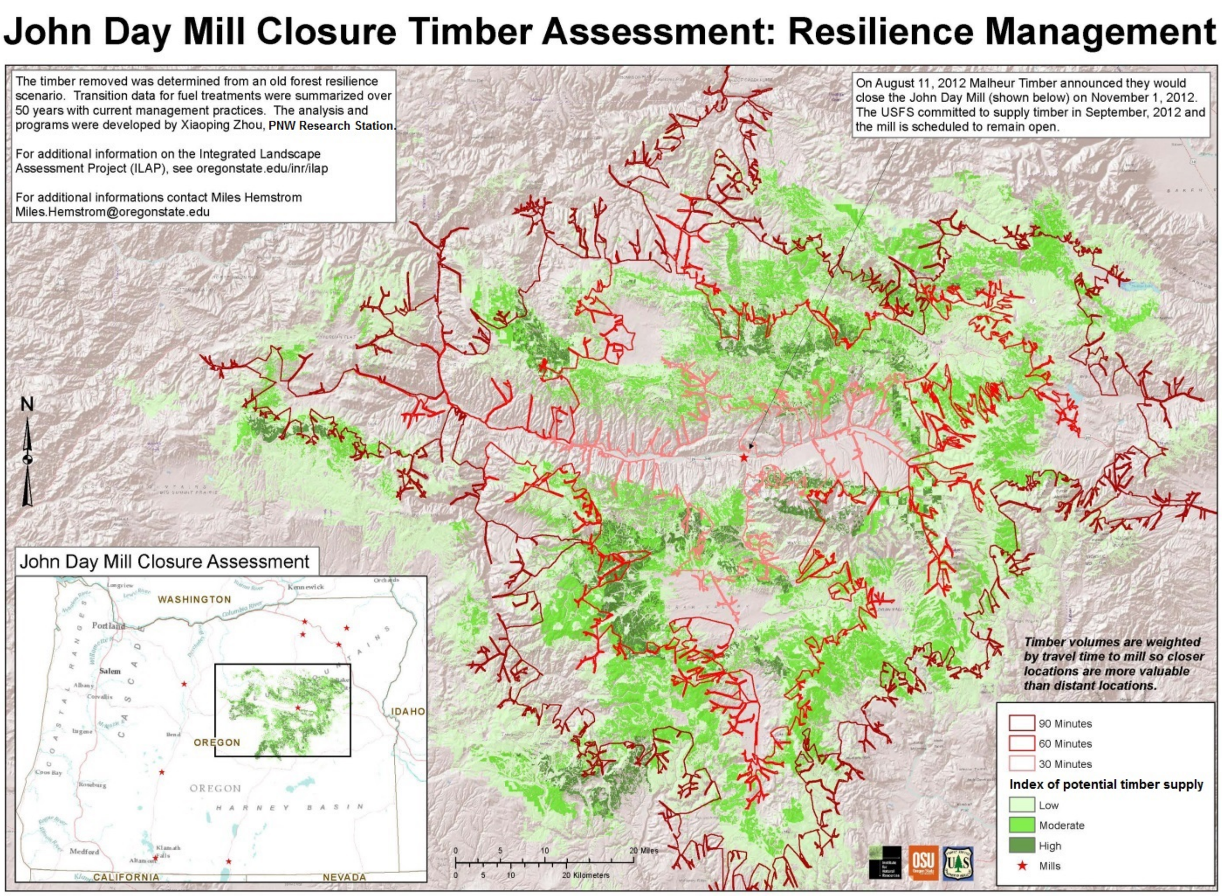


Figure 11. Example of ILAP fuel treatment economic output map for John Day area within Oregon

Community Economics Module

Team members: Claire Montgomery (OSU) team lead, Mindy Crandall and Jane Harrison (OSU)

The community economics module addressed the question of whether large-scale forest vegetation treatment programs can target stimulus to economic activity and contribute to well-being in communities that have been negatively impacted by recent federal forest policy changes. The team produced community impact scores for each 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. The goal was to provide information that enables managers to consider the current and historical state of communities in the 4-state area that may be affected by increased forest restoration activity.

The community impact score for a watershed will be larger for watersheds that need restoration treatment and for which the volume of woody material generated by those treatments is relatively large. It will also be larger if the watershed is near communities (so that distance measure is small) which have attributes indicating that they are in distress, have the potential capacity to use the woody material supplied to them in economic activities, and have been impacted by recent federal forest policy changes.

The attributes of each community are represented by three indexes that indicate a community's level of socioeconomic distress, business capacity, and federal forest policy impact. Preliminary Community Impact Scores for forested watersheds in Oregon and Washington that reflect the proximity of a watershed to communities in socioeconomic distress, communities with business capacity, and communities that have been impacted by federal forest policy are shown in Figure 1. These do not include the indexes of biomass supply potential that are currently under construction and, hence, do not yet indicate the potential of forest restoration activity in a watershed to impact community economies.

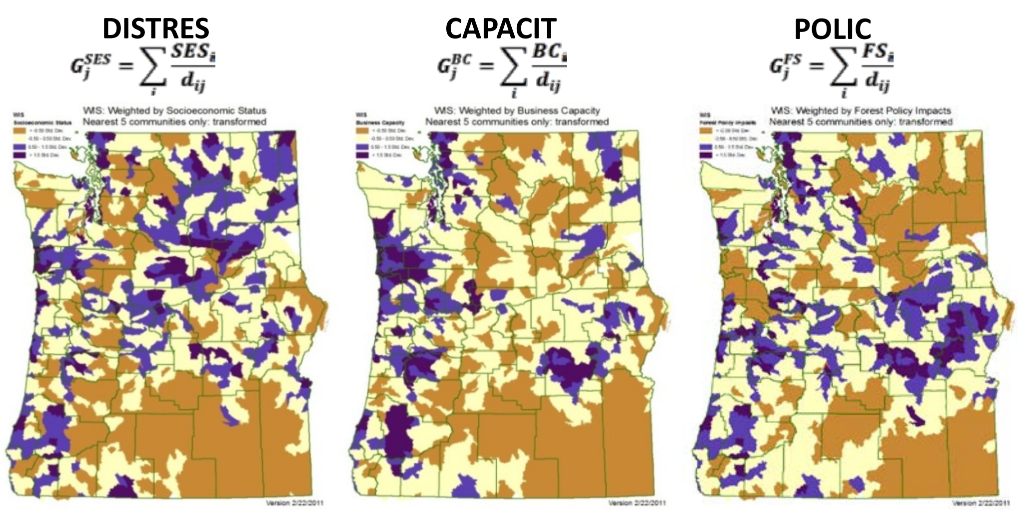


Figure 12. Examples of ILAP community economic outputs maps showing preliminary estimates of indexes that indicate proximity of each watershed to communities that (i) are in socioeconomic distress, (ii) have capacity to utilize woody biomass should it be supplied, and (iii) have been impacted by recent changes in federal forest policy. Dark purple indicates a relatively high index value.

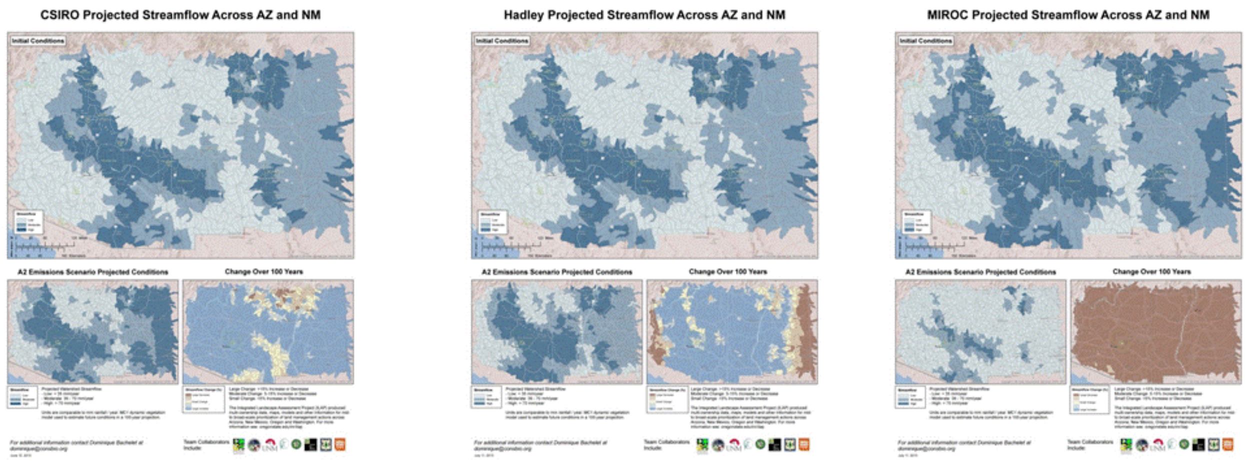
The specific methods for developing the community impact scores are documented in Halofsky, et al., 2013 (Chapter 6).

Climate Change and Vegetation Module

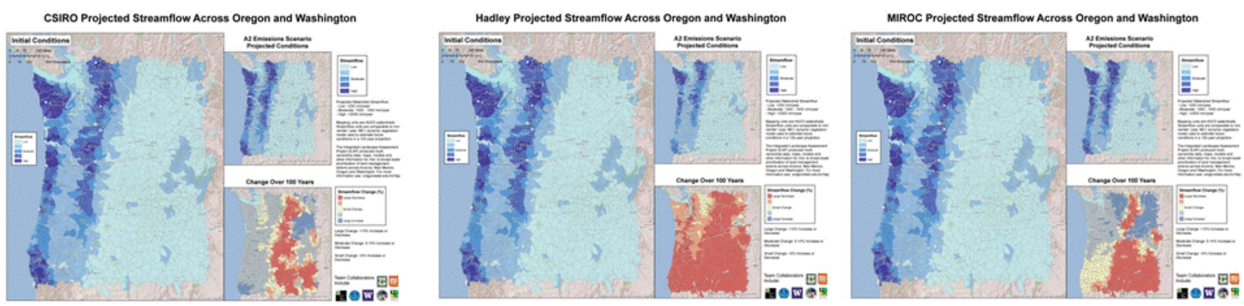
Team members: Dominique Bachelet (Conservation Biology Institute) lead investigator, and David Conklin (Common Futures), Jessica Halofsky (UW), Josh Halofsky (WA DNR), and Miles Hemstrom (USFS-PNW/INR).

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 study areas: central Oregon and the Apache-Sitgreaves area in eastern Arizona. 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 trade-offs associated with alternative management approaches under a changing climate. Analyses were conducted for three climate change scenarios (MIROC, CSIRO and Hadley) that bracket the range of projected climatic changes for the study areas. The specific methods for developing the “climate-informed” STMs are documented in Halofsky, et al., 2013 (Chapter 7).

In addition to the coupled model approach for the two study areas, the climate change and vegetation module team ran coarser-scale (4-km grid) simulations for the same three future climate scenarios 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 GIS plug-in that allows users to extract climatic, hydrologic, vegetation, and other data from these MC1 outputs.



Examples of ILAP Climate Change MC1 output maps for Southwest region



Examples of ILAP Climate Change MC1 output maps for Northwest region

Figure 13. Examples of climate change MC1 output maps for the Southwest and Northwest regions

Other ILAP-related climate modules

Climate Change and Watershed Module

Team members: Gordie Reeves (USFS-PNW) team lead, and Lee Benda (Earth Systems Institute)

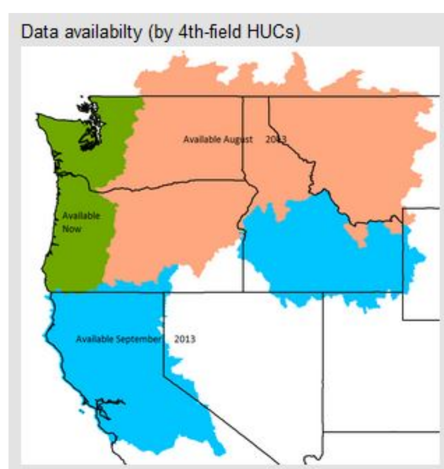


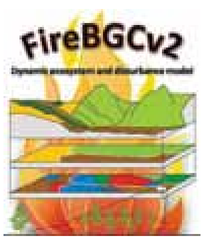
Figure 14. Data availability by 4th-field HUCs

In the *Climate Change and Watershed* module Investigator Gordie Reeves used Recovery Act funding to extend the geographic extent of NetMap – a system of watershed science analytical tools, digital maps, and databases developed by the Earth Systems Institute (www.netmaptools.org). NetMap is used to project the probable consequences of climate change to a variety of watershed and fish habitat attributes, at a finer scale than is typical for climate change models. The products of this module enable the predicting and mapping of such attributes as increased winter flooding, decreased summer flows, problematic stream temperatures in areas of high intrinsic potential for salmonid habitat, and areas of increased risk of post-fire erosion and sedimentation. For ILAP applications, the watershed and climate change analyses are limited to Northwest landscapes and watersheds containing federal lands.

Fire Probabilities and Climate Change module

Team members: Rebecca Kennedy (USFS-PNW) and Heather Greaves (OSU)

The goal of this module was to provide information about potential interactions between wildfire and dry forest vegetation dynamics in the future as the climate changes. This work helps to inform the ILAP state and transition models, by characterizing how vegetation may change in response to climate change, and also to fire as fire regimes are altered by climate change. Heather Greaves' Master's thesis work expanded on the ILAP goals by exploring how potential shifts in vegetation dynamics under future climate scenarios might change the spatial configuration of forest types and age classes using FireBGCv2 – a spatially explicit model. One important feature of FireBGCv2 is that the stand boundaries are not fixed on the landscape. As climate change and fire and management act over time, the stand boundaries can shift to reflect the new arrangement of cover types and ages on the landscape. The fire probabilities and climate change analyses were limited to a small study area (73,000 hectares) within the Deschutes National Forest and Deschutes river basin.



Decision Support Modules

Western Landscapes Explorer

Team members: Myrica McCune (INR) team lead, Theresa Burcsu (INR), Lisa Gaines (INR), Sean Gordon (OSU), Jimmy Kagan (INR), Marc Rempel (OSULP), Janine Salwasser (INR), Jack Triepke (USFS), Reuben Weisz (USFS), Kuuipo Walsh (INR), Michael Wing (OSU).

The Western Landscapes Explorer (www.westernlandscapesexplorer.info) provides public access to ILAP data, models and tools, as well as other landscape-level information. The long-term goal is to develop, maintain, and provide useful landscape-level data and tools that inform restoration decision-making across all Western States. The Institute for Natural Resources and OSU Libraries and Press (OSULP) are partners in this module.

Figure 15. Western Landscapes Explorer

The **Western Landscapes Map Viewer** is a visualization tool on the Western Landscapes Explorer that can be used to look at the ILAP vegetation summaries, ownership and potential vegetation types for these four western states. As the ILAP knowledge discovery data outputs are made available by the module team leads, they will also be uploaded to the Western Landscapes Map Viewer.

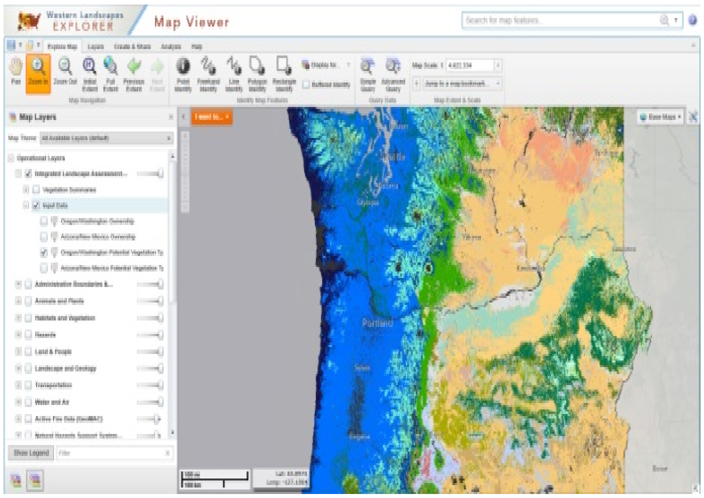


Figure 16. Western Landscapes Map Viewer

Ecosystem Management Decision Support (EMDS)

Team member: Sean Gordon (OSU)

The EMDS tool (www.redlands.edu/emds/) for ILAP integrates the separate factors of fuels, wildlife habitat, and economic returns into a combined, flexible assessment and prioritization process. This system should help managers and others explore and set priorities using color-coded maps, tables and reports based on different combinations of characteristics that best reflect their values. Depending on the tools employed, users can model the consequences of different land management or restoration strategies under different sets of assumptions, or they may search for the “optimal” solution given criteria of varying weights. In some cases the tools are spatially explicit, so users can create maps and analyze how networks or processes work in real landscapes. In other cases, users may want to analyze which of a set of factors contribute the most to a predicted outcome, or how sensitive various factors are relative to each other.

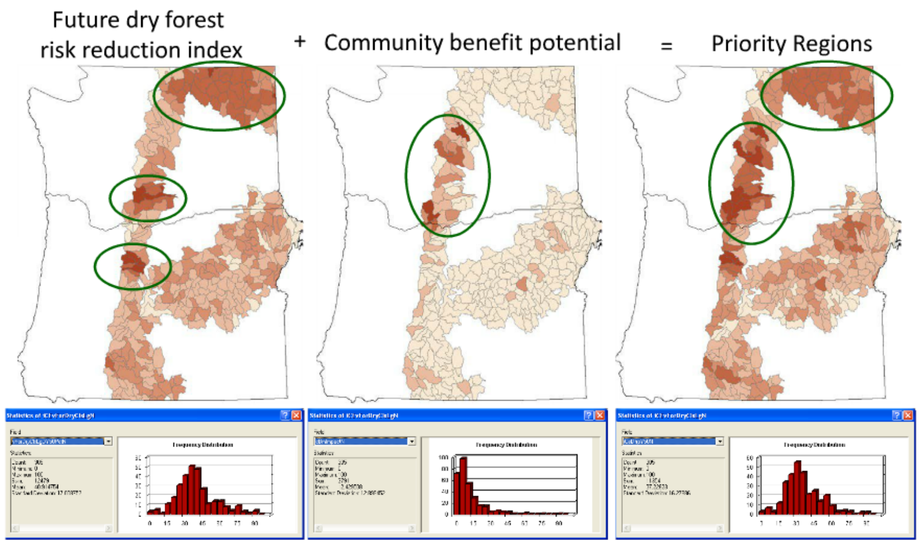


Figure 17. Example of EMDS outputs for eastside focus area in Oregon and Washington

Optimized Decision Support System

Team members: Michael Wing (OSU) team lead, Kevin Brown (OSU), Justin Long (OSU), Rene Zamora (OSU).

The *Optimized Decision Support System* team developed a defensible method that integrates landscape, wildlife habitat, and economic conditions into a spatially-based analytical process. The ODSS prototype involved an optimization of processing and transportation of forest biomass while preserving American Martin habitat.

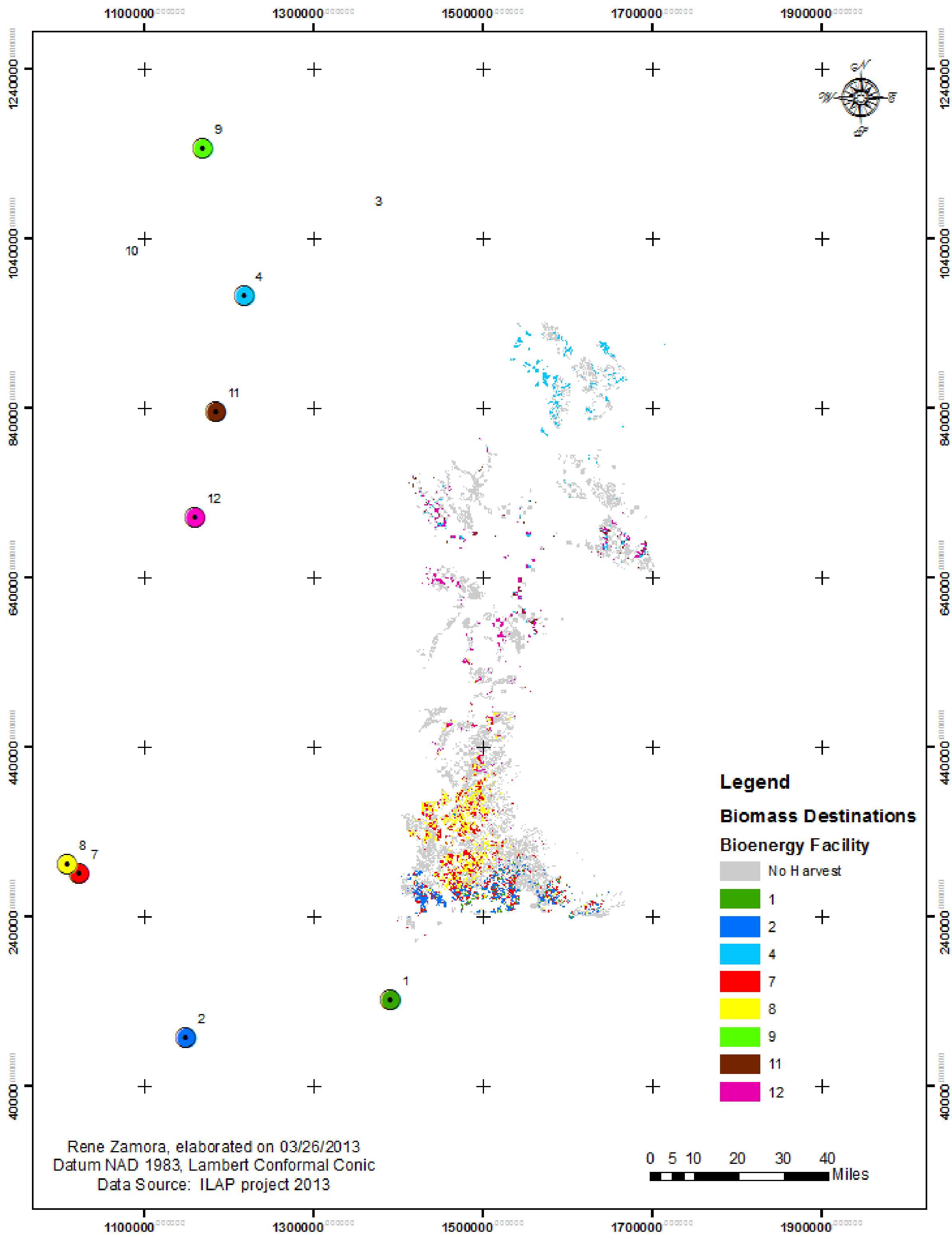


Figure 18. Example of ODSS output - Areas for biomass harvesting at a biomass delivery price of $100/BDMt

Outreach

Team members: Janine Salwasser (INR) team lead, Jamie Barbour (USFS-PNW), Paul Doescher (OSU), Lisa Gaines (INR), Sean Gordon (OSU), Miles Hemstrom (USFS-PNW/INR), Jimmy Kagan (INR), Steve Tesch (OSU), Jack Triepke (USFS), Rachel White (USFS-PNW).

The ILAP outreach goal was to expand the partnerships and conduct activities to improve awareness and use of ILAP information by regional decision makers, land managers, planners, analysts, local collaborative groups, and others. The principles that guided the ILAP outreach were to actively seek participation and input, focus on end-users at different scales, provide multiple ways in which people can engage, incorporate existing advisory groups and organizations, be willing to adapt, acknowledge team contributions, and always consider "all lands". The ILAP oversight team provided guidance to the ILAP project coordinator on the strategy and implementation of ILAP outreach throughout the project. See Appendix A for ILAP outreach strategy.

The ILAP outreach was conducted in four sequential phases: 1) promote project awareness; 2) solicit input; 3) promote partnerships and use; and 4) provide trainings and technology transfer.

In the first phase of promoting project awareness, a variety of outreach materials were produced. These included the ILAP website (www.oregonstate.edu/inr/ilap), fact sheets, monthly webinars that featured each of the modules; an ILAP booklet for the Northwest; and development of project posters, exhibits, and articles that were presented at key conferences and meetings. Briefings were also given regularly to public agencies in Oregon, Washington, Arizona, and New Mexico. A spreadsheet of ILAP contacts was developed and maintained throughout the project. Through the ILAP outreach, more than 220 individuals were made aware of ILAP and associated products. Nearly 75% of the people contacted represented public agencies.

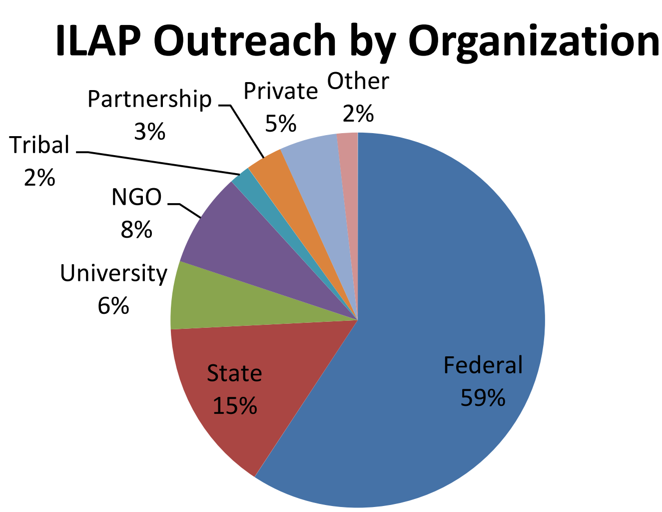


Figure 19. ILAP outreach by organization

In the second outreach phase, input on the ILAP approach and expected products was solicited through annual and semi-annual meetings with the ILAP advisory groups in the Northwest (IMAP User Group), Southwest (Arizona and New Mexico), Southwest stakeholder groups in Phoenix, Tucson, and Albuquerque, including the Sky Islands – ILAP collaboration group, and the Tapash Sustainable Forest Collaborative in Washington. An effort was made to balance the ILAP outreach throughout the four project area states (Oregon, Washington, Arizona, and New Mexico), as well as to inform national programs of the Forest Service and other federal agencies. However, because of the limitations of travel and available resources, more face-to-face meetings and briefings were conducted in the Northwest where most project leads were based. Input received included a recommendation to change the project name (from Integrated Fuels Prioritization Project to the Integrated Landscape Assessment Project); selection of the project focus areas (Central Washington, eastside forests of Oregon and Washington, and the Sky Islands of Arizona); recruitment of stakeholders; identification of relevant management questions and scenarios; feedback on web portal (Western Landscapes Explorer) and the preferred ILAP output formats.

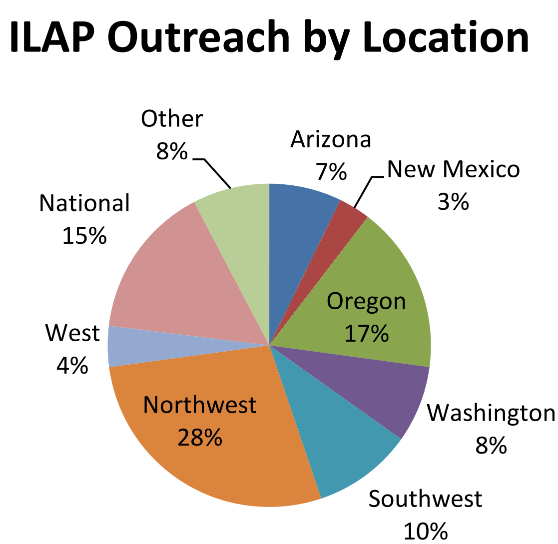


Figure 20. ILAP outreach by location

The promotion of partnerships, in the third outreach phase, focused on those organizations operating at landscape-scales across all lands. This included the newly formed Landscape Conservation Cooperatives – six of which overlapped with the ILAP project area, The Nature Conservancy, Bureau of Land Management and their Rapid Ecological Assessments, the Western Governors' Association and the Western Forestry Leadership Council. Although no formal partnerships established, ILAP data and models have been offered to all of these organizations and shared with many of them for specific landscape assessments. Specific applications of ILAP data and models were targeted to support regional landscape assessments, National Forest Plan revisions, collaborative landscape forest restoration projects, and statewide forest and resource assessments.

The fourth outreach phase, training and technology transfer, is occurring through a new ILAP funded project and a web portal. In a project funded by the Western Wildland Environmental Threat Assessment Center (WWETAC), forest planners with the Coronado National Forest will be trained by the Institute for Natural Resources in the use of the ILAP models to support the Coronado National Forest final environmental impact statement. Oregon State University also hosted a seminar series in the Fall of 2012 to share the ILAP work with the research community. The Western Landscapes Explorer (www.westernlandscapesexplorer.info) was developed to provide users with direct access to the ILAP products; specifically the GIS data, state and transition models, roll-up tools and documentation located on an ILAP ftp server.

ILAP in Use

"Success has come when people have taken pieces of what we've done and started using them." *--Jamie Barbour, ILAP Forest Service policy lead*

Even before the project was completed, ILAP models and data were being adapted for use in resource planning at local, statewide and regional scales. The ILAP outreach team actively worked with land managers, planners, analysts and collaborative groups to help inform land management decisions and policies across landscapes.

Summary of Analyses

Informing National Forest Plan revisions

Four national forests are using the models and data to explore the effects of alternative land management scenarios that will go into an Environmental Impact Statement and Record of Decision.

Analyzing regional forest conditions

Can more active management activities on public lands improve the resilience of older forests and provide sustainable levels of forest products for jobs and communities? ILAP models and data are being used to address this management question for the east-side forests in Oregon and Washington. The old forest resilience scenario moves forests to conditions less susceptible to loss from fire and insects while increasing the amount of older forest habitats. ILAP outputs inform managers on how 5th field watersheds (about 100,000 acres in size) can be prioritized for restoration across all lands.

ILAP Clients

•••

U.S. Forest Service

Pacific Northwest Research Station

Region 6 regional office

Region 3 regional office

Cibola National Forest

Colville National Forest

Coronado National Forest

Malheur National Forest

Okanogan-Wenatchee National Forest

Willamette National Forest

The Nature Conservancy

Mason, Bruce & Girard

Oregon Department of Energy

Northwest Climate Science Center

Washington Department of Natural Resources

FireScape Group

Assisting national forest watershed restoration

ILAP models and data were refined for use in a local collaborative planning effort by the Sweet Home Ranger District of the Willamette National Forest. ILAP models and data have been applied at sub-watershed scales (about 10,000 acres) to examine the potential effects of three management scenarios (fire suppression only, early seral, and sustainable harvest scenarios) in terms of future habitat conditions, forest vegetation structure and composition, and proposed management activities.

Supporting wildlife area ecological integrity monitoring

This joint project with the Washington Department of Fish and Wildlife uses ILAP vegetation data and other information to examine current and future conditions of important wildlife habitats for refuge planning and monitoring. Preliminary analyses of habitat connections and other key attributes (e.g., conditions and trends in forest species, invasive species, etc.) have been produces to assess the ecological integrity for key habitats across large areas.

Supporting forest health restoration economic assessments

Forecasting landscape-wide information on forest conditions, potential biomass and timber supply, and transportation of forest products to lumber mills and biomass plants in eastern Oregon was the focus of this project. ILAP work was part of a larger contract issued by the Oregon Department of Energy to Mason, Bruce, and Girard, Inc. to analyze the potential of national forest lands in eastern Oregon to provide additional supplies of forest products for "green" energy and to provide local economic benefits. The full report and the summary report can be accessed, respectively, at the following URLs: http://www.oregon.gov/gov/docs/OR_Forest_Restoration_Econ_Assessment_Nov_2012.pdf and http://oregonforests.org/sites/default/files/publications/pdf/NF_Restoration_Economic_Report.pdf.

Examples of Landscape Assessment Questions

• • OREGON• •

If Oregon were to double the average number of acres treated annually to benefit and restore forest ecosystem health in Oregon's dry-side national forests over the next 20 years, from an ~ 165,000 acres to 330,000 acres, then what would that cost and what would be the economic benefit?

--Federal Forestlands Advisory Committee (FFAC)

• • ARIZONA• •

What would it take in the way of fuel treatments to move toward desired or reference conditions in the Sky Islands landscape and how much will it cost?

--Sky Islands and FireScape Group

Examining forest resilience and forest products

This ILAP analysis examines the potential of a forest management scenario to improve the long-term resilience of older forests in the central Blue Mountains while also supplying biomass and timber to the existing mill in John Day, Oregon. The mill continues to be at high risk of closure. ILAP data and models have been used in conjunction with mill locations and road access to estimate long-term potential removals of timber and biomass, hauling costs, and effects on habitats and old forest conditions.

Examining climate change, land management and habitat in southwestern Oregon

Climate change and land management will interact to shape future forests. Information on the likely effects of these interactions is crucial for management planning in southwestern Oregon, where concerns about Northern Spotted Owl habitat intersect with the values and concerns that surround the local forests: their value to a natural resource economy, and risks associated with wildfires. With funding from the Northwest Climate Science Center, this analysis assesses which management approaches are most likely to meet multiple goals: increasing ecosystem resilience in the face of climate change, maintaining owl habitat, and (ideally) supporting the region's economy. This work is part of a broader study across three regions of the Pacific Northwest, which builds on the foundational work of ILAP and explores how climate change-land management interactions may shape spotted owl habitat in coastal Washington and also greater sage grouse habitat southeastern Oregon.

The Future of ILAP

Proposing a Service-centered Center for Integrated Landscape Assessments

Landscape assessments and planning efforts will increasingly look across political and ownership boundaries, requiring comprehensive, consistent data, models, and methods for “all lands”. For example, state-wide forest assessments, federal land management plan revisions, Landscape Conservation Cooperatives, Collaborative Forest Landscape Restoration efforts, BLM Ecoregional Assessments, and local collaborative efforts include hundreds of thousands to millions of acres and examine the contribution of all ownerships to landscape conditions. Most of these require an understanding of how alternative management approaches might interact with natural disturbances and climate change effects for landscape restoration.

In addition, landscape science continues to evolve. Important, on-going work includes: cross-scale interactions (e.g. connecting project planning to mid-scale assessments/plans), methods to construct continuous landscape condition and change data, efficient and effective software tools for multi-scale modeling, and integration of many disciplinary areas into one landscape assessment process. New methods need to be included to stay current with the science and create defensible landscape assessments and planning efforts.

While the needs for comprehensive landscape planning and analysis continue to grow, within-organization skills for acquiring data, building models, and running analyses are dropping as budgets decline. State and federal agencies find themselves working across larger landscapes and including all ownerships while staffing and expertise become thinly spread. There are increasing numbers of overlapping and inconsistent landscape assessments, making it difficult for decision makers, land managers, and policy analysts to understand overall priorities and effects.

We propose a ***Center for Integrated Landscape Assessments*** that is jointly directed and funded to address these issues.

We envision a client-driven center that will generate, maintain, and update a base set of GIS layers and models which will be consistent across ownerships. Complement the existing regional and centers and institutes already in place in the West, the Center would provide the data, methods, and support for government and non-government entities that need to conduct landscape assessments at across large landscapes. The Center would ensure the methods and data used are scientifically defensible and that assessment methods reflect current science. In addition, the Center would provide cost-efficiencies by pooling scarce resources and talents for use by organizations that do or need landscape assessments.

Goals and Objectives

The goal of the Center is to provide support, methods, and information for useful and defensible integrated landscape assessments to clients in a timely manner.

1) **Develop, document, maintain, and serve base data** that support cross-ownership and cross-jurisdiction landscape assessments and analyses.
2) **Develop, document, maintain, and serve models** that can be used to project future vegetation conditions given natural disturbances, management activities, and climate change. Models would include those designed for large areas and a connection to those designed for stands, projects, and similar fine-scale analyses. Methods and models will change over time, but careful succession planning will allow users to make relatively painless transitions to newer methods.
3) **Connect to state-of-the-art landscape science** to meet emerging practical needs. Many other organizations do basic research into landscape science. The center would focus on integrating new landscape science into assessments to directly support needs identified by users or short-comings in existing techniques.
4) **Client outreach** will be necessary to ensure the Center understands evolving client needs and to make certain the data and assessments are truly useful. Too often, products are generated which claim to be helpful but that are of marginal use because they are not tailored to meet client needs and capabilities. The Center's organizational structure and close work with clients on specific projects will help the Center meet client needs.
5) **Provide cost efficiency** by pooling scarce resources and talents. Organizations that need or do landscape assessments may not have the data, skills, and methods that are needed for landscape assessments. Budget and skills limitations often make it difficult for all the organizations that do landscape assessments to maintain the necessary data, models, and skill pools.

Scope and Scale

The geographic focus would be within Oregon, Washington, northern California and western Idaho, and to the degree possible British Columbia and western Alberta.

Products and Services

Develop, document, maintain, and serve base data
Well-documented base data will be available through an easily accessible web portal or similar source. The data will be consistent across all lands of participating clients and/or states. Data will include at least:

1) *Existing vegetation cover and structure* represents existing vegetation and cover information across all participating states. Existing vegetation data will be updated for major disturbances every year through a change detection process. The layer will also be remapped every 5 years using to incorporate changes in vegetation from management as well as urban growth.
2) *Potential vegetation* depicts the variety of environmental conditions that control long-term vegetation conditions.
3) *Topography, soils, hydrography, roads, and other base data* that are used in understanding ecological processes, human uses, and their interactions for use in assessments.

4) *Ownership and management* that determine the range of management objectives and acceptable human activities.
5) *Plot data* will include an on-going compilation of vegetation plots as they are established and data become available. Plot information would include geographic location and field sampled attributes. Memoranda of Understanding and other agreements will protect data according to requirements from contributors.

Develop, document, maintain, and serve models

The models that integrate vegetation growth, management, activities, natural disturbances, climate change, and other variables in a single modeling environment will form the backbone for landscape analyses.

1) Broad-scale models – State and transition models will be the backbone of landscape assessments at mid-to broad-scales, at least initially. Improvements to modeling strategies are likely as research and development produce new methods. In the near future, state and transition models are likely to become closely integrated with stand models such as the Forest Vegetation Simulator (FVS). In addition, our understanding of disturbance regimes will likely evolve as new data become available (e.g. www.mtbs.gov). The center will develop, maintain, and update the models to ensure they continue to reflect current science.
2) Stand-scale models – The center will incorporate methods to connect mid-to broad-scale analyses (e.g. using state and transition models) to finer-scale examinations that require patch-scale attributes, including: wildlife habitat, treatment locations, and detailed economic analyses. The specific methods used at various scales will change as a result of on-going research, but the center will maintain the capability to do multi-scale, connected analyses.

Focused applied research

The Center for Integrated Landscape Assessments will connect to applied research to update base mapping and modeling methods. Much research on landscape ecology, mapping, and analysis will be conducted through the proposed Northwest Landscape Science Center, the PNW Research Station, and Universities. The Center will adapt the latest methods from on-going research to meet client needs as new methods become available. This separate-but-connected approach will allow the Center to focus on applied objectives and funding streams while building a direct conduit from research to application in the field of landscape assessment and analysis.

Client needs

Those clients who support the center through annual contracts, personnel, or some combination the two will receive base support on an annual basis. Base support will be defined for each participating client and could include landscape analyses, software development, or GIS analyses. Client oversight will meet on a yearly or twice-yearly basis to guide CILA activities, set priorities, and approve funding. The Center provides a way for organizations that need landscape assessments to have on-going access to skills, data, models, and methods through a cost-share pool.

Connections

USDA Forest Service PNW Research Station. The Center will be a joint venture between the PNW Research Station and the Institute for Natural Resources. PNW will provide funding for the CILA chief scientist plus some administrative costs. The CILA will connect to other PNW Programs as needed, especially regarding landscape ecology, remote sensing, and assessment research. Perhaps the most straight-forward links will be to the Focused Science Delivery Program, the Forest Inventory and Analysis Program and the Western Wildlands Environmental Threats Assessment Center.

USDA Forest National Forest System. The Center could receive base funding to support 2 modeler/analysts and administrative support from the Washington Office and/or Regions. The modeler/analysts and administrative support might be in-kind, that is NFS people who are part of the Center to maintain modeling capability and data, but who work on NFS-prioritized assessments. Initially, work will focus on the Southwest and Pacific Northwest Regions, but the intention is to pull in support from all of the western Regions over time.

USDA Forest Service, State and Private Forestry (S&PF). CILA could seek funding for 2 or more modeler/analysts per year plus administrative costs to assist state and private entities with landscape assessments from S&PF. This would facilitate consistent state-wide forest assessments, for example, using similar state-to-state base data and modeling approaches. S&PF funding would also facilitate assistance to private organizations that need data, assistance, or assessments for various purposes. Examples include local NGOs doing collaborative landscape restoration planning, Landscape Conservation Cooperatives, and similar efforts.

The Institute for Natural Resources. The CILA could formally be part of INR. This would allow the Center to function impartially for all clients rather than focus on one client group. It would allow the Center to compete for funding through a variety of grant sources. Perhaps the Center could be part of the Cooperative Ecosystem Studies Unit network through either OSU or PSU to facilitate funding and reduce overhead costs.

Bureau of Land Management and other federal entities. The BLM and other agencies could either be part of the base supporting agency group or could contract with the CILA for landscape assessments or support as needed.

State Agencies. State Departments of Forestry, Natural Resources, Fish and Wildlife and others would be clients and collaborators as they need landscape assessment support. If some portion of the CILA base funding came from S&PF, there would be some dedicated staffing to assist with state-wide forest assessments and similar efforts.

Non-Governmental Organizations. The Center would collaborate with a variety of non-governmental organizations to coordinate landscape datasets, models, and methods and to provide data, support, and assessment work. Some base level of support and assessment work will be funded by S&PF, but much will come through collaborative grant acquisition and other funding approaches.

Northwest Landscape Science Center. The CILA could be the applied sister organization to the proposed Northwest Landscape Science Center. The NLSC is a proposed research entity that would be a collaborative effort between the PNW Research Station and several universities. NLSC would conduct research into landscape ecology, mapping, and assessment methods. CILA would provide a direct linkage for NLSC research application.

Organizational Structure

The Center will be part of the Institute for Natural Resources (INR), a non-profit institute operating under the auspices of the Oregon University System, whose mission is provide individuals with relevant science-based information, methods, and tools for better understanding natural resource management challenges and solutions. The center will be flexible and affordable in serving data and models, supporting landscape analyses/assessments by users, and in contracting work for clients. Work done by the center cannot be prohibitively expensive. The center will function as a public service, non-profit organization, with minimal overhead costs. It will be accessible to a variety of clients ranging from NGOs, to state agencies, federal agencies, and others.

A small, consistent base funding level will be contributed by a core group of partners. The core partners will receive flexible service, commensurate with contributed resources.   Base funding might be in-kind (e.g. salaries paid for employees who work part or full time at the center) or direct. The ability to quickly adjust staffing is critical, likely meaning that the center will be a quasi-governmental or non-profit organization. A Board of Directors from the core partners will direct priorities, budgets, personnel, and other management oversight for the center. The Board and center will operate under MOUs with the core partners. Core partners might include federal agencies, state agencies, universities, and other governmental entities. Private entities (e.g. NGOs) could participate as long as FACA procedures were followed.

The center will maintain flexible funding support for research faculty and staff working on key issues. Work and projects should be undertaken to solve problems identified by the core partners. The center should pursue a combination of research and applied grants to fund work that directly contributes to client needs. However, the center will not pursue piecemeal funding that dilutes objectives of the core partners.

Staffing

Base staffing of the Center will include funding to cover:

- An overall center lead and chief scientist
- A project coordinator to handle outreach and client relations
- Some administrative support, space, computers, and other basic requirements
- A GIS Analyst with spatial data serving expertise

- Three landscape modelers to create and update existing vegetation, potential vegetation, and vegetation models; develops connections to other models and data (e.g. climate change, watersheds, economics, etc.)
- A high-level programmer/analyst to develop and support analysis tools.

Through outside grant funding we will hire a changing cadre of highly qualified recent masters and PhD students. These one to three year hires will conduct high quality research whose benefit to clients will be ensured by working with the center and its clients.

Funding

Base staff funding will be provided by a core group of clients such as the National Forests, PNW Station, BLM, and state agencies like the DNR or ODF. Funding by a core group of clients increases the connection and understanding of needs between center work and those who will use the products and services. Staff could maintain their affiliation with the client who is providing funding or could be directly hired through INR. In addition, the CILA will pursue grants from a variety of clients who need landscape assessment work or data. Much of the work done by the CILA will be on an as-needed, as-funded basis from federal and state agencies. Additional temporary staff at the center will fluctuate as work load demands change.

Other Proposed Missions for a Center

Based on a November 2011 meeting, including: Jamie Barbour (USFS PNW Research), Matt Betts (OSU), John Bolte (OSU), Kelly Burnett (USFS PNW Research), Sam Cushman (USFS Rocky Mountain Research), Lisa Gaines, (OSU Institute for Natural Resources), Nancy Grulke (USFS PNW Research), Miles Hemstrom (USFS-PNW/INR), David Hulse (UO), Catherine Mater (OSU and Pinchot Institute), Brenda McComb (OSU), Anita Morzillo (OSU), Tom Spies (USFS PNW Research), Steve Tesch (OSU), Bea Van Horne (USFS PNW Research)

We propose the formation of a Northwest Landscape Science Center (NLSC) that would complement the existing regional and centers and institutes already in place in the Pacific Northwest. The NLSC is designed to address the effects of contemporary and complex interacting stressors on integrated social and ecological systems. The center would:

1. Accumulate and synthesize existing information to address landscape management problems faced by managers, landowners, Non-Governmental Organizations, and affected publics.
2. Provide educational opportunities to train the next generation of landscape scientists, science technicians, managers and decision makers, and also provide online resources for the general public.
3. Explore and test novel and practical theoretical, technological and applied approaches to advance our understanding and management of complex systems.

The Center would bring together the rich expertise in the region as represented by landscape ecology, economics, genetics, sociology, epidemiology, geomatics, hydrology, and policy analysis and include all landscapes forested (forested, woodland, shrubland, grassland, desert, croplands, urban).

Scope

The Center would address multiple aspects of landscape condition and landscape change to meet sustainability objectives for a wide variety of constituents. The primary geographic focus would include the following Environmental Protection Agency's Level 3 Ecoregions:

1 Coast Range	2 Puget Lowland
3 Willamette Valley	4 Cascades
5 Sierra Nevada	9 Eastern Cascades Slopes
11 Blue Mountains	15 Northern Rockies
41 Canadian Rockies	77 North Cascades
78 Klamath Mountains	80 Northern Basin and Range

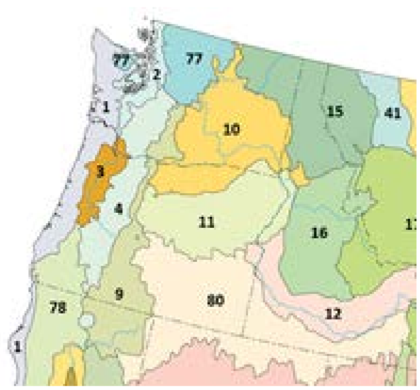


Figure 21. Environmental Protection Agency's Level 3 Ecoregions

The geographic focus would be within Oregon, Washington, northern California and western Idaho, and to the degree possible British Columbia and western Alberta

Structure and Approach

The Center would be led by a Center Director charged with coordinating the needs of the constituents with the capabilities of the scientists and staff at cooperating universities and agencies. The Director would work with three Associate Directors, each of which had primary responsibilities for each of the three missions of the Center. Each of the three missions has a set of objectives designed to develop, use, and disseminate information that must be linked to specific locations in space over time.

Objectives

Objectives1: **Accumulate existing information to address landscape management problems faced by managers, landowners, NGOs, and affected publics**.

The objectives for this aspect of the Center are to develop an *Ecoinformatics Assessment Team* that works directly with clients to assist them in solving spatial monitoring, assessment, future projection, and trade-off analysis needs. Specifically we will:

1. **Accumulate currently available spatially explicit information and facilitate its use** by land managers, private land owners, regulatory agencies, resource and urban planners, and NGOs by using and enhancing spatially-based data portals, such as Data Basin (http://databasin.org/) to include information that can be integrated among the areas of expertise represented in the Center.
2. ***Engage clients*** to adapt currently available modeling frameworks that connect spatially explicit information to models of system change and allow assessments of current and possible future conditions. We would hope to expand on use of this approach to facilitate development of innovative approaches for incorporating the needs of both humans and other species into promotion of ecosystem services novel solutions to complex environmental and social problems, such as using payments from ecosystem services (e.g., carbon sequestration) to fund health care for rural forest landowners.
3. ***Create meta-assessments*** (assessments of assessments) to understand areas of consistency and uncertainty in landscape assessment science that have been completed or are underway by agencies.

Objectives 2: **Provide educational opportunities for early-, mid- and late-career professionals** through short courses and on-line courses to train the next generation of landscape specialists, and also provide online resources for the general public.

The objectives for this aspect of the Center are to provide training opportunities for entry-, middle-, and upper-management level professionals in order to train the next generation of resource professionals to be competent in a wide range of landscape-level areas of expertise. We will develop different modules for each level of career professionals because people at these stages of their careers have different knowledge requirements to use landscape science information effectively in their jobs. Entry-level professionals likely will want to be capable of using the analytical tools and interpreting the results to an interdisciplinary (or transdisciplinary) team. They are the 'doers'. The middle-management professionals will need the knowledge to ask the correct questions of the doers to ensure that assessments are complete and interpretable in an interdisciplinary team environment. These are the 'users'. Training for upper management professionals will provide a basic understanding of landscape science, with a focus on interpreting results, trade-off and sensitivity analyses, and use of information in decision making. They are the 'decision makers'. Specifically we will:

1. ***Develop on-line courses*** available to OSU Masters of Natural Resources (MNR) students (and others) to complement the existing MNR courses in Geographic Information Systems. These new courses provide in-depth, state of the art information on landscape ecology, economics, genetics, sociology, epidemiology, geomatics, hydrology, and policy analysis and are designed for the 'doers' in an organization.

2. **Expand on existing 2-week short-courses** designed for 'users' such as the "Landscape Ecology in Theory and Practice: Application to National Forest Management" taught by Drs. Kevin McGarigal and Sam Cushman. Similar 1- to 2-week short courses would be developed for other areas of landscape science by Center members in topics such as economics, genetics, sociology, epidemiology, natural resources conflict resolution, geomatics, hydrology, and policy analysis.
3. ***Develop 3 one-week short courses for upper management***, to allow decision makers the opportunity to gain the background, understand results, and make informed decisions using information from integrated landscape assessments. The first short course is an introduction to landscape science theory and application. The second course introduces students to the approaches taken to conduct an integrated landscape assessment. The final and third course introduces to students to use of information from integrated landscape assessments to make decisions, including the concepts of risk assessment, uncertainty estimation and sensitivity analysis.
4. ***Basic introductory information*** will be made available on a Center website that is available to everyone who would like information on the basic concepts of landscape ecology, economics, genetics, sociology, epidemiology, geomatics, hydrology, and policy analysis.

Objectives 3. Develop new technological and theoretical approaches to advance our understanding of and management of complex systems.

The objectives of this aspect of the Center are to advance the technology, theory, and application of landscape science to achieve several important visions for a 'landscape science' in the next decade. Specifically we hope to advance the following areas of scientific inquiry significantly over the next 10 years.

1. ***Ecotechnology***. Just as biotechnology and bioengineering joined the disciplines of the biological sciences and engineering, we expect to advance our ability to measure and monitor environmental resources on the ground and remotely through significant advances in technology. In order to make landscape-scale information of use to a broad suite of users and decision makers we must know or be able to forecast what landscape conditions are at any point in time and space. Daily or hourly updates of fine scale features of landscapes will be facilitated through on-the ground arrays of eco-sensors in combination with remotely sensed data that accumulates fine-scale information from terrestrial-, air-, and space-borne platforms. Recent advances in uses of LIDAR allow us to foresee a time when spatially explicit data spanning scales from individual plants to continents are available with rapid updating. Data management, archiving, and processing are additional technological challenges that must be met. We will partner with colleagues in engineering, such as the Northwest Alliance for Computational Science & Engineering (http://www.nacse.org/) to ensure that ecological data are available over such a wide range of spatial scales and time frames.
2. ***Ecoinformatics***. This new cross-disciplinary area of science "…integrates environmental and information sciences to define entities and natural processes with language common to both humans and computers" (ecoinformatics.org). We will work closely through the Ecoinformatics

collaboratory (http://www.ecoinformatics.org/index.html) to ensure that the data that we use and develop are broadly available to meet our regional needs and contribute to ecological scientific studies within the Pacific Northwest and beyond. Conversely, we will use the data available through this collaboratory to continue to develop innovative solutions to problems faced by land managers and to advance landscape science theory and application. As technology advances and data volumes increase dramatically, data management, analysis, and modeling will be best facilitated through these collaborative open-source efforts.

3. ***Scaling***. Landscape science of the next decade will allow scientists and managers to scale seamlessly from a very fine grain (e.g., individual plants) to very broad extents (e.g., continental or global). Such seamless scaling is currently not possible; partially because of the computational limitations of current hardware and software, and partially due to our conceptualization of scaling theory. In addition to seamless spatial scaling, we will need seamless temporal scaling abilities to allow users to understand likely futures over a range of time frames from hours to centuries.
4. ***Decision Theater development***. We will be working toward seamless interactions between spatially and temporally explicit dynamic models of likely future conditions, with users asking questions about the implications of future conditions that reflect alternative land or water management decisions, disturbance conditions, or similar environmental stressors. The initial conditions for these projections will be automatically updated frequently to reflect ongoing changes in landscape structure and composition. Users of the decision theater will be able to query model outputs over a wide range of spatial and temporal scales.

References

Produced by ILAP

Creutzburg, M. K., Halofsky, J.S., Hemstrom, M.A. 2012. Using state-and-transition models to project cheatgrass and juniper invasion in southeastern Oregon sagebrush steppe. In: Kerns, B.K., Shlisky, A.J., Daniel, C.J., eds. Proceedings of the First Landscape State-and-Transition Simulation Modeling Conference, June 14–16, 2011, Portland, Oregon. Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Pg 73–84.

Creutzburg, Megan K.; Halofsky, Joshua S.; Hemstrom, Miles A. 2012. Using state-and-transition models to project cheatgrass and juniper invasion in Southeastern Oregon sagebrush steppe. In: Kerns, Becky K.; Shlisky, Ayn J.; Daniel, Colin J., tech. eds. Proceedings of the First Landscape State-and-Transition Simulation Modeling Conference, June 14–16, 2011, Portland, Oregon. Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 73-84.

Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 103-114.

Halofsky, Jessica E.; Creutzburg, Megan K.; Hemstrom, Miles A., eds. 2013. Integrating Social, Economic, and Ecological Values across Large Landscapes. Gen.Tech. Rep. PNW-GTR-xxx. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Xxx p. *Submitted for publication and in review.*

Halofsky, J.E., M.A. Hemstrom, D.R. Conklin, J.S. Halofsky, B.K. Kerns, and D. Bachelet. 2013. Assessing potential climate change effects on vegetation using a linked model approach. *Accepted for publication in Ecological Modeling.*

Hemstrom, Miles A.; Salwasser, Janine; Halofsky, Joshua; Kagan, Jimmy; Comfort, Cyndi 2012. The integrated landscape assessment project. In: Kerns, Becky K.; Shlisky, Ayn J.; Daniel, Colin J., tech. eds. Proceedings of the First Landscape State-and-Transition Simulation Modeling Conference, June 14–16, 2011, Portland, Oregon. Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 57-72..

Kerns, Becky K.; Shlisky, Ayn J.; Daniel, Colin J. 2012. Proceedings of the First Landscape State-and-Transition Simulation Modeling Conference, June 14–16, 2011, Portland, Oregon. Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 215 p

Kerns, Becky K.; Hemstrom, Miles A.; Conklin, David; Yospin, Gabriel I.; Johnson, Bart; Bachelet, Dominique; Bridgham, Scott 2012. Approaches to incorporating climate change effects in state and transition simulation models of vegetation. In: Kerns, Becky K.; Shlisky, Ayn J.; Daniel, Colin J., tech. eds. Proceedings of the First Landscape State-and-Transition Simulation Modeling Conference, June 14–16, 2011, Portland, Oregon. Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 161-172.

Mason, Bruce and Girard 2012. National Forest Health Restoration: an economic assessment of forest restoration on Oregon's eastside national forests. Prepared for Governor John Kitzhaber and Oregon's Legislative Leaders. 94 pp.

Morzillo, Anita T.; Halofsky, Joshua S.; DiMiceli, Jennifer; Csuti, Blair; Comeleo, Pamela; Hemstrom, Miles 2012. Balancing feasibility and precision of wildlife habitat analysis in planning for natural resources. In: Kerns, Becky K.; Shlisky, Ayn J.; Daniel, Colin J., tech. eds. Proceedings of the First Landscape State-and-Transition Simulation Modeling Conference, June 14–16, 2011, Portland, Oregon.

Pacific Northwest Research Station. Landscape models: helping land managers thing big. Science Update, Issue 21, Fall 2011. 12 pp.

Shlisky, Ayn J.; Vandendriesche, Don. 2012. Use of state-and-transition simulation modeling in National Forest planning in the Pacific Northwest, U.S.A. In: Kerns, Becky K.; Shlisky, Ayn J.; Daniel, Colin J., tech. eds. Proceedings of the First Landscape State-and-Transition Simulation Modeling Conference, June 14–16, 2011, Portland, Oregon. Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 23-42

Weisz, Reuben; Vandendriesche, Don 2012. Use of the forest vegetation simulator to quantify disturbance activities in state and transition models. In: Kerns, Becky K.; Shlisky, Ayn J.; Daniel, Colin J., tech. eds. Proceedings of the First Landscape State-and-Transition Simulation Modeling Conference, June 14–16, 2011, Portland, Oregon. Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 143-160.

Zhou, Xiaoping; Hemstrom, Miles A. 2012. Forecasting timber, biomass, and tree carbon pools with the output of state and transition models. In: Kerns, Becky K.; Shlisky, Ayn J.; Daniel, Colin J., tech. eds. Proceedings of the First Landscape State-and-Transition Simulation Modeling Conference, June 14–16, 2011, Portland, Oregon. Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 115-122.

Appendices

Appendix A: Outreach Strategy

Preface

The project team is committed to creating products that are useful. The best way to create useful products is to involve users throughout project development. We also want to explore the value of a Center that provides multi-disciplinary expertise, regional data, tools and services to analyze and assess a broad spectrum of natural resource issues that occur over large landscapes and mixed ownerships. For such a Center to be used and useful, we will need to develop strong partnerships and a supportive user base.

This strategy is proposed to guide outreach activities both during and after project completion (in December 2011). Project outreach team members include: Janine Salwasser (lead), Sean Gordon, Jamie Barbour, Miles, Hemstrom, Lisa Gaines, Steve Tesch, and Jack Triepke. The Outreach Team will report to the Oversight Team on progress made toward implementing the strategy. Advisory groups (IMAP and SW) will also have an opportunity to review and provide input on the Outreach Strategy.

General Outreach Goals

1. improve awareness, trust and accurate understanding of project goals
2. increase collaboration and communication efforts with potential partners
3. promote use of project products and feedback from end-users
4. disseminate information about the project
5. explore value of an Integrated Science and Landscape Analysis (ISLA) Center

General Outreach Objectives

1. inform the development of useful and used products
2. form a network of interest and support
3. share resources and exchange ideas
4. solicit new ways of collaborating that provide mutual benefits
5. promote partnerships that extend beyond the life of the project
6. identify the level of technology transfer(and existing capacity) that will be needed by the targeted user groups and end-users

Specific Outreach Objectives

1. Focus on the use of ILAP products to support:
    a. National Forest Plan revisions
    b. BLM Resource Management Plans and Ecoregion Assessments
    c. 2015 Forest and Resource Assessments
    d. Collaborative Landscape Forest Restoration projects
    e. Interagency assessments at regional and national level
2. Provide trainings so users understand scope and appropriate use of products
3. Secure support for Center

Guiding Principles for Project Outreach

- Expand visibility and awareness
- Actively seek participation and input throughout project development
- Make an extended effort to include representation from all primary and secondary targeted user groups
- Work to incorporate existing advisory groups and organizations into the product development process (e.g., IMAP user group, statewide forest assessment groups)
- Employ a multi-faceted approach that utilizes a variety of strategies for outreach, communication, and marketing
- Provide multiple ways in which individuals can participate and contribute ideas
- Focus on end-users involved with statewide forest assessments, collaborative forest landscape restoration projects, forest plan revisions

Generic User Groups

Primary

- Decision makers from public agencies (e.g., forest supervisors)
- Planners and analysts from NGOs, public agencies, private industries, tribes
- Land managers from public agencies, NGOs, private industries, tribes
- Collaborative restoration groups working at landscape-levels

Secondary

- Community leaders
- Scientists and researchers
- Elected officials

Other User Groups (to consider if project continues beyond 2 years)

- Community Wildfire Protection Planning groups
- Extension agents
- Watershed Councils
- Soil and Water Conservation Districts
- General public
- Private landowners

Specific Groups to Target

Primary

Through multiple user interactions:

- NW advisory group (i.e. IMAP user group) – biannual meetings
- SW advisory group – biannual meetings

- 2 Collaborative Forest Landscape Restoration Program Groups (one in Northwest ; one in Southwest)
- Forest Supervisors and FS support staff
    - NFs associated with CFLR proposed and/or funded projects

Secondary

Through annual (or opportunistic) project briefings:

- Statewide forest assessment groups (OR, WA, AZ, NM state forestry divisions, TNC) (see attachment 1)
- Fire Learning Network
- Federal landscape-oriented project and program groups
    - BLM Rapid Ecoregion Assessments
    - FWS Landscape Conservation Cooperatives
    - LandFire
    - USFS Collaborative Forest Landscape Restoration Program
    - USFS Priority Watersheds Integrated Resource Restoration Program
    - USGS Climate Change Centers
- Forest industry organizations (American Forest Resource Council, Oregon Forest Industry Council, etc.)
- Congressional staff visits

Outreach Phases

Outreach for the Integrated Landscape Assessment Project will be implemented in 4 phases :1) promote general awareness of project and products; 2) solicit input on project products from targeted users; 3) promote partnerships and use of project products; and 4) train in use of project products

<u>Phase 1 – Project Awareness</u>

1. Produce publicly accessible website with relevant materials
2. Develop and promote use of fact sheets for project and project modules
3. Develop and promote use of 2-3 minute ILAP video
4. Conduct and make accessible project (module) webinars
5. Develop constituent/user database for use by team members
6. Produce and distribute external e-newsletter (*note: may use INR e-news to accomplish this task*)
7. Produce posters (e.g. for SAF Convention in Oct. 2010)
8. Attend and present at appropriate conventions (e.g., SAF, IALE)
9. Maintain outreach calendar on SharePoint
10. Develop and make accessible project presentations on SharePoint
11. Conduct speaking engagements during and after project ends
12. Author articles/guest columns
13. Assemble media/press packets
14. Archive and make accessible quarterly and annual reports
15. Develop key points
16. Publish in peer reviewed literature
17. Prepare a General Technical Report on the project methodologies
18. Communicate regularly with congressional representatives
19. Create a matrix of project products (data, tools, analyses, etc.) and user types (technical, non-technical user)

20. Create a web portal that provides access to ILAP data, models, tools, products, expertise, etc.

Phase 2 – Solicit Input

21. Use project advisory groups to provide input on use and usability of products at State and regional scales
22. Use focus area groups to provide input on use and usability of products at landscape scales
23. Develop list of questions (i.e. user needs) that we want to ask of potential project partners and supporters
24. Facilitate science reviews of new models, methodologies associated with the project

Phase 3 – Promote Partnerships and Use

25. Provide project briefings to target organizations/leaders working on landscape assessments across "all lands"
    a. USFS
    b. BLM
    c. NRCS
    d. USGS
    e. FWS
    f. TNC
    g. Collaborative Landscape Forest Restoration Groups
    h. State forest and wildlife agencies
26. Establish a project description and links on the FRAMES fire research clearinghouse website when project done
27. Promote partnerships to re-purpose or enhance data and tools for new landscape analyses
28. Develop and maintain partnership database
29. Request letters of support
30. Create a matrix/diagram of major land management decisions (e.g., fuel treatment allocations), how they are made and how our information could contribute

Phase 4 – Provide Trainings

31. Produce training videos on products
32. Conduct webinar training sessions
33. Conduct educational meetings
34. Conduct workshops (e.g., VDDT user workshop)
35. Coordinate activities with OSU Extension (Janean Creighton)

Outreach Action Plans

1. Develop short-term action plan for targeted outreach with collaborative landscape groups for project duration (through March 2012)
    a. Plan for at least one outreach activity/month
    b. Ask module leads about what kind of user input they need or have planned for their module products
    c. Ask NW and SW project advisors to select "focus areas" to facilitate review of draft products at the landscape scale
    d. Develop timeline of user input needed for product evaluation
    e. Document user needs (see attachment 2 for specific questions)

f. Identify specific outreach steps (see attachment 2 for generic outreach steps)
g. Identify plan for technology transfer during project

2. Develop long-term action plan that extends beyond project end date (March 2012)
    a. Research what makes tools useful in different decision-making situations at multiple scales
    b. Develop long-term plan for technology transfer
    c. Identify plan for information access and archiving after the project
    d. Evaluate use, including usability, of project products over time
    e. Prepare conceptual model for Center
    f. Publication

Sources

Black, A. and S. Perin, Delivering the Science Synthesis: FuelsTools. 2007. http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1058&context=usdafsfacpub (accessed 5-14-10)

NOAA fisheries Northeast Region. Outreach Strategic Plan. http://www.nero.noaa.gov/nero/outreach/outreachplan-final.pdf (accessed 4-20-10)

Toman, E and B. Shindler, Wildlife Fire and Fuel Management: Principles for Effective Communication. 2006. http://www.treesearch.fs.fed.us/pubs/18689 (accessed 4-20-10)