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Interagency Mapping and Assessment Project Study Plan

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IMAP Background

The Interagency Mapping and Assessment Project (IMAP) effort is a large, interagency cooperative to build data and models for integrated landscape planning and analysis. The IMAP cooperative began as a research and development project designed to find integrated approaches to understanding how natural disturbances, vegetation development, and management activities interact to produce a variety of goods and services across large landscapes. IMAP uses a variety of modeling tools and data to provide information policy makers, resource managers, and other interested parties can use to evaluate alternative land management approaches. IMAP tools are supposed to be easy to use and understand, fairly inexpensive to apply, and provide a reasonable representation of the implications of vegetative succession, management, and natural disturbances. In addition, MAP vegetation data and models are designed to be compatible with existing agency data standards, including those from the Northwest Forest Plan Effectiveness Monitoring effort, R6 and USFS national standards, and the interagency national LANDFIRE effort (www.landfire.gov).

Landscape assessments and plans are needed by several state and federal agencies, including the Oregon Department of Forestry (ODF), Region 6 National Forests, Washington Department of Natural Resources, the Oregon and Washington/Washington Bureau of Land Management, and others. Ideally, these planning efforts would share models, methods, and data. Key issues for all these planning and assessment activities include integrating fire risks, fuel conditions, wildlife habitats, old forests, forest products, rangeland conditions, potential biomass supplies, carbon sequestration, and others.

The cooperative effort began to attract interest from a variety of federal agencies, state agencies, and non-government cooperators becoming, over the course of several years, a somewhat formalized effort with an interagency charter (Appendix A) and oversight group – the IMAP User Group. Current partners include: the Oregon Dept. of Forestry (ODF), USDA Forest Service R6 (R6), USDA Forest Service PNW Research Station (PNW), Washington Department of Natural Resources (WADNR), Oregon/Washington Bureau of Land Management (BLM), and Oregon Department of Fish and Wildlife (ODFW). Other partners are welcome to join the cooperative as need dictates.

IMAP User Group Questions

In July 2007, the IMAP User Group met to describe the key questions that each IMAP partner hoped or expected to answer using IMAP models, data, and methods (Table 1). The User Group directed the development of a study plan that describes User Group questions and the methods, models, and data that IMAP might be used to answer those questions (Table 2). This study plan contains our recommendations for how best to answer User Group questions. Proposed methods, tools, and data are not an exhaustive list and additional approaches can be included as needed or as new methods, tools, and data sources become available. This study plan is not meant to be an exhaustive methodology description for all the various IMAP components; rather it describes how IMAP methods, models, and data could be used to answer User Group questions. It also describes what resources might be needed and which agency and person might take lead in answering each question.

We arranged the User Group Questions into topical areas that reflect broad categories of subject matter, using a hierarchical numbering system that indicates topical area, then similar questions within each topic. We also arranged this document into two Chapters: 1) Generating Information to Answer User Group Questions, and 2) Performing Analyses to Answer User Group Questions.

TOPIC A: Land Use Change

A1. How much wildland is there?
A2. Where is wildland currently being developed for other uses?
A3. What areas of wildland are likely to be developed in the future?
A4. How might alternative management policies affect where wildland development occurs in the future?
A5. How might wildland development and fragmentation affect potential wildfire behavior and risk in the future?
A6. How might wildland development and fragmentation affect potential ecosystem services including carbon sequestration and potential to generate forest products in the future?

TOPIC B: Forest Characteristics and Ecosystem Services

B1a. What is the current mix and spatial distribution of vegetation cover types and stand structural stages?
B1b. How might different management approaches and natural disturbances alter the mix and spatial distribution of vegetation cover types and stand structural stages in the future?
B1c. What are the current effects of vegetation conditions on important ecosystem services including carbon sequestration and potential to generate forest products?
B1d. How might different management approaches and natural disturbances alter important ecosystem services including carbon sequestration, and potential to generate forest products in the future?
B2. What integrated strategies and opportunities (e.g. increased carbon sequestration) could be used to achieve policy goals such as improving vegetation health and the sustainability of resource outputs, enhancing local economies, and maintaining desired vegetation characteristics?

TOPIC C: Wildlife habitat conditions and trends

C1a. What are the current mid-scale (e.g. several watersheds and larger) amount, composition, and pattern of habitat for key wildlife species?
C1b. How might different management approaches, natural disturbances, and climate change alter the mid- and broad scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?
C1c. How might future changes in habitat amount, composition, and pattern affect mid- and broad scale population trends for key wildlife species?
C2a. What are the current fine scale (e.g. several watersheds and larger) amount, composition, and pattern of habitat for key wildlife species?

C2b. How might different management approaches, natural disturbances, and climate change alter the fine scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?
C2c. How might future changes in habitat amount, composition, and pattern affect fine scale population trends for key wildlife species?

TOPIC D: Aquatic and riparian habitat conditions and trends

D1a. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function at present?
D1b. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function in the future under different management approaches and natural disturbance regimes?
D2a. How do vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales at present?
D2b. How might vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales in the future?
D3a. What are the current production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas?
D3b. What might the future production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas be under different management approaches and natural disturbance regimes?

TOPIC E: Wildfire, Insect & Disease, and other natural disturbances

E1a. How many acres of Oregon and Washington wildland are currently in conditions that may result in high-severity or unnaturally intense insect and disease outbreaks and wildfires?
E1b. How many acres of Oregon and Washington wildland have been treated to reduce these hazards?
E2a. What Oregon and Washington wildland areas are likely to experience unnaturally intense insect and disease outbreaks and wildfires in the future?
E2b. How does this differ from historical patterns?
E2c. How might different management strategies affect these disturbances?
E3. What are the likely landscape-scale effects of pre- and post-fire management (i.e., thinning, fuels management, salvage) on ecosystem processes and components, including fish and wildlife habitats values?
E4. What are likely trade-offs between short term loss of wildlife habitat values from management designed to reduce unnaturally intense disturbances and long term damage to habitat from unnaturally intense disturbances?
E5a. Where do opportunities currently exist to improve forest health and generate sustainable outputs of important forest values through active management?
E5b. How much difference might active management make in landscape wildlife habitat, forest products, and other resource values compared to passive management?
E5c. How might landscape priorities be developed and displayed that integrate trade-offs between disturbance risks, wildlife habitat and other landscape values, and social/economic benefits?

E6a. How might different mixes of wildfire, fuels management, and fire suppression provide alternative landscape economic, social, and ecological benefits?
E6b. What might the economic trade-offs be for different management approaches to wildfire, fuels management, and fire suppression?

TOPIC F: Invasive Species

F1. How many acres of Oregon and Washington wildland are currently affected by non-native insects and diseases and invasive plants and animals?
F2. Is Oregon and Washington successful in excluding or containing the worst invasive species threats to the state's forests?
F3a. Where might invasive species be most likely to have adverse effects on Oregon and Washington's forests in the future?
F3b. How might alternative management strategies and climate change assumptions affect invasive species risks across Oregon and Washington's forested landscapes?

TOPIC G: Forest Products

G1. What is the location and capacity of existing wood products mills and processing plants, including biomass?
G2. How will this likely change over time under various management and policy scenarios?
G3. How will changes in those locations/capacities influence the ability to economically manage forests within Oregon's timbersheds, to provide biomass for energy production, to maintain and enhance rural economies, provide and to provide revenues to state and local government for public services?

IMAP User Group Questions and Partner Business Needs

Using information from the July 2007 User Group meeting and additional discussions with IMAP partners, we developed a presumed relation between each User Group question and the key business needs of the partners and estimated the degree to which IMAP methods, models, and data might answer each question(Table 1). Our ranking of the degree to which IMAP might answer the User Group question included:

- H – IMAP will directly supply information to answer question;
- M – IMAP will supply information that could, with additional work or data, answer question;
- L – IMAP either will supply little or no information to answer question;
- R – currently a research topic or research and methods development will be required to link IMAP information to answer question.

We also ranked the degree to which we thought the User Group questions were related to partner business needs. Business needs are presumed to be the key resource-related issues that each IMAP partner discussed during the July 2007 meeting. The degree to which each User Group question addresses a partner business need varies according to the legislative mandate that established each partner agency as well as any local or national policies the agency may have adopted. This listing of business needs is not comprehensive for the partner agencies. Rather, it focuses on issues the partners thought might be reasonably addressed by IMAP methods, data, and models. Our ranking of business needs included:

- B – critical business need;
- b – minor business need;
- dash(-) – no stated business need.

Table 1. The potential for IMAP to answer mid- and broad scale user group questions and key business needs by partner[1]. Mid-scale effects are those that occur over a few to many watersheds (Hydrologic Unit Code 5 drainages). Broad scale effects are those that occur across subbasins (Hydrologic Unit Code 4) and larger landscapes. All questions are assumed to apply to mid-and broad scale landscapes unless otherwise specified.

	Partner						
Question	**IMAP Answer**	**BLM**	**ODFW**	**ODF**	**PNW**	**R6**	**WDNR**
A1. How much wildland is there?	**H**	**-**	**-**	**B**	**b**	**-**	**-**
A2. Where is wildland currently being developed for other uses?	**H**	**-**	**B**	**B**	**b**	**b**	**b**
A3. What areas of wildland are likely to be developed in the future?	**M**	**b**	**B**	**B**	**b**	**b**	**b**
A4. How might alternative management policies affect where wildland development occurs in the future?	**M**	**b**	**b**	**B**	**b**	**b**	**b**
A5. How might wildland development and fragmentation affect potential wildfire behavior and risk in the future?	**M**	**B**	**b**	**B**	**B**	**B**	**B**
A6. How might wildland development and fragmentation affect potential ecosystem services including carbon sequestration and potential to generate forest products in the future?	**M**	**b**	**b**	**B**	**b**	**b**	**b**

[1] ODFW= Oregon Department of Fish and Wildlife, ODF = Oregon Department of Forestry, PNW = USDA Forest Service Pacific Northwest Research Station including the Western Wildland Environmental Threats Center, R6 = USDA Forest Service Pacific Northwest Region, , BLM = USDI Bureau of Land Management – Oregon and Washington, WDNR = Washington Department of Natural Resources

	Partner						
Question	**IMAP Answer**	**BLM**	**ODFW**	**ODF**	**PNW**	**R6**	**WDNR**
B1a. What is the current mix and spatial distribution of vegetation cover types and stand structural stages?	H	B	b	B	B	B	B
B1b. How might different management approaches and natural disturbances alter the mix and spatial distribution of vegetation cover types and stand structural stages in the future?	H	B	b	B	b	B	B
B1c. What are the current effects of vegetation conditions on important ecosystem services including carbon sequestration and potential to generate forest products?	M	B	-	B	b	B	B
B1d. How might different management approaches and natural disturbances alter important ecosystem services including carbon sequestration, and potential to generate forest products in the future?	M	B	-	B	b	B	B
B2. What integrated strategies and opportunities (e.g. increased carbon sequestration) could be used to achieve policy goals such as improving vegetation health and the sustainability of resource outputs, enhancing local economies, and maintaining desired vegetation characteristics?	M	B	b	B	b	B	B
C1a. What are the current mid-scale (e.g. several watersheds and larger) amount, composition, and pattern of habitat for key wildlife species?	H	B	B	B	b	B	B

	Partner						
Question	IMAP Answer	BLM	ODFW	ODF	PNW	R6	WDNR
C1b. How might different management approaches, natural disturbances, and climate change alter the mid- and broad scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?	H	B	B	B	b	B	B
C1c. How might future changes in habitat amount, composition, and pattern affect mid- and broad scale population trends for key wildlife species?	R	B	B	B	B	B	B
C2a. What are the current fine scale (e.g. several watersheds and larger) amount, composition, and pattern of habitat for key wildlife species?	R	B	B	B		B	B
C2b. How might different management approaches, natural disturbances, and climate change alter the fine scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?	M	B	B	B	B	B	B
C2c. How might future changes in habitat amount, composition, and pattern affect fine scale population trends for key wildlife species?	R	B	B	B	B	B	B
D1a. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function at present?	R	B	B	B	-	B	B

	Partner						
Question	IMAP Answer	BLM	ODFW	ODF	PNW	R6	WDNR
D1b. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function in the future under different management approaches and natural disturbance regimes changes?	R	B	B	B	-	B	B
D2a. How do vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales at present?	R	B	B	B	-	B	B
D2b. How might vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales in the future?	R	B	B	B	-	B	B
D3a. What are the current production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas?	R	B	B	B	-	B	B
D3b. What might the future production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas be under different management approaches and natural disturbance regimes?	R	B	B	B	-	B	B
E1a. How many acres of Oregon and Washington wildland are currently in conditions that may result in high-severity or unnaturally intense insect and disease outbreaks and wildfires?	H	B	-	B	B	B	B

	Partner						
Question	IMAP Answer	BLM	ODFW	ODF	PNW	R6	WDNR
E1b. How many acres of Oregon and Washington wildland have been treated to reduce these hazards?	H	B	-	B	B	B	B
E2a. What Oregon and Washington wildland areas are likely to experience unnaturally intense insect and disease outbreaks and wildfires in the future?	H	B	-	B	B	B	B
E2b. How does this differ from historical patterns?	H	B	-	B	B	B	B
E2c. How might different management strategies affect these disturbances?	H	B	-	B	B	B	B
E3. What are the likely landscape-scale effects of pre- and post-fire management (i.e., thinning, fuels management, salvage) on ecosystem processes and components, including fish and wildlife habitats values?	R	B	B	B	B	B	B
E4. What are likely trade-offs between short term loss of wildlife habitat values from management designed to reduce unnaturally intense disturbances and long term damage to habitat from unnaturally intense disturbances?	M	B	B	B	B	B	B
E5a. Where do opportunities currently exist to improve forest health and generate sustainable outputs of important forest values through active management?	M	B	-	B	B	B	B
E5b. How much difference might active management make in landscape wildlife habitat, forest products, and other resource values compared to passive management?	M	B	-	B	B	B	B

	Partner						
Question	IMAP Answer	BLM	ODFW	ODF	PNW	R6	WDNR
E5c. How might landscape priorities be developed and displayed that integrate trade-offs between disturbance risks, wildlife habitat and other landscape values, and social/economic benefits?	H	B	B	B	B	B	B
E6a. How might different mixes of wildfire, fuels management, and fire suppression provide alternative landscape economic, social, and ecological benefits?	M	B	-	B	B	B	B
E6b. What might the economic trade-offs be for different management approaches to wildfire, fuels management, and fire suppression?	H	B	-	B	B	B	B
F1a. What are the current distribution and amount of wildlands affected by non-native insects and diseases and invasive plants and animals?	M	B	-	B	B	B	B
F1b. How might different management approaches, natural disturbances, and climate change affect future amount and distribution of area potentially affected by non-native insects and diseases and invasive plants and animals?	M	B	-	B	B	B	B
F2. Have management policies been successful in excluding or containing the worst invasive species threats to wildlands?	L	b	b	B	b	b	b
F3. Where might invasive species be most likely to have adverse effects on wildlands in the future?	R	B	B	B	B	B	B

	Partner						
Question	IMAP Answer	BLM	ODFW	ODF	PNW	R6	WDNR
G1. What is the location and capacity of existing wood products mills and processing plants, including biomass?	H2	b	-	B	b	b	-
G2. How will this likely change over time under various management and policy scenarios?	H	b	-	B	b	b	-
G3. How will changes in those locations/capacities influence the ability to economically manage forests within Oregon's timbersheds, to provide biomass for energy production, to maintain and enhance rural economies, provide and to provide revenues to state and local government for public services?	H	b	-	B	b	b	-

2 Data for questions under topic G provided by ODF.

Table 2. Base data, applications, spatial scale, and other information required to answer IMAP study questions.

Data/applicaton	Study Questions	Scale & Scope	Used how?	Lead Agency/Contact[3]
FIA forest inventory	All	• County groupings • Statewide • Regional	GNN, FVS calibration of VDDT models, yield streams	FIA, PNW Research Station
FIA/ODF and other land use change information	All	• Point sample data – counties, state wide, regional • Polygon data – watersheds and ownership/allocation classes	• VDDT model urbanization development probabilities • TELSA urbanization development probabilities	• Jeff Kline - PNW • Gary Lettman ODF
GNN map existing vegetation data	All	• Area in VDDT state classes within Huc5/ownership/ allocation strata	• VDDT and TELSA initial conditions	Janet Ohmann - PNW
GNN ecological systems data	All	• Area in potential vegetation types within Huc5/ ownership/allocation strata	• VDDT and TELSA model stratification for environment, disturbance regimes, growth/productivity	Janet Ohmann - PNW Research Station
Potential vegetation types	All	• Stand-scale polygons for some National Forests • 30 m pixel – modeled plant association groups	• VDDT and TELSA model stratification for environment, disturbance regimes, growth/productivity	Tom DeMeo – R6

[3] PNW = USDA Forest Service, Pacific Northwest Research Station. ODF = Oregon Department of Forestry. OSU = Oregon State University. R6 = USDA Forest Service, Pacific Northwest Region. IMI = Inventory and Monitoring Institute, Ft. Collins, CO. FMC = USDA Forest Service, Forest Management Service Center, Ft. Collins, CO. ESSA = ESSA Technologies Ltd., Vancouver, B.C. FPS = Fire Program Solutions, LLC, Sandy, OR. WWETAC = Western Wildlands Environmental Threat Assessment Center, Prineville, OR. TNC = The Nature Conservancy, Oregon Field Office. WWU = Western Washington University, Bellingham, WA.

Data/applicaton	Study Questions	Scale & Scope	Used how?	Lead Agency/Contact[3]
Land ownerships and allocation GIS coverages	All	• Oregon and Washington state wide • Washington state wide • Watershed to Regional strata	• VDDT and TELSA initial conditions • VDDT and TELSA modeling stratification	• Andy Herstrom – ODF • Washington source?
Vegetation Development Dynamics Tool	All	• Watershed to Regional	• Integrated scenario projection – non-spatial	• Bob Lee – WO, IMI • ESSA Technologies
Tool for Exploratory Spatial Landscape Analysis	All	• many stands to many watersheds (e.g. 1 million acres)	• Integrated scenario projection – spatially explicit	ESSA
Forest Vegetation Simulator	All	• Stands	• VDDT/TELSA growth and management transition calibration • Yield stream estimation • Fire/fuels effects estimation	• Melinda Moeur – R6 • USDA Forest Service – FMC
Timber supply model	B2, B3, E5, E6	• Counties and larger areas	• Integrated estimates of potential timber supply from private and public lands	Darius Adams - OSU
Non-spatial wildlife habitat Bayesian Network models	A5, B1, B2, B3, C1, C2, D2, E3, E4, E5, E6	• Watersheds and larger areas	• Estimate trends in suitable habitat for selected species from VDDT output	Barb Wales – PNW/R6
Spatial wildlife habitat models	A5, B1, B2, B3, C1, C2, C3, D2, E3, E4, E5, E6	• many stands to many watersheds (e.g. 1 million acres)	• Estimate trends in suitable habitat for selected species from TELSA output	Barb Wales – PNW/R6
Occurrence based	A5, B1, B2, B3, C1,	• Watersheds and	• Biomapper and other	Andrew Yost – ODF

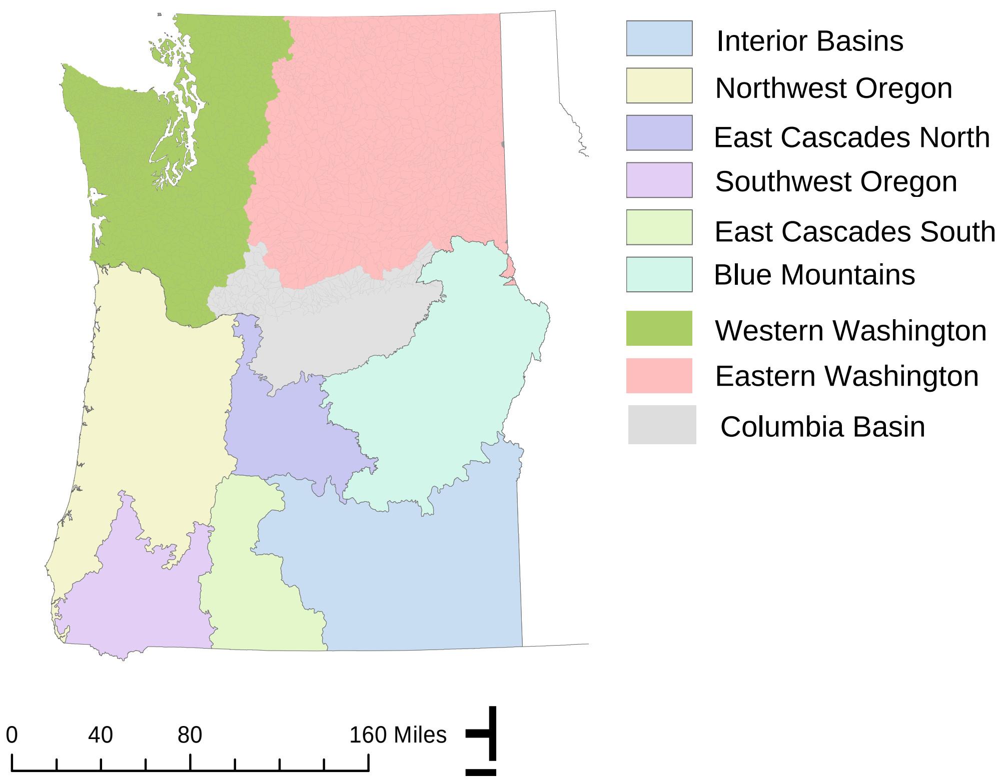
Data/applicaton	Study Questions	Scale & Scope	Used how?	Lead Agency/Contact[3]
wildlife models (e.g. BIOMAPPER)	C2, C3, D2, E3, E4, E5, E6	larger areas	processes	Yost - ODFW
Land development model	A2, A3, A4, A5, C2, C3, E5, E6, F3	• Watersheds and larger	• Estimate trends in conversion of wildlands to other uses from VDDT output.	• Jeff Kline – PNW • Gary Lettman - ODF
Non-spatial mid-scale wildfire modeling	All	• many stands to many watersheds (e.g. 1 million acres)	• Calibration of VDDT and TELSA fire probabilities	Don Carlton – FPS
Spatial broad-scale wildfire modeling	All	• subbasins and larger areas	• Calibration of mid- and broad-scale wildfire variation	Rebecca Kennedy - PNW
Spatial fine and mid-scale wildfire modeling	All	• Many stands to many watersheds	• Calibration of wildfire probabilities, patch characteristics, risks for VDDT and TELSA models	Alan Ager - WWETAC
Historical wildfire acres and locations data	All	• Many watersheds to regions	• Calibration of mid- to broad-scale wildfire probabilities for VDDT and TELSA	John Foster - TNC
Risk analysis model	A4, E4, E5, E6	• Many watersheds to regions	• Compute relative risks for different VDDT or TELSA scenario outputs	Wayne Landis – WWU Alan Ager – WWETAC Becky Kerns - WWETAC
Spatial stream sediment and debris routing model (e.g. NetMap – Benda/Reeves)	All D questions	• Watersheds to subbasins	• Estimate sediment and woody debris routing for TELSA models for riparian/aquatic questions	Lee Benda – Earth Systems Institute Gordie Reeves – PNW Research Station

Chapter 1 – Generating Information to Answer User Group Questions

Project Areas

IMAP work is organized by geographic region (fig. 1). Regions are combinations of ecological and hydrological units and drawn to include entire watersheds (Huc5). Work schedules were originally designed to provide data for National Forest Plan revisions and to provide data for a 2010-2011 State-wide assessment in Oregon.

Figure 1. IMAP study regions in Oregon and Washington. Washington regions are draft and subject to change.



Project Area 1 – Eastern Blue Mountains

The Eastern Blue Mountains project area includes the Washington and eastern portion of the Oregon Blue Mountains ecological regions. GNN data and VDDT models have been developed in conjunction with the Malheur, Umatilla, and Wallowa-Whitman National Forests. Models and data are currently being used in the Forest Plan revision process. VDDT models include all major forest, woodland, shrubland, and grassland vegetation types.

Project Areas 2&3 – Oregon Eastern Cascades North and South

The eastern Cascades regions in Oregon have been combined into one IMAP project area. GNN data have been developed for the entire area and are available for partner use. VDDT models have been drafted for the area and include all major forest, woodland, shrubland, and grassland vegetation types. Model calibration with FVS is underway.

Project Areas 4&5 – Southwest and Northwest Oregon

The western regions in Oregon have been combined into one study area for vegetation data assembly and VDDT model development. Initial models have been constructed for major forest vegetation types in NW Oregon. A set of models is under development for SW Oregon as well. The goal is to have models and data for the entire study area available by the end of FY2009.

Project Area 6 – Interior Columbia and Northern Great Basins

No work has been done for these areas except the generation of GNN data for forest lands and ecological systems (an amalgamation of existing and potential vegetation). There is no existing demand for VDDT models in the study area from current IMAP partners.

Project Area 7 – Western Washington

IMAP regions have been tentatively defined for Washington. Work on vegetation data for Western Washington is scheduled for completion in early FY09. VDDT models have not been developed and no work is currently underway. The IMAP product schedule calls for VDDT model development in FY10.

Project Area 8 – Eastern Washington

Substantial work has already been done in Eastern Washington as part plan revision process for the Colville, Okanogan, and Wenatchee National Forests. Though the plan revision work began before IMAP officially started, the work is based on earlier VDDT modeling and GNN data that fits very well into the IMAP framework. VDDT models exist for all major forest environments that occur in the three National Forests. Models have been calibrated to some extent with FVS and inventory data. Wildlife habitat models associated with the models exist. Work is underway to build an IMAP-related landscape assessment on about 3 million acres near Ellensburg.

Project Area 9 – Northern California

GNN data will be produced for Northern California as part of the Northwest Forest Plan monitoring effort. There are no plans to develop VDDT models or other information.

Budget

This budget (Table 3) reflects the costs of generating the models, data, and information necessary to answer User Group questions, not the costs for analyzing information to produce answers – part of Chapter 2. IMAP is designed about collaboratively shared and leveraged resources. Much or most of the needed resources are contributed as in-kind rather than through exchange of funds. Exchange of funds may be necessary to accomplish specific tasks. The base deliverable products in the draft timeline are mid-scale landscape models, data, and documentation, but other kinds of products could be developed and delivered, depending on

partner needs. Base deliverables do not include specific analyses of policy scenarios, written reports, or other materials unless the partners have agreed on resources necessary to complete those deliverables. For example, while IMAP develops models, methods, and data to answer questions related to the Oregon Indicators or Sustainable Forests, the project does not currently have resources to run policy scenarios across Oregon, analyze results, and write a report. Partner-specific needs for analyses, reports, and other similar products have to be developed and resources supplied as needed and on an individual basis.
Resources needed but not yet committed (Funds Needed row) are largely to complete GNN and Ecological Systems mapping. Funds beyond FY08 are very tentative and subject to change depending on desired deliverables and the ability of the funding partner to contribute.

Table 3. Draft budget for IMAP through FY10. These numbers need to be verified by partners and are subject to change. Fiscal years (fy) are October 1 through September 31 of the following year. The totals for each year include funds needed.

Partner[4]	**fy06**	**fy07**	**fy08**	**fy09**	**fy10**	**total**
R6	$280,000	$540,000	$520,000	$530,000	$530,000	$2,400,000
Interagency Monitoring	$90,000	$170,000	$190,000	$190,000	$190,000	$830,000
BLM	$0	$0	$0	$0	$0	$0
ODF	$260,000	$220,000	$70,000	$90,000	$90,000	$730,000
PNW	$360,000	$310,000	$310,000	$360,000	$360,000	$1,700,000
WWETAC	$420,000	$390,000	$70,000	$0	$0	$880,000
DNR	$0	$0	$0	$0	$0	$0
Total	$1,410,000	$1,630,000	$1,160,000	$1,170,000	$1,170,000	$6,540,000

[4] R6 = USDA Forest Service, Pacific Northwest Region. Interagency monitoring = funding for monitoring contributed by cooperating agencies in monitoring the Northwest Forest Plan. BLM = Oregon/Washington USDI Bureau of Land Management. ODF = Oregon Department of Forestry. PNW = USDA Forest Service, Pacific Northwest Research Station. WWETAC = Western Wildland Environmental Threats Assessment Center. DNR = Washington Department of Natural Resources.

IMAP Methods

IMAP's highest priority will be to use the best models, data, and other tools available to answer user Group Questions. Answering user group questions is the project's highest priority, but much other useful information will be developed for forest plans and other assessments ranging in scale from fine scale to regional. The assessments, tools, and data outlined in this report are not an exhaustive listing of those that might be useful. The IMAP cooperative could develop or adapt alternative methods, tools, and data as new issues and planning needs arise and as necessary to meet partner needs or as new methods, tools, and data become available.

Vegetation and other base data are critical for depicting the current condition

Modeling strata

At the finest scale of resolution, IMAP VDDT models will be run on strata of watersheds (Hydrologic Unit Code 5 or Huc5, averaging about 100,000 acres) and categories of ownership and land allocation. Existing vegetation data will be summarized into area within each VDDT state class, within each watershed, and within each ownership/allocation class. VDDT models do not attempt to track locations of stands within strata. Consequently, model outputs are estimates of area or proportion of area in each VDDT state class and stratum. Since IMAP vegetation data come from GNN and local information, care must be taken not to stratify too finely. *The smallest individual strata should generally be several thousand acres.* Ownership and allocation strata used in current IMAP models include:

1. Huc5 watersheds averaging about 100,000 acres in size
2. Ownership categories – federally managed lands, state lands, private industrial lands, and private non-industrial lands.
3. Land allocation categories – FS general lands, BLM general lands, federal reserves (e.g. late-successional reserves within the Northwest Forest Plan area), wilderness and similar lands, State Forests, wildland-urban interface areas, and land development classes.

VDDT models must incorporate expected annual variation in natural disturbances to be realistic. Natural disturbances are assigned annual severity levels. For example, wildfires may occur in years with moderate, high, or extreme amounts of area burned. Insect outbreaks may occur either somewhat periodically or at random and may include a sequence of years that ramp up the outbreak to a maximum level, then taper off to low levels. The probability of different intensity levels will come from historical records, other modeling processes, or expert opinion. Sequences of disturbance severity years will be drawn at random so that while the sequence of wildfire severity, for example, varies, overall average, long-term probabilities remain constant. Models will usually include many Monte Carlo simulations so the range, mean, and variability of disturbances can be included in vegetation and other landscape characteristics (Hemstrom et al. 2007).

Modeling scale and time frame

IMAP user questions are framed at broad to mid-scales (e.g. several watersheds of 100,000 acres or more) and fine scales (e.g. vegetation patches or stands and aggregations of stands across areas of a few thousand acres to one or two watersheds). The specification of fine-scale versus mid- to broad scale landscapes is related to the availability of sufficiently accurate vegetation data for fine-scale analysis, the availability of habitat models for fine-scale analysis, the practical limitations of computing resources and time for projecting thousands or hundreds of thousands of vegetation patches through time, limitations on confidence in results from spatially-explicit, stand-scale models, and the need to include a variety of vegetation types ranging from forests to woodlands, shrublands, grasslands, and other conditions.

While many additional datasets and models could be used, we currently use somewhat differing methods for assessing current and potential future conditions:

1. Current conditions assessment
    a. Inventory plots (e.g. FIA/CVS plots, DNR inventory plots) can be used to assess current forest structure and composition, wildlife habitat, forest product, and other conditions for relatively large landscapes, depending on plot density and expansion factor. FIA plots, for example, are generally useful for estimating forest conditions across counties and larger landscapes. Sufficient sample size typically limits the finer-scale utility of inventory plots.
    b. Gradient Nearest Neighbor and similar spatial data on vegetation are often useful down to the scale of watersheds (e.g. 100,000 acres) or similar areas depending on the density of empirical data upon which they are based.
    c. Stand maps from aerial photograph interpretation and acquisition processes with similar resolution are useful down to the scale of stands, limited by sampling resolution. Stand maps may not be available for entire landscapes, especially in areas with mixed ownership.
    d. Stand examination plots are useful for characterizing sampled stands or strata from stand scales to larger areas, depending on sampling density and methods.
2. Potential future conditions
    a. Inventory plots and stand-scale silvicultural models (e.g. the Forest Vegetation Simulator – FVS) can be used to project potential future conditions of forest vegetation across landscapes for which inventory data exist. This methodology becomes problematic in large landscapes, especially those of mixed ownership or those with substantial non-forest vegetation types.
    b. State and transition models using initial conditions data from Gradient Nearest Neighbor or similar sources can be used for projecting potential future conditions in areas as small as one or two watersheds (e.g. 100,000 to 200,000 acres) and as large as regions or States.
    c. Spatially explicit landscape disturbance models using initial conditions from stand maps or similar sources can be used to project potential future conditions in areas as small as several thousand acres and as large as one million acres or more. These methods are of limited use for analysis of larger areas due to computational constraints, data storage and analysis problems, or stand-scale data availability.

Recommended Tools and Data

Recommended tools and data for answering User Group Questions come from an analysis of the questions and the kinds of tools and data that may be useful in answering them. The tools and data outlined in this report are not an exhaustive listing of those that might be useful. The IMAP cooperative could develop or adapt alternative methods, tools, and data as necessary to meet partner needs or as new methods, tools, and data become available.

Vegetation and other base data are critical for depicting the current condition of important resources and as inputs to models that simulate likely future trends (Table 1). Existing vegetation data will come from a combination of Gradient Nearest Neighbor (GNN) imputation of inventory plots (e.g. Ohmann and Gregory 2002) to 30 meter pixels (http://www.fsl.orst.edu/lemma/common/studyAreas.php), existing data from field units (if of sufficient accuracy) provided those data can be linked to VDDT state classes, LANDFIRE vegetation data (www.landfire.gov), and GAP products (http://inr.Oregon and Washingtonstate.edu/data_index.html). Potential vegetation data, used to develop environmental strata of VDDT models, come from the same sources, relying heavily upon geographic information systems (GIS) data from National Forests and GNN analysis. Methods for updating of vegetation data over time have been proposed, including change detection and re-mapping GNN plot imputations. Existing vegetation data sets currently range from 1995 vintage to 2000, depending on the dates of remotely sensed imagery used (fig. 2). Existing plans call for mapping all of the IMAP within the Northwest Forest Plan area for two dates (1995 and 2006) by the end of FY2007.

IMAP will approach landscape simulation at multiple spatial scales through coupled non-spatial state and transition models (Vegetation Dynamics Development Tool or VDDT, www.essa.com) stand-scale distance-independent individual tree models (Forest Vegetation Simulator or FVS, http://www.fs.fed.us/fmsc/fvs/), and, where appropriate, spatially-explicit models (e.g. Tool for Exploratory Landscape Scenario Analysis or TELSA, www.essa.com). Other models and modeling approaches may be used as needed. VDDT is a state and transition approach, building on transition matrix methods that represent vegetation development as a set of transition probabilities among various vegetative states (Westoby et al. 1989, Hann et al. 1997, Hemstrom et al. 2007). Vegetative composition and structure define each state class. State classes are also separated into potential vegetation types (PVTs) that determine average productivity, growth rates, and natural disturbance probabilities). IMAP VDDT state classes are categories of cover types (dominant vegetation species in the upper-most canopy layer; Appendix C) and structure classes (Appendix A). States are linked by transitions that represent successional vegetation development over time or disturbance. Successional and growth transitions may be either deterministic – a fixed growth period separates states in the absence of disturbance – or stochastic. Natural disturbances (e.g. wildfire and insect outbreaks) are stochastic events with annual probabilities that depend on state class and environment. VDDT and TELSA are designed to work together so that vegetation states and transition probabilities developed in VDDT are also used in TELSA. VDDT and TELSA models are also stratified by potential vegetation types (Appendix XX) that indicate different environmental conditions that determine the potential for different: 1) successional sequences and vegetation composition, 2) tree growth rates and stand productivity, 3) disturbance regimes (e.g. wildfire frequency and severity) under historical conditions, and 4) wildlife habitat potentials.

Average transition rates and directions due to growth and management activities and average yield streams resulting from management activities are estimated using FVS based on empirical plot data from the Forest Inventory and Analysis (FIA) (Barrett 2004) and Continuous Vegetation Survey (CVS) (Max et al. 1996) sampling systems. FIA and CVS plots are assigned to VDDT model state classes and FVS simulates growth in the absence of disturbance or changes due to management activities. FVS includes numerous treatment and disturbance possibilities and has is parameterized to match empirical growth rates from re-measured plot data. FVS extensions allow simulating fire effects, canopy fuel conditions, and carbon stored in above-ground tree biomass. Average conditions for a variety of resources of interest can be assigned to VDDT state classes and transitions among state classes, including: wildlife habitat suitability, carbon stored in above-ground tree biomass, canopy fuels, ground fuels, fire condition class, and many others.

Timber and Forest Products Information and Tools

Two different approaches would be used to answer questions about timber and forest products production: 1) Using the next Oregon and Washington forest product mill studies and 2) interactively using market driven supply and demand models developed by the Oregon State University College of Forestry (OSU) linked to the mill studies and VDDT models.

The forest product mill studies would provide information about the location and capacity of existing wood products mills and biomass energy plants and the flow of wood fiber harvest through primary timber-processing or biomass energy production. Current and projected technology and investment/disinvestment trends would also be analyzed.

According to Greg Latta (Oregon State University), the model of western Oregon timber markets has five basic components: 1) inventory data describing private lands; (2) assumptions about likely future silvicultural regimes to be applied to those lands; (3) projections of future timber yields under the several regimes; (4) assumptions about changes in timberland area through gains or losses to other uses or owners; and (5) a model that projects future harvests based on inventory and other assumptions, applies the management regimes, and updates the inventory over time.

The market driven timber supply and demand models developed by OSU would be updated using the mill studies and other information. Biomass would be an addition to the OSU models, but updated mill studies and other reports would provide information necessary for that rapidly developing market sector.

The OSU models are best suited for modeling private forests outputs because they would both supply and demand interactions in determining harvest and treatment levels. Private harvest levels would then be brought into VDDT models to determine landscape level ecological and other non-market changes. For public forests, harvest level impacts of a policy change could be determined via other more spatial models such as VDDT or TELSA and then brought into the market model to get the market interaction and subsequent private harvest response, which would then go into VDDT to help determine the output of wildlife habitat and other non-market values.

Land Use Change Information and Tools

Information and tools are being developed to (1) analyze trends in land use, (2) project changes and patterns future land use, and (3) determine implications of land use change on management costs and production on wildland management. Databases and GIS layers documenting historical land use and land use change have been completed for Oregon; work has commenced in Washington and will be completed in the Summer of 2008.

The FIA/ODF land use study information and other data will be used to show the amount of development occurring on wildland and, when combined with other data, to examine socioeconomic and geographic factors that influence the location and rate of development. This development includes changes from wildland to urban and low-density residential areas and changes in numbers of structures in remaining wildland. By comparing this information at selected time intervals, it is possible to analyze changes in development patterns and land use.

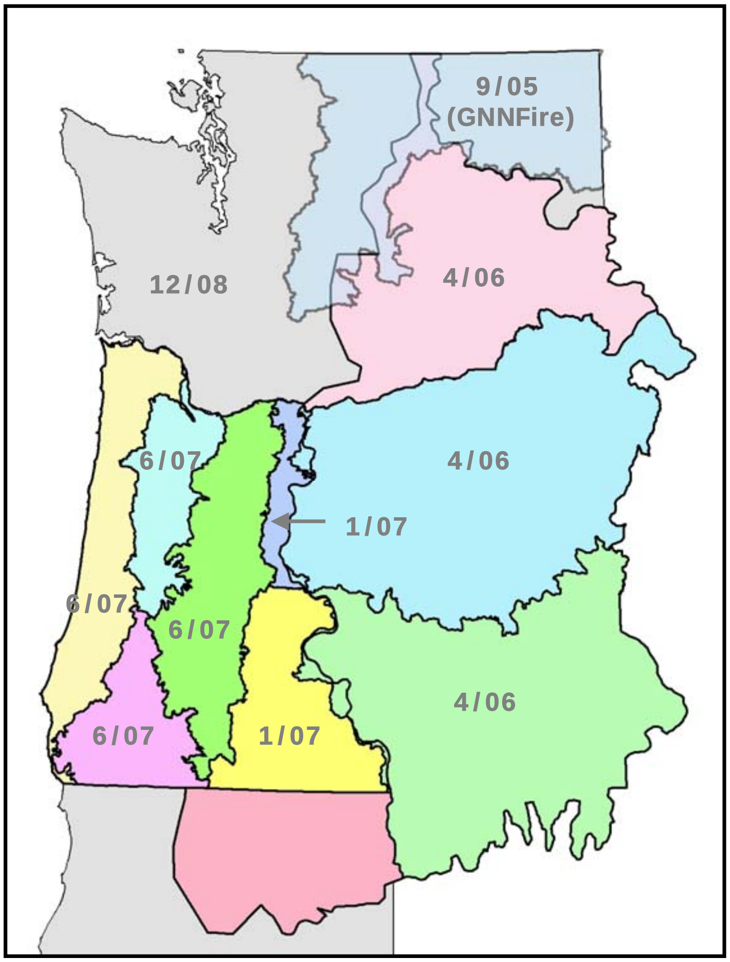
Models to project of future development are being created to project land use changes for broad scale VDDT landscape projections and at finer resolutions to support TELSA models. Broad scale development projections will be based on historical rates of development reported by key strata including current and planned land use zoning, land ownership, and other information, to best portray likely development occurring under alternative scenarios. Finer scale projections will be based on econometric analysis of historical changes as a function of land use zoning, land ownership, topography (e.g. slope and elevation), existing development patterns, driving distances to likely work destinations and natural resource and recreational amenities, and other spatially explicit information.

Policy makers are concerned about the impact of development on the ability of wildlands to continue to produce clean water, wildlife habitat, timber, and other ecosystem services that people have come to expect from the Pacific Northwest's forests. Also of concern is the growing difficulty and expense in protecting wildlands, both public and private, from wildfire as development within wildlands expands. Work will continue to better integrate VDDT and TELSA projections with land use change projections and with indicators of water quality, wildlife habitat, fire protection costs, and other important metrics of forest sustainability. Comparing the impacts on indicators of forest sustainability from projections including different land use policies will help better prepare policy makers for a rapidly changing future.

Vegetation Data

The IMAP mid-scale process requires wall-to-wall data on existing and potential vegetation conditions. Data must suitable for summarization to VDDT model state classes consisting of cover type, structure, and potential vegetation groups. Several different approaches might be used to generate wall-to-wall existing vegetation data. IMAP is currently using a gradient nearest neighbor approach that assigns or imputes inventory plots to 30-meter pixel maps (Ohmann and Gregory 2002). GNN is a cost-effective way to generate multiple-scale vegetation summaries of known quality. GNN uses Forest Inventory Analysis (FIA) and inventory plot data coupled with satellite imagery and other spatial data to populate 30-meter pixel maps with vegetation data. At present, the current vegetation survey (CVS) data collected by USFS is used along with FIA data as the inventory base. In this approach, each pixel is assigned an inventory plot and the entire associated tree list and other plot data. These pixels can be aggregated upwards into "traditional" polygons using eCognition (http://www.definiens.com/) and field validation. Given the dynamic nature of vegetation and the need for vegetation summaries at multiple scales, the cost of producing a polygon map and supporting sample of stand exams across all National Forests and nonfederal ownerships is prohibitive. However, if a local unit has a polygon map with which they are comfortable; those data can be substituted for GNN data as long *as the local data can be summarized to IMAP state classes and are of suitable accuracy*. In addition, the GNN process can use local inventory plots in addition to FIA and CVS plots if inventory plots are available, spatially located, and contain tree list data.

Figure 2. Schedule of Gradient Nearest Neighbor vegetation data products.



Input inventory data to the GNN approach is CVS and FIA grid plots. CVS/FIA is a regionally-available database, with a long-term strategy for continuous inventory and national data stewardship. The GNN approach takes advantage of the Washington Office direction from 1992 to establish a grid of plots across all NFS lands that would be compatible with the FIA grids. Region 6 installed the Current Vegetation Survey (CVS) beginning in 1993 as the strategic inventory to support broad-scale inventory and monitoring of forest and range vegetation of National Forest Lands in the Pacific Northwest Region (Max et al. 1996). BLM followed suit, implementing the CVS plots on their lands in the NWFP area. The CVS plots on the 3.4-mile grid will transition to FIA's annual inventory which will provide funding and administer ongoing re-measurement of these plots. The CVS plots on the 1.7-mile grid ("intensification plots") will continue to be supported by R6, and re-measured according to the FIA annual inventory protocol.

FVS Methods

IMAP is designed to meet multi-scale landscape analysis needs from project planning to regional assessments. While the project planning scale link is still in development, the need to connect mid-scale models and analyses to empirical plot-scale data is important. The transitions due to vegetation development, management activities, and natural disturbances in IMAP VDDT and TELSA models should mirror stand development and reaction trajectories at stand scales. Growth and yield estimations from mid-scale VDDT models should be in line with averages from stand-scale projections. Vegetation fuel conditions calculated from stand-scale data should match those estimated across landscapes with VDDT models. All these issues point to a need to calibrate VDDT and TELSA models with stand-scale vegetation development and management models. We have chosen to link IMAP state and transition models to empirical inventory plots and stand-scale projections made with the Forest Vegetation Simulator (FVS) ((Dixon 2002)). Unfortunately, we do not have a similar stand-scale vegetation simulation model for non-forest conditions, so must at present rely on expert opinion and the sparse published literature for estimating transition rates and reactions to management and disturbance for non-forest vegetation types.

The process to link state and transition models to stand-scale simulation models requires several steps:

1. State and transition model state classes are defined in quantitative terms (e.g. tree diameters, canopy cover, stand density, species composition) that can be translated into a rule set for classifying inventory plot data into model state classes.
2. Inventory plots are individually assigned to state classes using the rule set and plot scale measurements.
3. The FVS model is calibrated to accurately reflect forest growth and development within VDDT model potential vegetation groups using re-measured inventory plot data.
4. The plots comprising each VDDT model potential vegetation type are run through many growth cycles without management or disturbance to estimate average transition time and direction due to growth and development alone.
5. Sets of management activities are designed to reflect the kinds of treatments that might occur on the ground and implemented as FVS model runs.
6. Inventory plots comprising VDDT model state classes are run through management treatment runs to estimate stand reaction, generate tables of forest products generated by the activity, and resulting canopy fuels conditions.
7. Natural disturbances (major insect outbreaks and wildfires) are implemented in FVS as model runs.
8. Inventory plots (treated and un-treated) are run through natural disturbances in FVS to estimate tree mortality, ending stand structure/composition, ending fuel conditions, and salvage potential.
9. State and transition models are updated to reflect estimated transition rates, transition directions, forest products yields, fuel conditions, and other factors.

The process of using inventory data and FVS to calibrate VDDT and TELSA model state classes, transitions, and yield streams is well underway and being developed as a semi-automated system (personal communication, Melinda Moeur, USDA Forest Service). The process has also been used previously by Forest Planning teams on the Wenatchee, Okanogan, Colville, Malheur, Umatilla, and Wallowa-Whitman National Forests.

Wildlife habitat models

Several approaches might be used for assessing wildlife habitat suitability and trends at mid- and fine scales. We have chosen two approaches that follow methods currently used by the USDA Forest Service Pacific Northwest Region (R6) and Oregon and Washington Departments of Fish and Wildlife (DFW). The first approach involves linking analyses of suitable habitat based on vegetation cover types, structure, patch conditions, connection, and other attributes related to IMAP state and transition models. At present, the R6 approach links vegetation cover types and structure classes from IMAP VDDT models to source habitats for species of conservation concern and focal species using Bayesian Network models (Wisdom et al. 2000). The similar DFW approach uses habitats described by Johnson and O'Neil (2001a) and species linked to those habitats. IMAP state and transition model state classes are developed so that they can be explicitly linked to habitat descriptions used in both approaches. Area of suitable habitat at present, under historical conditions, or potentially available in the future under different management scenarios can be linked to species population trends using the R6 focal species approach. In addition, any wildlife habitat assessment that uses similar vegetation characteristics could be done using IMAP data. At mid- and broad scales (e.g. areas of many watersheds and larger sizes), IMAP models and data provide stratum-level information and projections rather than stand-scale detail. Habitat assessments of potential future conditions that require stand or patch scale detail will also require fine-scale modeling using TELSA or a similar spatially explicit model.

The second approach used by IMAP Partners analyzes current habitat conditions, including patch characteristics, from GIS grid cell data depicting current vegetation. BIOMAPPER (Hirzel 2000) and FRAGSTATS (McGarigal and Marks 1995) are examples habitat analysis tools in common use. Both tools could be used with either IMAP state and transition model classes or other data from GNN imputation as inputs. There may be inconsistencies in results, however, if current conditions are analyzed using different class characteristics and potential future conditions are analyzed using state and transition model classes. We suggest an analysis that includes both current and future conditions use state and transition model classes as a common base. In addition, differences need to be reconciled between current habitat conditions estimated with BIOMAPPER or FRAGSTATS and those estimated by Bayesian models.

Riparian Sediment and Debris Routing Models

Integration of riparian and aquatic systems into IMAP landscape analyses will require integration of upland disturbances and management effects with riparian and aquatic habitats and conditions. We suggest that spatially explicit state and transition models (e.g. TELSA) could be linked to riparian sediment and debris models. Research funded by the Oregon Watershed Enhancement Board and conducted by Steve Wondzell (PNW Research Station, Olympia, WA) and colleagues will construct example spatially explicit state and transition models in two areas in Oregon. These models could be linked to projected inputs of sediment and large woody debris from NetMap (Benda et al. 2007) for analyses User Group questions related to riparian and aquatic topics.

IMAP User Group Questions

TOPIC A: Land Use Change

A1. How much wildland is there?

A2. Where is wildland currently being developed for other uses?

A3. What areas of wildland are likely to be developed in the future?

A4. How might alternative management policies affect where wildland development occurs in the future?

A5. How might wildland development and fragmentation affect potential wildfire behavior and risk in the future?

A6. How might wildland development and fragmentation affect potential ecosystem services including carbon sequestration and potential to generate forest products in the future?

<u>Background</u> Area of forest land is a key to the economies, lifestyles, and environmental benefits enjoyed by Pacific Northwest residents and visitors alike. Consequently, an enduring policy concern has been conversion of Oregon and Washington's and Washington's forests and farms to more developed uses. To meet State and Federal mandates, maintaining the Pacific Northwest's wildland base for producing fish and wildlife habitat, timber, and other traditional forest values on a sustainable basis is important to IMAP cooperators.

With passage of Oregon and Washington's land use laws, land development has slowed. Even so, the number of dwellings on private forest and agricultural lands continues to grow, albeit at a slower than historical rate. Development of forest land in Washington continues at high rates and the future of land use planning in Oregon and Washington is unclear. With development likely to continue, it is important to know where this development will occur and what impact it will have on production of forest values.

Understanding what areas of wildland are likely to be developed in the future is necessary to complete assessments of capability of Pacific Northwest forests to produce timber, non-commodity forest products, recreation, water, fish and wildlife habitat, and other forest values and to determine the likely consequences of land use and other forest policies. This information will also help policymakers better manage wildfire, including examining likely future changes in the wildland-urban interface (WUI), determine future forest fuel hazards, assess changes in the fire risk associated with WUI areas, and assist in numerous other agency and private analyses.

<u>Methodology Description</u> Area of forest land will be determined from FIA inventory data and from existing vegetation Geographic Information Systems (GIS) data. These data will be used to show the amount of forest land by ownership, land class, and by forest use: reserved, wood

production, multiple resources, and urban. Separate and different from but integrated with FIA forest plot information, FIA/ODF land use study information and other data will be used to show the amount of development within forested areas and in forested structural stages on private lands. Development of private forest land will be modeled using information developed in FIA/ODF land use change studies and similar information for the state of Washington.

For all ownerships, broad scale forest vegetation maps and tabular data will be developed with gradient nearest neighbor (GNN) methodology using FIA and other data. For some areas more detailed vegetation data will be developed by IMAP using image segmentation processing based on GNN data. Changes in wildland area on public lands and impacts of forest area changes on forest values for all forest lands will then be projected using VDDT models. For all ownerships, land use changes will be translated into disturbances that cause some portion of a set of IMAP state and transition model (STM) boxes that represent wildland vegetation to move to developed condition. Development rates calculated from the FIA/ODF data sets and other information will be incorporated into the STM and will be used as the basis for different scenarios about where and at what rate development will occur in different wildlife habitats, fire risk areas, and other areas of interest to analysts and policy makers.

Given the strata for which the STM are developed, projections will be possible for combinations of watershed, ownership/allocation strata, and potential vegetation type. Maps showing where development might occur could be made for watersheds, ownership/allocation, and potential vegetation group strata. Information on land use change will be input to timber supply and other models used to project outputs of forest values, including ecosystem services and other special attributes, under alternative forest policies. Linkage of development disturbances and changes to from wildlands to developed lands to wildlife habitats are included in IMAP VDDT models and vegetation cover and structure classes.

Table 4. Matrix of data, applications, spatial scale, and other information required to answer Topic C questions. Question statements are abbreviated forms of those in text body.

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/Contact	Limitations/Considerations
A1. How much wildland is there?	No[5]	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional	• Gary Lettman - ODF	• Tabular estimates only – non-spatial
	Yes[6]	GNN and other existing vegetation GIS data	GIS analysis	• Watershed and larger	• Melinda Moeur – R6	• Relies on combination of GNN and other data – unknown variability when combined
A2. Where is wildland currently being developed for other uses?	Yes in Oregon	FIA/ODF and other land use change data	GIS and database analysis	• County groupings • Statewide • Regional	• Gary Lettman - ODF	• Data are available for Oregon, but not Washington • Links between land use data sets and fire modeling and other assessment work have yet to be developed.
A3. What areas of wildland are likely to be developed in the future?	Yes in Oregon	• FIA/ODF and other land use change GIS data • GNN and other existing vegetation GIS data • VDDT modeling strata	VDDT projections	VDDT modeling strata within watersheds and larger landscapes	• Jeff Kline - PNW • Gary Lettman – ODF • Miles Hemstrom - PNW	• Links between land use data sets and fire modeling and other assessment work have yet to be developed.
A4. How might alternative management policies affect where wildland development occurs in the future?	Yes in Oregon	• FIA/ODF and other land use change GIS data • GNN and other existing vegetation GIS	VDDT projections	VDDT modeling strata within watersheds and larger landscapes	• Jeff Kline - PNW • Gary Lettman – ODF • Miles Hemstrom -	• Links between land use data sets and fire modeling and other assessment work have yet to be developed.

[5] Data and models for inventory plot analysis are not part of standard IMAP deliverables. FIA data analysis apart from that used to calibrate state and transition models is not a standard part of IMAP, but FIA data could be used to answer the question at the given scale.
[6] Standard data and models are developed for historical conditions and current management as part of normal IMAP work. Users need to develop and run their own model scenarios to represent different management or policy approaches.

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/Contact	Limitations/Considerations
		data • VDDT modeling strata			PNW	
A5. How might wildland development and fragmentation affect potential wildfire behavior and risk in the future?	Yes in Oregon	• FIA/ODF and other land use change GIS data • GNN and other existing vegetation GIS data • VDDT modeling strata – including WUI	VDDT projections	VDDT modeling strata within watersheds and larger landscapes	• Jeff Kline - PNW • Gary Lettman – ODF • Miles Hemstrom – PNW • Alan Ager – WWETAC • Wayne Landis – WWU • Becky Kerns - WWETAC	• Assumptions about fuel treatments in developed lands will be required. • Requires choice of WUI area to be specified • Requires risk analysis methodology • Projections of fuels/vegetation with and without development
A6. How might wildland development and fragmentation affect potential ecosystem services including carbon sequestration and potential to generate forest products in the future?	Yes in Oregon	• FIA/ODF and other land use change GIS data • GNN and other existing vegetation GIS data • VDDT modeling strata	• VDDT models •	VDDT modeling strata within watersheds and larger landscapes	• Jeff Kline - PNW • Gary Lettman – ODF • Miles Hemstrom - PNW • Darius Adams – OSU • Barb Wales – R6/PNW • Andrew Yost - ODF	• Assumptions about fuel treatments in developed lands required. • Carbon sequestration link to VDDT models output required • Timber supply model link to VDDT model output required • Other ecosystem services link to VDDT model output required

Related State, National, or International Indicators of Forest Sustainability Indicators, benchmarks, and performance measures are measurement tools used by most public forestry agencies for conveying critical and complex information more simply. They can tell us what current conditions and trends are and can be used to benchmark projections of future resource trends. They can also be used to build public confidence and facilitate better communication and cooperation among all parties interested in forest resources. Examples of commonly referenced indicators related to land use change include:

Montreal Process: Criterion 2—Maintenance of the productive capacity of forest ecosystems: Indicator 10: Area of forest land and net area of forest land available for timber production.
Northeastern Area—Area of timberland.
Heinz Center—Forest area and ownership.
Heinz Center—Forest pattern and fragmentation.
Oregon Benchmark #81—Percent of Oregon and Washington's non-federal forest land in 1974 still preserved for forest use.
Oregon Indicator of Forest Sustainability Ca—1) Area of Oregon and Washington's non-federal wildland forest; 2) Parcelization of private forest land.

Meeting Agency Business Needs. Area and location of forest land, how this might change over time, and how this might affect forest values and outputs of ecosystem services over time is an essential element in all IMAP partners monitoring and assessment work. IMAP partners recognize that monitoring and assessment must be landscape level and across all ownerships. The amount, condition, and trends in forest land on one ownership will affect the production of forest and range values on other ownerships. In addition, the amount of forest land is a metric in all international, national, and state indicators of forest sustainability.

Area and location of development affects the production of other forest values, such as wildlife habitat quality through connectivity, and is an important element in examining current forest issues, such as fire risk, across the landscape and across all ownerships. Development location is a key element of land use policy in many states and, in concert with parcelization, relates to metrics in national, state, and other indicators of forest sustainability.

Table 5. Products generated to answer Topic A questions. Question statements are abbreviated forms of those in text body.

Products	*Description*	*General Applications*	*Users*	*Specific Applications*
Tables and maps of important forest land cover and structure categories by stratum (e.g., dominant land use and amount of development within forested and range areas by cover types and structure groups) for specific modeling simulation time steps (e.g. current, 10, 25, 50, & 100 years)	• Tables - addressing status and trend of indicators of forest sustainability and other uses. • Maps provide visual mid-scale summaries of status and trend of forest and range land cover in different vegetation conditions at specific modeling time steps.	• Allow comparison of vegetation characteristics through time and among management scenarios. • Identify the present and projected amount of forest and range land and the amount of development within forest or range land for different owners • Identify the landscapes in which development is occurring and likely to occur in the future • Identify availability of and where important changes to ecosystem services might occur across mid- and broad scale landscapes.	Oregon Board of Forestry	Current and potential future conditions under different forest management policy scenarios for: • *Oregon Benchmark #81*—Percent of Oregon and Washington's non-federal forest land in 1974 still preserved for forest use. • *Oregon Indicator of Forest Sustainability Ca*—1) Area of Oregon and Washington's non-federal wildland forest; 2) Parcelization of private forest land. • *Oregon Indicator of Forest Sustainability Ea*—Composition, diversity, and structure of forest vegetation • *Oregon Indicator of Forest Sustainability Eb* —Extent of area by forest cover type in protected area categories • Determine how past and future development on private lands affects production of forest values from public forests.
			• USDA Forest Service R6 • USDI Bureau of Land Management • Washington Department of Natural Resources	Historical, current, and potential future conditions under different forest management policy scenarios for: • Important vegetation conditions (e.g. old forests, high quality rangelands, juniper invasion, etc.) • Departure of current and potential future conditions from historical conditions • Where past and future development on private lands affects production of forest values from public forests.
Maps of ecosystem service potential	These maps will be derived from VDDT outputs by relating cover types, structures, and ancillary data to indicators of ecosystem services	These maps will provide initial information as we begin identifying the present and projected conditions of ecosystem services	Oregon Board of Forestry	*Oregon Indicator of Forest Sustainability Cb*—Forest ecosystem services contributions to society
			USDA Forest Service	Forest Plan Revisions
Tables and maps showing probable	These tables and maps will be based on	Provide information about future timber supply,	Oregon Board of Forestry	*Oregon Indicator of Forest Sustainability Cb*—Timber harvest trends compared to planned and projected harvest levels, and

Products	*Description*	*General Applications*	*Users*	*Specific Applications*
changes in timber supply and forest products industry infrastructure under alternative land use policies	timber supply modeling specifically incorporating alternative state and federal land use change policies.	industry investment and the location of production facilities		the potential to grow wood *Oregon Indicator of Forest Sustainability Bd*—Forest products sector vitality
			USDA Forest Service	Forest Plan Revisions

TOPIC B: Forest Characteristics and Ecosystem Services

B1a. What is the current mix and spatial distribution of vegetation cover types and stand structural stages?

B1b. How might different management approaches and natural disturbances alter the mix and spatial distribution of vegetation cover types and stand structural stages in the future?

B1c. What are the current effects of vegetation conditions on important ecosystem services including carbon sequestration and potential to generate forest products?

B1d. How might different management approaches and natural disturbances alter important ecosystem services including carbon sequestration, and potential to generate forest products in the future?

B2. What integrated strategies and opportunities (e.g. increased carbon sequestration) could be used to achieve policy goals such as improving vegetation health and the sustainability of resource outputs, enhancing local economies, and maintaining desired vegetation characteristics?

Background Topic B questions revolve around the interactions of vegetation cover and structure with natural disturbances, management activities, and climate change that produce a variety of ecosystem services now and in the future. Ecosystem services are the conditions and processes through which natural ecosystems and the species that make them up, sustain and fulfill human life (Daily 1997, Chee 2004). Vegetation is the source of primary production and a primary determinant for many important ecosystem services, including: habitat for many important wildlife species, the flow of economically important products, sequestration of carbon, recreation, and others. Changes in vegetation as a result of different management approaches, natural disturbance regimes, and climate change may substantially alter the mix of services provided by ecosystems now and in the future. An integrated evaluation of the combined, synergistic effects of different management approaches, natural disturbance regimes, and assumed future climate conditions will help policy makers, managers, and other interested parties understand how current and future management choices might influence important ecosystem services in the future.

Methodology Description

B1a. What is the current mix and spatial distribution of vegetation cover types and stand structural stages?

Gradient Nearest Neighbor (GNN) data combined with local unit vegetation data provides information for generalized summaries and maps of Oregon and Washington's vegetation at present. GNN data already exist for all of eastern Oregon and Washington and are nearly complete for western Oregon and Washington. While the pixel level data are not likely sufficiently accurate for map display, cover type and structural stages can be summarized and displayed by watershed (Huc5) and ownership/allocation strata.

FIA/CVS plots, with any associated species lists, can be assigned to VDDT vegetation state classes. The Forest Vegetation Simulator could then be used to refine transitions among state classes and to estimate yield streams associated with forest management, carbon stored in trees, forest canopy fuel conditions, and similar attributes. This approach links mid-scale, stratum level VDDT estimates of vegetation growth, management reaction, and vegetation characteristics to empirical plot data and a stand-scale silvicultural model. For example, wildlife habitat for key species could be estimated from area in a combination of VDDT state classes that are important to meet species requirements. Tree data could be interpreted in terms of carbon stored in trees of varying species and size, allowing estimates of average carbon stored in landscapes to be made for current and future conditions. Species lists to from plots could be used to estimate species richness or other species diversity attributes by VDDT model stratum. Projected future conditions under different policy scenarios can come from VDDT models and could be used to re-map selected ecosystem services under future conditions.

B1b. How might different management approaches and natural disturbances alter the mix and spatial distribution of vegetation cover types and stand structural stages in the future?

Various management scenarios would be developed from User Group, policy maker, land manager, or public input. Management scenarios will be translated into VDDT models that would be run to estimate potential future vegetation, disturbance conditions, and management activities. Any vegetation cover or structure condition that could be summarized from VDDT cover types, structure classes, management activities, or natural disturbances could be displayed at multiple spatial scales from regions to watersheds and ownership-allocation strata within watersheds. Due to the mid-scale nature of existing vegetation and other data used in the modeling process model projections should not be used below the scale of watersheds and ownership-allocation strata. Finer-scale analyses might be possible if higher-resolution data were available.

B1c. What are the current effects of vegetation conditions on important ecosystem services including carbon sequestration and potential to generate forest products?

Vegetation and disturbance conditions will be linked to ecosystem services through look-up tables or external models. Since VDDT model state classes will be associated with a set of FIA/CVS inventory plots, tree lists from plots will be used to calculate forest products characteristics, carbon storage, and other average plot-scale conditions represented by model state classes. The FVS model currently contains links to carbon stored in trees by size and species, so carbon storage can be easily calculated for each state class that contains trees and inventory plots. Watersheds might be color coded, for example, to show current levels of carbon stored in above ground tree biomass. At present, only a few key ecosystem services (carbon stored above ground vegetation, timber products, biomass products, wildlife habitat) can be explicitly linked to vegetation cover type, structure class, tree cut lists, natural disturbances and management activities modeled in VDDT. It seems likely that other ecosystem services that derive mainly from vegetation conditions, natural disturbances, and management activities (e.g. some aspects of recreation value) might also be linked to model outputs. Current conditions analyses need not be constrained to VDDT state classes since individual FIA/CVS plots can be used to analyze ecosystem service and other current conditions for individual plots.

B1d. How might different management approaches and natural disturbances alter important ecosystem services including carbon sequestration, and potential to generate forest products in the future?

Vegetation and disturbance conditions would be linked to ecosystem services through look-up tables or other external models. This would allow examination of potential longer-term effects of various management approaches on ecosystem services. It would also provide information to aid prioritization of landscapes for management action to reduce risks of loss of important services. Watersheds might be color coded, for example, to show where fuel treatments might economic returns, have significant effects on important wildfire risks, and have favorable or neutral effects on wildlife habitats. At present, only a few key ecosystem services (carbon stored above ground vegetation, timber products, biomass products, wildlife habitat) can be explicitly linked to vegetation cover type, structure class, tree cut lists, natural disturbances and management activities modeled in VDDT. It seems likely that other ecosystem services that derive mainly from vegetation conditions, natural disturbances, and management activities (e.g. some aspects of recreation value) could also be linked to model outputs. Future conditions for forest lands could be estimated for individual FIA plots as well using the FVS model as long as management scenarios can be translated into FVS model simulations. However, FVS methods do not easily integrate a variety of natural disturbances, so can be somewhat limited regarding integrated landscape analyses.

B2. What integrated strategies and opportunities (e.g. increased carbon sequestration) could be used to achieve policy goals such as improving vegetation health and the sustainability of resource outputs, enhancing local economies, and maintaining desired vegetation characteristics?

VDDT models could be used to examine the potential effects of various management approaches on longer-term forest products outputs, forest vegetation conditions (e.g. older forests, forest fuels, etc.), biomass supply potential, wildlife habitats, and others. The modeling approach does not optimize outputs, but does allow examining a variety of approaches to understand potential effects. Since models can be run and outputs examined at multiple scales from watersheds and ownership-allocation strata to larger areas, effects of different management approaches could be examined from local to regional perspectives. Optimization approaches have been used with FVS models and FIA/CVS inventory plot data (Bettinger et al. 1997, Sessions et al. 1999, Bettinger et al. 2004), but may be difficult to develop for integrated questions, large landscapes, and non-forest land.

Table 6. Matrix of data, applications, spatial scale, and other information required to answer Topic B questions. Question statements are abbreviated forms of those in text body.

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
B1a. Current vegetation cover and structure types?	No[7]	Inventory plots	Inventory database analysis with FVS and other tools	•County groupings •Statewide •Regional	Who?	• Forested lands only
	Yes	GNN and other existing vegetation GIS data	GIS and other tools	Ownership & allocation classes within watersheds and larger landscapes		• May use combinations of GNN and other data – unknown variability when combined • Pixel-scale GNN data may not be reliable when used at scales finer than VDDT modeling strata.
B1b. Potential future vegetation cover and structure types	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forested lands only • Requires development of alternative management scenarios for the future and FVS prescriptions/runs to match
	Yes	GNN and other existing vegetation GIS data	VDDT projections	VDDT modeling strata within watersheds and larger landscapes		• Requires development of alternative management scenarios for the future and VDDT prescriptions/runs to match • Ability to run future scenarios is standard, but only historic and current management scenarios are built as standard products.
B1c. Current ecosystem services	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forested lands only • Linkage to ecosystem services attributes limited to carbon and a few others at present
	Yes	GNN and other	GIS and other	Ownership &		•

[7] Data and models for inventory plot analysis are not part of standard IMAP deliverables. FIA data analysis apart from that used to calibrate state and transition models is not a standard part of IMAP, but FIA data could be used to answer the question at the given scale.

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
		existing vegetation GIS data	tools	allocation classes within watersheds and larger landscapes		ay use combinations of GNN and other data – unknown variability when combined • Pixel-scale GNN data may not be reliable when used at scales finer than VDDT modeling strata. • Linkage to ecosystem services attributes limited to carbon and a few others at present
B1d. Potential future ecosystem services	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forested lands only • Requires development of alternative management scenarios for the future and FVS prescriptions/runs to match • Linkage to ecosystem services attributes limited to carbon and a few others at present
	Yes	GNN and other existing vegetation GIS data	VDDT projections	VDDT modeling strata within watersheds and larger landscapes		• Linkage to ecosystem services attributes limited to carbon and a few others at present • Requires development of alternative management scenarios for the future and VDDT prescriptions/runs to match • Ability to run future scenarios is standard, but only historic and current management scenarios are built as standard products.
B2. Strategies and opportunities to integrate and improve vegetation conditions, resource outputs, local economies, and ecosystem services	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forested lands only • Optimization methodologies for combined objectives will prove difficult. Scenario gaming might be used. • Requires a process to integrate individual ecosystem services and resource conditions into combined opportunities or priorities. Decision support tools such as Bayesian

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
						network models[8] or EMDS could be used. • Linkage to ecosystem services attributes limited to carbon and a few others at present • Ability to run future scenarios is standard, but only historic and current management scenarios are built as standard products.
	Yes	GNN and other existing vegetation GIS data	VDDT projections	VDDT modeling strata within watersheds and larger landscapes		• Linkage to ecosystem services attributes limited to carbon and a few others at present • Optimization with VDDT models is not currently possible – use scenario gaming instead. • Requires development of alternative management scenarios for the future and VDDT prescriptions/runs to match • Requires a process to integrate individual ecosystem services and resource conditions into combined opportunities or priorities. Decision support tools such as Bayesian network models or EMDS could be used.

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Table 7. Products generated to answer Topic B questions. Question statements are abbreviated forms of those in text body.

Products	***Description***	***General Applications***	***Specific Applications***
B1a. Current vegetation cover and structure types	From FIA data analysis • Tabular data or maps by counties and larger area showing current conditions for forested lands with associated text descriptions From GNN and other vegetation map data analysis • Watershed stratum and larger maps and tabular data showing current vegetation cover and structure conditions for watershed strata or larger combinations with associated text descriptions.	• Description of vegetation characteristics at present to provide an assessment of the current condition for planning and analysis purposes • Establish a baseline for comparison of potential future conditions under alternative management approaches • Provide a basis for comparison to historical ranges	Oregon Board of Forestry and Washington Board of Natural Resources Current conditions for: • *Oregon Indicator of Forest Sustainability Ea*—Composition, diversity, and structure of forest vegetation • *Oregon Indicator of Forest Sustainability Eb* —Extent of area by forest cover type in protected area categories USDA Forest Service R6, USDI Bureau of Land Management, and Washington Department of Natural Resources Current important vegetation conditions (e.g. old forests, high quality rangelands, juniper invasion, etc.)

Products	***Description***	***General Applications***	***Specific Applications***
B1b. Potential future vegetation cover and structure types	From FIA data analysis • Tabular data or maps by counties and larger area showing potential future conditions under different management approaches for forested lands with associated text descriptions From GNN and other vegetation map data analysis • Watershed stratum and larger maps and tabular data showing potential future vegetation cover and structure conditions for watershed strata or larger combinations with associated text descriptions. • Watershed stratum scale summaries and maps.	• Description of potential future vegetation characteristics under different management approaches to evaluate trends toward desired conditions • Provide a basis for comparison of potential future trends to historical ranges	Oregon Board of Forestry and Washington Board of Natural Resources Potential future conditions under different management approaches for: • *Oregon Indicator of Forest Sustainability Ea*— Composition, diversity, and structure of forest vegetation • *Oregon Indicator of Forest Sustainability Eb* — Extent of area by forest cover type in protected area categories USDA Forest Service R6, USDI Bureau of Land Management, and Washington Department of Natural Resources Potential future conditions under different management approaches for important vegetation conditions (e.g. old forests, high quality rangelands, juniper invasion, etc.)

Products	Description	General Applications	Specific Applications
B1c. Current ecosystem services	From FIA data analysis • Tabular data or maps by counties and larger area showing current ecosystem services for forested lands with associated text descriptions From GNN and other vegetation map data analysis • Watershed stratum and larger maps and tabular data showing current ecosystem services conditions for watershed strata or larger combinations with associated text descriptions.	• Description of ecosystem services at present to provide an assessment of the current condition for planning and analysis purposes • Establish a baseline for comparison of potential future conditions under alternative management approaches	Oregon Board of Forestry and Washington Board of Natural Resources Current conditions for: USDA Forest Service R6, USDI Bureau of Land Management, and Washington Department of Natural Resources
B1d. Potential future ecosystem services	From FIA data analysis • Tabular data or maps by counties and larger area showing potential future ecosystem services under different management approaches for forested lands with associated text descriptions From GNN and other vegetation map data analysis • Watershed stratum and larger maps and tabular data showing potential future ecosystem services for watershed strata or larger combinations with associated text descriptions.	• Description of potential future ecosystem services under different management approaches to evaluate trends toward desired conditions	Oregon Board of Forestry and Washington Board of Natural Resources Potential future conditions under different management approaches for: • USDA Forest Service R6, USDI Bureau of Land Management, and Washington Department of Natural Resources

Products	***Description***	***General Applications***	***Specific Applications***
B2. Integrated opportunity analysis	From FIA data analysis • Tabular data, maps, and associated text by counties and larger area showing potential synergistic opportunities under different management approaches for forested lands with associated text descriptions From GNN and other vegetation map data analysis • Watershed stratum and larger maps, tabular data, and text showing potential synergistic opportunities across watershed strata or larger areas.	• Prioritization of management activities and other land owners/managers across larger landscapes to get the most bang for the buck	Oregon Board of Forestry and Washington Board of Natural Resources Potential future conditions under different management approaches for: • Integrated prioritization of activities or funding to achieve multiple objectives • Integrated prioritization of interactions with multiple land owners to achieve larger policy objectives USDA Forest Service R6, USDI Bureau of Land Management, and Washington Department of Natural Resources • Integrated prioritization of activities or funding to achieve multiple objectives • Integrated prioritization of interactions with multiple land owners to achieve larger policy objectives

TOPIC C: Wildlife habitat conditions and trends

C1a. What are the current mid-scale (e.g. several watersheds and larger) amount, composition, and pattern of habitat for key wildlife species?

C1b. How might different management approaches, natural disturbances, and climate change alter the mid- and broad scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?

C1c. How might future changes in habitat amount, composition, and pattern affect mid- and broad scale population trends for key wildlife species?

C2a. What are the current fine scale (e.g. several watersheds and larger) amount, composition, and pattern of habitat for key wildlife species?

C2b. How might different management approaches, natural disturbances, and climate change alter the fine scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?

C2c. How might future changes in habitat amount, composition, and pattern affect fine scale population trends for key wildlife species?

<u>Background</u> Topic C questions relate to the current amounts, distributions, and patterns of habitat for important wildlife species, potential trends in habitats with future climate change, different management policies/scenarios, and natural disturbances, and the effects of wildlife habitats on wildlife species populations and population trends. The questions are framed at broad to mid-scales (e.g. several watersheds of 100,000 acres or more) and fine scales (e.g. vegetation patches or stands and aggregations of stands up across areas of a few thousand acres to one or two watersheds). The specification of fine-scale versus mid- to broad scale landscapes is related to the availability of sufficiently accurate vegetation data for fine-scale analysis, the availability of habitat models for fine-scale analysis, the practical limitations of computing resources and time for projecting thousands or hundreds of thousands of vegetation patches through time, limitations on confidence in results from spatially-explicit, stand-scale models, and the need to include a variety of vegetation types ranging from forests to woodlands, shrublands, grasslands, and other conditions. Broad and mid-scale analyses and projections of potential future habitat conditions and trends would be done from VDDT model outputs. Fine scale analyses and projections would require the use of TELSA or some similar spatially explicit model.

There are many ways to assess current and future wildlife habitat conditions and trends. Since IMAP develops base information on current and potential future vegetation cover type and structure class, interpreting wildlife habitat with IMAP data involves linking vegetation cover and structure classes to wildlife habitats. Current IMAP partners use similar but not identical habitat classifications:

- Oregon Department of Fish and Wildlife - (Johnson and O'Neil 2001a)
- Washington Department of Fish and Wildlife - (Johnson and O'Neil 2001a)

- USDA Forest Service, Pacific Northwest Region – (Johnson and O'Neil 2001a) and (Wisdom et al. 2000)

IMAP vegetation cover and structure classes were developed to link to the Johnson and O'Neil (2001a) classification. While there are some minor differences because the IMAP process has to consider forest products, fire and fuel characteristics, and other vegetation classification as well as wildlife habitat, IMAP vegetation classes are designed to allow landscape wide analyses within Oregon and Washington.

Methodology Description

C1a. What are the current mid-scale (e.g. several watersheds and larger) amount, composition, and pattern of habitat for key wildlife species?

Mid- and broad scale assessments of current habitat conditions and trends could be done with a variety of processes that link the amount of vegetation cover type and structure classes within VDDT modeling strata to wildlife habitats. Johnson and O'Neil (2001b), for example, describe habitat conditions for a variety of wildlife species in Oregon and Washington and IMAP VDDT state classes closely approximate their wildlife habitat classes. Wisdom et al (2000) provide a somewhat different approach that uses Bayesian Belief Network models to estimate current conditions in habitat and population status. Habitat assessments using Johnson and O'Neil (2001a) and Wisdom et al. (2000) are possible using IMAP vegetation classes and an explicit cross-walk between IMAP classes and their habitat descriptions. IMAP also develops simulation models of historical (i.e. prior to 1850) vegetation and disturbance conditions that can be used to compare current habitat amounts within VDDT modeling strata to historical amounts. Because the mid-scale data are not normally sufficiently accurate for analysis of habitat patches, landscape pattern of habitats could only be inferred from habitat amount within watershed and ownership-allocation strata.

Mid- to broad scale wildlife habitat issues that require analyses of patch characteristics would also require current vegetation data at 30-meter pixel or similar scales. In this case, GIS-based analyses of stand-scale vegetation data for current conditions could be done using FRAGSTATS (McGarigal and Marks 1995), BIOMAPPER (Hirzel 2000) or other tools. The existence of standard IMAP vegetation classes that link to wildlife habitat classes used by partner agencies will facilitate landscape-wide habitat analysis provided that local vegetation data can be placed into IMAP vegetation classes.

C1b. How might different management approaches, natural disturbances, and climate change alter the mid- and broad scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?

Mid- and broad scale assessments of potential future habitat conditions and trends could be done using the same habitat classification cross-walk process as used for assessing current habitat condition. Simulation outputs of amounts of vegetation state classes by

VDDT modeling stratum using different management scenarios, climate change assumptions, and natural disturbance levels would be linked to wildlife habitat classifications. The relative abundances of important habitats under varying future conditions could be compared to evaluate the effects of management policies and climate change assumptions on wildlife habitats. . Since IMAP develops simulation models of historical (i.e. prior to 1850) vegetation and disturbance conditions simulated future conditions under varying management policies, climate change assumptions, and natural disturbance regimes can be compared current habitat amounts. Because the mid-scale data are not normally sufficiently accurate for analysis of habitat patches, future landscape pattern of habitats could only be inferred from habitat amount within watershed and ownership-allocation strata.

C1c. How might future changes in habitat amount, composition, and pattern affect mid- and broad scale population trends for key wildlife species?

Linking current mid-scale habitat amount and distribution to wildlife populations is difficult because it requires linking population trend models to mid-scale vegetation amount and distribution. Wisdom et al. (2000) used vegetation cover and structure class amount and distribution with other ancillary data (e.g. road densities, human populations, topographic conditions, etc.) to estimate potential future habitat and population trends under different management scenarios compared to historical conditions. Their approach relied on comparisons to assumed habitat conditions prior to 1850 and could be modified for use with IMAP models and data. Other methods to assess current population status (e.g. Hirzel 2000) could be used provided that they could be linked to IMAP vegetation classes and that other necessary ancillary data were available.

C2a. What are the current fine scale (e.g. several watersheds and larger) amount, composition, and pattern of habitat for key wildlife species?

Fine-scale wildlife habitat issues that require analyses of patch characteristics would also require current vegetation data at stand-scales. In this case, GIS-based analyses of stand-scale vegetation data for current conditions could be done using FRAGSTATS (McGarigal and Marks 1995), BIOMAPPER (Hirzel 2000) or other tools. The existence of standard IMAP vegetation classes that link to wildlife habitat classes used by partner agencies will facilitate landscape-wide habitat analysis provided that local vegetation data can be placed into IMAP vegetation classes.

C2b. How might different management approaches, natural disturbances, and climate change alter the fine scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?

Assessment of potential future conditions and trends of wildlife habitat at fine scales will require stand-scale projections of potential future vegetation conditions. In this case, GIS-based analyses of stand-scale vegetation data from simulated future conditions using TELSA or other stand projections model output could be done using FRAGSTATS

(McGarigal and Marks 1995), BIOMAPPER (Hirzel 2000) or other tools. The existence of standard IMAP vegetation classes that link to wildlife habitat classes used by partner agencies will facilitate landscape-wide habitat analysis provided that local vegetation data can be placed into IMAP vegetation classes.

C2c. How might future changes in habitat amount, composition, and pattern affect fine scale population trends for key wildlife species?

Linking potential future habitat to wildlife populations is difficult because it requires population models with mid-scale vegetation amount and distribution at the watershed and ownership-allocation stratum. Wisdom et al. (2000) used vegetation cover and structure class amount and distribution with other ancillary data (e.g. road densities, human populations, topographic conditions, etc.) to estimate potential future habitat and population trends under different management scenarios. Their approach relied on comparisons to assumed habitat conditions prior to 1850 and could be modified for use with IMAP models and data. Other methods (e.g. Hirzel 2000) to assess potential future population trends could be used provided that they could be linked to IMAP vegetation classes and that other necessary ancillary data were available.

Table 8. Matrix of data, applications, spatial scale, and other information required to answer Topic C questions. Question statements are abbreviated forms of those in text body.

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
C1a. Current mid-scale habitat amount, distribution, pattern	No[9]	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional	Who?	• Forested lands only • Habitat defined by vegetation cover and structure only. Patch metrics not available. • Wildlife species list for analysis to be developed • Rare or special habitat features poorly represented or absent
	Yes[10]	GNN and other existing vegetation GIS data	GIS and other tools	Ownership & allocation classes within watersheds and larger landscapes		• Relies on combination of GNN and other data – unknown variability when combined • Habitat defined by vegetation cover and structure only. Patch metrics from mid-scale data may not be reliable. • Wildlife species list for analysis to be developed • Rare or special habitat features poorly represented or absent
C1b. Potential future mid-scale habitat amount, distribution, pattern	No	Inventory plots	• Inventory database analysis with FVS and other tools • Species or group-specific habitat models	• County groupings • Statewide • Regional		• Forested lands only • Requires development of alternative management scenarios for the future and FVS prescriptions/runs to match • Habitat defined by vegetation cover and structure only. Patch metrics not available. • Wildlife species list for analysis to be developed • Rare or special habitat features poorly

[9] Data and models for inventory plot analysis are not part of standard IMAP deliverables. FIA data analysis apart from that used to calibrate state and transition models is not a standard part of IMAP, but FIA data could be used to answer the question at the given scale.
[10] Standard data and models are developed for historical conditions and current management as part of normal IMAP work. Users need to develop and run their own model scenarios to represent different management or policy approaches.

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
						represented or absent
	Yes	GNN and other existing vegetation GIS data	VDDT projections	VDDT modeling strata within watersheds and larger landscapes		• Requires development of alternative management scenarios for the future and VDDT prescriptions/runs to match • Ability to run future scenarios is standard, but only historic and current management scenarios are built as standard products. • Habitat defined by vegetation cover and structure only. Patch metrics not available. • Wildlife species list for analysis to be developed • Rare or special habitat features poorly represented or absent
C1c. Potential future effects of mid-scale habitat changes on population trends	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forested lands only • Linkage of mid-scale habitat amount and distribution data to species populations to be developed. • habitat area within strata only; patch metrics not available
	Yes	GNN and other existing vegetation GIS data	VDDT projections	VDDT modeling strata within watersheds and larger landscapes		• Requires development of alternative management scenarios for the future and VDDT prescriptions/runs to match • Ability to run future scenarios is standard, but only historic and current management scenarios are built as standard products. • Linkage of mid-scale habitat amount and distribution data to focal species population trends in development by R6. • Patch metrics not available
C2a. Current fine scale habitat amount, distribution, pattern	No	FIA forest inventory				FIA/CVS plot data of insufficient sample size for fine scale analysis.
	No	• GNN and local stand-scale existing	• GIS • FRAGSTATS • BIOMAPPER	Habitat types defined by species		• Relies on combination of GNN and local stand data – unknown variability when combined

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
		vegetation GIS data • Ancillary data	• others			• Wildlife species list for analysis and linkage to patch-scale habitat features to be developed • Rare or special habitat features may be poorly represented or absent
C2b. Potential future fine scale habitat amount, distribution, pattern	NA No	FIA forest inventory • GNN and local stand-scale existing vegetation GIS data • Ancillary data	• Spatially explicit projection model (e.g. TELSA, FVS) • GIS, FRAGSTATS	Stand-scale modeling limited to about 100,000 polygons		FIA/CVS plot data of insufficient sample size for fine scale analysis. • Requires development of alternative management scenarios for the future and TELSA prescriptions/runs to match • TELSA models are likely limited to selected landscapes due to data requirements, and computing limitations. • Ability to run future scenarios is standard, but only historic and current management scenarios are built as standard products. • Relies on combination of GNN and local stand data – unknown variability when combined • Wildlife species list for analysis and linkage to patch-scale habitat features to be developed • Rare or special habitat features may be poorly represented or absent
C2c. Potential future effects of fine scale habitat changes on population trends	NA No	FIA forest inventory Stand-scale outputs from simulation models for selected time periods	• Patch-scale habitat models (e.g. TELSA) • BIOMAPPER	Stand-scale modeling limited to about 100,000 polygons		FIA/CVS plot data of insufficient sample size for fine scale analysis. • Requires development of alternative management scenarios for the future and TELSA prescriptions/runs to match • TELSA models are likely limited to selected landscapes due to data requirements, and computing limitations. • Ability to run future scenarios is standard, but only historic and current management scenarios are built as

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
						standard products. • Relies on combination of GNN and local stand data – unknown variability when combined • Wildlife species list for analysis and linkage to patch-scale habitat features to be developed • Rare or special habitat features may be poorly represented or absent

Table 9. Products generated to answer Topic C questions. Question statements are abbreviated forms of those in text body.

Products	***Description***	***General Applications***	***Specific Applications***
Data for mid to broad-scale maps and descriptions of important wildlife habitat conditions at present	Maps and tabular data showing the current distribution of important wildlife habitats by watersheds and ownership-allocation strata. The finest scale of resolution is ownership and land allocation strata within watersheds. Maps can be color coded to show amounts of selected habitats.	• Illustrate current habitat conditions across mid to broad-scale landscapes for selected important species. • Compare habitat amount by geographic area and ownership-allocation strata. • Identify current distribution of important habitats by protected area strata. • Identify locations of important wildlife habitat concentrations for discussions about conservation priorities. • Baseline monitoring data for comparison to future re-measured or re-mapped conditions.	• All - current conditions of important species habitats, promising areas for potential cooperation and collaboration with partners • ODF – Reporting for Oregon Board of Forestry Indictors E.b., E.c. • ODFW – Reporting for Conservation Strategy Elements 1, 2, 3, 7; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies 1, 2, 3, 6
Data for mid to broad-scale maps and descriptions of important wildlife habitat conditions in the future	Maps and tabular data showing the potential future distribution of important wildlife habitats by watersheds and ownership-allocation strata in the future under different management scenarios at selected time steps (e.g. 5, 10, 25, 50, 100 years). The finest scale of resolution is ownership and land allocation strata within watersheds. Maps can be color coded to show amounts of selected habitats.	• Compare habitat conditions through time among management scenarios for selected important species. • Provide data for examining short and long-term tradeoffs among management approaches (e.g. passive vs. active management) at several spatial scales and over time. • Provide data for examining tradeoffs among various other ecosystem conditions and services with wildlife habitats over time. • Anticipated trends for wildlife habitat to be used in monitoring and adaptation programs across agencies.	• All - desired trends in important species habitats, trade-offs of different management alternatives, promising areas for potential cooperation and collaboration with partners • ODF – Reporting for Oregon Board of Forestry Indictors E.b., E.c. • ODFW – Reporting for Conservation Strategy Elements 1, 2, 3, 7; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies 1, 2, 3, 6

Products	*Description*	*General Applications*	*Specific Applications*
Data as input to mid- and broad scale wildlife population status models	Maps and tabular data showing wildlife amounts and types of habitat classes within watersheds and ownership-allocation strata or larger aggregations.	• Illustrate population status for important species across mid to broad-scale landscapes. • Compare wildlife population status by geographic area and ownership-allocation strata. • Identify current distribution of important habitats for species of conservation concern. • Identify areas where the current population status for important wildlife species indicates need for prioritization of habitat conservation or restoration.	• All - desired trends in wildlife populations, trade-offs of different management alternatives • ODF – Reporting for Oregon Board of Forestry Indictors E.b., E.c. • ODFW – Reporting for Conservation Strategy Elements 1, 2, 3, 7; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies 1, 2, 3, 6
Shared mid-scale population status and trend models	Wildlife habitat and population trend models that can be shared across partner agencies. These might be USFS focal species models, BIOMAPPER models/analyses, or other shared models or analysis processes.	• Integrated, cross-agency tools for understanding population trends for species of concern • Conceptual models that describe current understanding of species population and habitat relations. • Conceptual models that highlight important monitoring items and research needs	• All - Promising areas for potential cooperation and collaboration with partners, common language and analysis process for public discourse on wildlife habitat and populations, decreased redundancy in data collection and analysis • ODF – Reporting for Oregon Board of Forestry Indictors E.b., E.c. • ODFW – Reporting for Conservation Strategy Elements 1, 2, 3, 7; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies 1, 2, 3, 6

Products	***Description***	***General Applications***	***Specific Applications***
Data for fine scale maps and analyses of important wildlife habitat conditions at present	Maps and tabular data showing the current distribution of important wildlife habitats in selected analysis areas. The finest scale of resolution is stands or pixels of habitat classes. Maps can be color coded to show amounts of selected habitats.	• Illustrate current habitat conditions within selected landscapes for selected important species. • Compare habitat amount for selected study areas. • Identify current distribution of important habitats within selected study areas. • Identify locations of important wildlife habitat concentrations and patterns for on-the-ground project planning activities. • Baseline monitoring data for comparison to future re-measured or re-mapped conditions in selected study areas.	All - current conditions of important species habitats for project planning, promising areas for potential cooperation and collaboration with partners
Data for fine scale maps and analyses of important wildlife habitat conditions in the future	Maps and tabular data showing the potential future distribution of important wildlife habitats with watersheds or similar sized areas in the future under different management scenarios at selected time steps (e.g. 5, 10, 25, 50, 100 years). These data could be used for fine scale habitat projection models (e.g. TELSA models) or for initial project planning and cumulative effects analyses.	• Illustrate potential future habitat conditions within selected landscapes for selected important species. • Compare potential habitat amount for selected study areas under different management approaches over short and long-terms • Identify priority locations of important wildlife habitat concentrations and patterns for on-the-ground project planning activities. • Baseline projections of anticipated fine-scale habitat trends for monitoring and adaptive management.	All - Desired trends of important species habitats for project planning, trade-offs for project planning and cumulative effects analysis, promising areas for potential cooperation and collaboration with partners.

Products	***Description***	***General Applications***	***Specific Applications***
Potential future effects of fine scale habitat changes on population trends	Maps and tabular data showing the potential future trends for important wildlife populations with watersheds or similar sized areas in the future under different management scenarios at selected time steps (e.g. 5, 10, 25, 50, 100 years for initial project planning and cumulative effects analyses.	• Illustrate potential future population trends within selected landscapes for selected important species. • Compare potential population trends for selected study areas under different management approaches over short and long-terms • Identify priority locations of important wildlife population trends and patterns for on-the-ground project planning activities. • Baseline projections of anticipated fine-scale population trends for monitoring and adaptive management.	All - Desired trends of important species habitats for project planning, trade-offs for project planning and cumulative effects analysis, promising areas for potential cooperation and collaboration with partners.

TOPIC D: Aquatic and riparian habitat conditions and trends

D1a. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function at present?

D1b. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function in the future under different management approaches and natural disturbance regimes?

D2a. How do vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales at present?

D2b. How might vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales in the future?

D3a. What are the current production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas?

D3b. What might the future production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas be under different management approaches and natural disturbance regimes?

Background Topic D questions relate to the current amounts, distributions, and patterns of riparian and aquatic habitats and associated fish and wildlife species, water quality and quantity, river dynamics, and flood plain function. Topic D questions also concern effects of future climate change, different management policies/scenarios, and natural disturbances, on riparian and aquatic conditions. The questions are generally framed at broad to mid-scales (e.g. several watersheds of 100,000 acres or more) though include issues related to fine scale (e.g. stream reaches and riparian habitats within one or two watersheds) attributes. Linkage of upland conditions, management activity effects, and disturbance effects riparian/aquatic have been described in selected environments (e.g. Tabacchi et al. 1998, Baxter et al. 1999, Olson 2000, Bisson et al. 2003, Dwire and Kauffman 2003, Reeves et al. 2003, Wondzell et al. 2007), but are not available for many areas in Oregon and Washington. A cooperative effort is underway in several areas in Oregon to document the effects of intensive management on important riparian and aquatic conditions (http://watershedsresearch.org/Home/Home.html). This research might provide key information that could be linked to assessments and modeling exercises to answer Topic D questions.

At present, modeling and projection methods that integrate upland vegetation with riparian and aquatic characteristics are limited. Reeves et al. (2003) and Benda et al. (2002) developed geographic information systems modeling methods that link upland sediment and large woody debris sources to in-stream sediment and large wood. Their methods, however, do not include the full suite of natural disturbances and management activities that might impact upland vegetation and associated stream systems. Wondzell et al. (2007) describe state and transition modeling methods compatible with IMAP models and data, but their work does not fully integrate upland and riparian conditions with down-stream routing of materials and consequent habitat effects. Broad and mid-scale analyses and projections of potential future habitat or water quality conditions and trends might be done from VDDT model outputs, but other modeling processes or ancillary data would be needed to connect these to riparian and aquatic conditions. Fine scale analyses and projections would require the use of TELSA or some similar spatially explicit model. Fine-scale analyses may be limited by availability of sufficiently accurate vegetation data, the availability of useful habitat models, sufficiently accurate topographic features and stream channel data, and the practical limitations of computing resources. IMAP vegetation data are possibly suitable for use with riparian wildlife habitat models (Johnson and O'Neil 2001a) at mid-scales only when GNN data have been augmented by finer-scale vegetation data.

All spatially explicit riparian/aquatic modeling approaches require sufficiently accurate stream network and topographic data. Digital Elevation Models (DEMs) can be used to derive stream networks and other topographic features through GIS modeling using available 10m or 30m DEMs, but resulting stream networks need to realistically represent on-the-ground conditions, perhaps using high-resolution DEMs derived from light detection and ranging (LiDAR) data (e.g. Bufton et al. 1991, Fleece 2002). Because standard wall-to-wall IMAP data (GNN supplemented by local data where available and included) and mid- and broad scale landscape models (VDDT) are not generally useful for mapping and modeling riparian features, all questions in topic D are optional because IMAP will likely not supply wall-to-wall data and models for riparian/aquatic topics without additional work and funding.

Methodology Description

D1a. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function at present?

Research to build state and transition models that link riparian/aquatic features to upland vegetation, natural disturbances, management activities, and geomorphic features has been funded by the Oregon Watershed Enhancement Board (Steve Wondzell, USDA Forest Service, Pacific Northwest Research Station, personal communication). Linkage might be accomplished within TELSA models, perhaps in conjunction with NetMap methods developed by Reeves et al. (2003) and Benda et al. (2002). Methods to address potential effects of climate change have not been developed, but might be developed using linkage of VDDT or TELSA models to mid- and broad scale climate, vegetation, and disturbance models (e.g. Neilson 1995, Bachelet et al. 2001).

D1b. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function in the future under different management approaches, natural disturbance regimes, and assumed climate changes in the future?

Research is underway to build state and transition models that link upland with riparian aquatic systems to project the potential effects of different management scenarios and natural disturbance regimes (Steve Wondzell, USDA Forest Service, Pacific Northwest Research Station, personal communication). One objective is to link projections of potential future conditions in riparian/aquatic systems under different management approaches to flood plain and in-channel conditions, perhaps using the methods developed by Reeves et al. (2003) and Benda et al. (2002). Methods to address potential effects of climate change have not been developed.

D2a. How do vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales at present?

Answering this question requires connecting upland and riparian vegetation, disturbances, and management activities to in-stream habitats and conditions. This has been the subject of considerable research, but predictive models that could be used across mid- and broad scale landscapes in Oregon and Washington are lacking. Initial work by Wondzell et al. (2007) that ties aquatic habitat conditions to riparian vegetation and disturbances might be used with landscape sediment, large woody debris, and water routing methods developed by Reeves et al. (2003) and Benda et al. (2002) to depict the effects of existing vegetation and recent disturbances on in-stream habitats. However, this work is not sufficiently mature for widespread application.

D2b. How might vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales in the future?

On-going, funded research will link state and transition model projections of potential future conditions under different management approaches across landscapes that include upland and riparian/aquatic systems (Steve Wondzell, USDA Forest Service, Pacific Northwest Research Station, personal communication). Linking vegetation changes and disturbances to flood plain and in-channel conditions are part of this work and might use methods developed by Benda et al. (2002). Methods to address potential effects of climate change have not been developed.

D3a. What are the current production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas?

Reeves et al. (2003) and Benda et al. (2007)propose methods that could be integrated with IMAP data on upland and riparian vegetation conditions to highlight sources of large woody debris recruitment in aquatic systems. Recent work by Benda (personal communication) has extended this work to many landscapes in the Northwest and California. Full integration of their methods into IMAP has not occurred, but seems feasible.

D3b. What might the future production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas be under different management approaches and natural disturbance regimes?

IMAP state and transition modeling using either VDDT for broad and mid-scales or TELSA for fine scales simulates natural disturbances, including wildfire and insect outbreaks, and management activities that generate large wood. Existing landscape modeling methods developed by Benda et al. (2007) link uplands with riparian systems and flood plains via delivery mechanisms such as debris torrents, floods, wind-throw, and others. On-going research by will provide simulations of upland and riparian disturbances, management activities, and vegetation conditions that feed large woody debris into riparian settings and stream channels (Steve Wondzell, USDA Forest Service, Pacific Northwest Research Station, personal communication). These modeling methods, when mature, will simulate complete landscapes, including riparian systems and sediment/woody debris delivery systems. Methods model the potential effects of climate change hinge on successful inclusion of climate change in VDDT and TELSA models as well as the effects of climate change on precipitation and hydrology, all of which are current topics of research. In addition, cooperative research on several watersheds in Oregon may shed light on key relations between management activities and riparian/aquatic conditions (http://watershedsresearch.org/Home/Home.html).

Table 10. Matrix of data, applications, spatial scale, and other information required to answer Topic D questions. Question statements are abbreviated forms of those in text body.

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
D1a. How do upland landscape effects on riparian/aquatic conditions at present?	No	• GNN and other existing vegetation GIS data • Sufficiently accurate stream network maps	• NetMap or similar tools • GIS	Watersheds and groups of watersheds		• Current models may not include all important upland disturbances and management activities • NetMap models have been developed for a limited set of watersheds and landscapes in Oregon and Washington
D1b. How might upland landscape effects on riparian/aquatic conditions in the future?	No	• TELSA model projections of vegetation and disturbance under different management scenarios • Sufficiently accurate stream network maps	• NetMap • TELSA • GIS	Watersheds and groups of watersheds		• Linkage between TELSA and NetMap have not been developed or tested • Modeling would be complex and likely limited to selected watersheds • Linkage between broad-scale, non-spatial landscape models (e.g. VDDT) and spatially explicit stream routing models (e.g. NetMap) have not been developed and may not be feasible. • Management and disturbance scenarios need to be developed for TELSA projections • TELSA models are likely limited to selected landscapes due to data requirements, and computing limitations.
D2a. How do upland conditions affect riparian/aquatic fish and wildlife at present?	No	• GNN and other existing vegetation GIS data • Sufficiently accurate stream network maps	• NetMap or similar tools • Aquatic habitat models • GIS	Watersheds and groups of watersheds		• Current models may not include all important upland disturbances and management activities • NetMap models have been developed for a limited set of watersheds and landscapes in Oregon and Washington • In-channel habitat values for important aquatic species would need to be

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
						linked to channel conditions that can be derived from GIS data or NetMap output.
D2b. How might upland conditions affect riparian/aquatic fish and wildlife in the future?	No	• NetMap outputs of simulated channel conditions from TELSA disturbance and vegetation outputs at selected future time steps. • Sufficiently accurate stream network maps	• TELSA • NetMap • Habitat potential models for selected aquatic species • GIS	Watersheds and groups of watersheds		• Current NetMap models may not include all important upland disturbances and management activities • NetMap models have been developed for a limited set of watersheds and landscapes in Oregon and Washington • In-channel habitat values for important aquatic species would need to be linked to channel conditions that can be derived from GIS data or NetMap output. • Management and disturbance scenarios need to be developed for TELSA projections • TELSA models are likely limited to selected landscapes due to data requirements, and computing limitations.
D3a. What is the current status of large woody debris in aquatic/riparian areas?	No	• GNN and other GIS data • Sufficiently accurate stream network maps	• NetMap • GIS	Watersheds and groups of watersheds		• NetMap models have been developed for a limited set of watersheds and landscapes in Oregon and Washington
D3b. What might be the future status of large woody debris in	No	• NetMap outputs of simulated channel conditions from TELSA disturbance	• TELSA • NetMap • GIS	Watersheds and groups of watersheds		• Management and disturbance scenarios need to be developed for TELSA projections • TELSA models are likely limited to

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
aquatic/riparian areas?		and vegetation outputs at selected future time steps. • Sufficiently accurate stream network maps				selected landscapes due to data requirements, and computing limitations. • Current NetMap models may not include all important upland disturbances and management activities • NetMap models have been developed for a limited set of watersheds and landscapes in Oregon and Washington

Table 11. Products generated to answer Topic D questions. Question statements are abbreviated forms of those in text body.

Products	***Description***	***General Applications***	***Specific Applications***
Maps and databases showing the current locations, amounts, of various vegetation types and geomorphic conditions by stream reach or habitat element	GIS coverages and associated databases that show the current location of riparian vegetation cover class, vegetation structure class stratified by geomorphic condition (e.g. valley floor gradient, valley floor width, channel sinuosity, channel width, channel depth, surface material).	• Summaries of current riparian/aquatic vegetation and disturbance conditions by watershed and larger areas • Inputs of initial conditions to simulation models that project potential future conditions • Inputs to habitat analyses for important riparian/aquatic species • Baseline information for monitoring and adaptive management	• All – Describing current riparian vegetation and disturbance conditions for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors D.a., D.b., D.c. • ODFW – Reporting for Conservation Strategy Elements 2, 3, 7, 8; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements 2, 3, 6, 7, monitoring and adaptation
Maps and databases showing the potential future locations, amounts, of various vegetation types and geomorphic conditions	GIS coverages and associated databases that show the simulated future conditions of riparian vegetation cover class, vegetation structure class stratified by geomorphic stratum (e.g. valley floor gradient, valley floor width, channel sinuosity, channel width, channel depth, surface material). Data are outputs from landscape projection models (e.g. TELSA) and stream network models (e.g. NetMap) under different management scenarios.	• Trade-off evaluation of the effects of different upland and riparian management scenarios on riparian/aquatic vegetation and disturbance conditions in the future. • Trade-off evaluation of short term versus longer term impacts and benefits of different management approaches. • Evaluation of potential future fire and other natural disturbance risks to important aquatic/riparian vegetation features.	• All - Describing potential future riparian vegetation and disturbance conditions under different management approaches (e.g. active vs. passive) for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors D.a., D.b., D.c. • ODFW – Reporting for Conservation Strategy Elements 2, 3, 7, 8; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements 2, 3, 6, 7, monitoring and adaptation

Products	*Description*	*General Applications*	*Specific Applications*
Maps and databases showing current riparian/aquatic habitat conditions	GIS coverages and associated databases that show current habitat conditions for important riparian/aquatic species. Data are outputs from stream network models (e.g. NetMap) given current upland and riparian vegetation and geomorphic conditions, translated into aquatic/riparian habitat value by species-specific habitat models.	• Summaries of current riparian/aquatic habitat conditions by stream reach or habitat element within watersheds and larger areas	• All – Describing current riparian/aquatic habitat conditions for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors D.a., D.b., D.c. • ODFW – Reporting for Conservation Strategy Elements 2, 3, 7, 8; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements 2, 3, 6, 7, monitoring and adaptation
Maps and databases showing potential future riparian/aquatic habitat conditions	GIS coverages and associated databases that show the simulated future conditions of habitat for important riparian/aquatic species. Data are simulation projections from landscape models (e.g. TELSA) and stream network models (e.g. NetMap) under different management scenarios, translated into aquatic/riparian habitat value by species-specific habitat models.	• Trade-off evaluation of the effects of different upland and riparian management scenarios on important riparian/aquatic species habitat conditions in the future. • Trade-off evaluation of short term versus longer term impacts and benefits of different management approaches. • Evaluation of potential future fire and other natural disturbance risks to important aquatic/riparian habitat conditions.	• All - Describing potential future riparian/aquatic habitat conditions under different management approaches (e.g. active vs. passive) for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors D.a., D.b., D.c. • ODFW – Reporting for Conservation Strategy Elements 2, 3, 7, 8; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements 2, 3, 6, 7, monitoring and adaptation

Products	Description	General Applications	Specific Applications
Maps and databases showing current source areas for large woody debris conditions	GIS coverages and associated databases that show estimated current large woody debris conditions by stream reach or habitat element. Data are outputs from stream network models (e.g. NetMap) given current vegetation conditions and recent upland disturbances (e.g. wildfires).	• Summaries of current large woody debris source areas and current conditions by stream reach or habitat element within watersheds and larger areas	• All – Describing current large woody debris conditions for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors D.a., D.b., D.c. • ODFW – Reporting for Conservation Strategy Elements 2, 3, 7, 8; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements 2, 3, 6, 7, monitoring and adaptation
Maps and databases showing potential future source areas for large woody debris conditions	GIS coverages and associated databases that show potential future large woody debris source areas and in-channel conditions by stream reach or habitat element. Data are outputs from landscape simulation models (e.g. TELSA) and stream network models (e.g. NetMap) under different management scenarios and natural disturbances (e.g. wildfires).	• Trade-off evaluation of the effects of different upland and riparian management scenarios on recruitment and in-channel conditions of large woody debris in the future. • Trade-off evaluation of short term versus longer term impacts and benefits of different management approaches on large woody debris. • Evaluation of potential future fire and other natural disturbance risks to large woody debris.	• All - Describing potential future large woody debris conditions under different management approaches (e.g. active vs. passive) for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors D.a., D.b., D.c. • ODFW – Reporting for Conservation Strategy Elements 2, 3, 7, 8; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements 2, 3, 6, 7, monitoring and adaptation

TOPIC E: Wildfire, Insect & Disease, and other natural disturbances

E1a. How many acres of Oregon and Washington wildland are currently in conditions that may result in high-severity or unnaturally intense insect and disease outbreaks and wildfires?

E1b. How many acres of Oregon and Washington wildland have been treated to reduce these hazards?

E2a. What Oregon and Washington wildland areas are likely to experience unnaturally intense insect and disease outbreaks and wildfires in the future?

E2b. How does this differ from historical patterns?

E2c. How might different management strategies affect these disturbances?

E3. What are the likely landscape-scale effects of pre- and post-fire management (i.e., thinning, fuels management, salvage) on ecosystem processes and components, including fish and wildlife habitats values?

E4. What are likely trade-offs between short term loss of wildlife habitat values from management designed to reduce unnaturally intense disturbances and long term damage to habitat from unnaturally intense disturbances?

E5a. Where do opportunities currently exist to improve forest health and generate sustainable outputs of important forest values through active management?
E5b. How much difference might active management make in landscape wildlife habitat, forest products, and other resource values compared to passive management?

E5c. How might landscape priorities be developed and displayed that integrate trade-offs between disturbance risks, wildlife habitat and other landscape values, and social/economic benefits?

E6a. How might different mixes of wildfire, fuels management, and fire suppression provide alternative landscape economic, social, and ecological benefits?

E6b. What might the economic trade-offs be for different management approaches to wildfire, fuels management, and fire suppression?

Background Topic E relates to the roles that various natural disturbances play at present, how they may have occurred in the past, and how they may change in the future under different management approaches. Topic E questions are generally framed at broad to mid-scales (e.g. several watersheds of 100,000 acres or more) though may include issues related to fine scale (e.g. stream reaches and riparian habitats within one or two watersheds) attributes. While not specifically listed by in User Group questions, possible future impacts of climate change on natural disturbances are certainly an issue with most partner agencies.

Natural disturbance effects are particularly important to the land management agencies because management activities potentially alter the kind, extent, and severity of natural disturbances. Other IMAP partners may not directly manage lands, but generally have strong interest in the influences that natural disturbances and management activities have on important natural resources like wildlife habitat, water quality, air quality, recreation use, and others. Most IMAP partners use historical (e.g. vegetation and disturbance patterns as they varied prior to about 1850) and current conditions as references for detecting and evaluating change. This means that some representation of historical conditions and their variation are important IMAP modeling and data products. This does not imply that historical conditions are in some way preferred or desired future conditions unless some specific management decision has designated them as such. Since IMAP produces both current conditions and simulated historical conditions of vegetation and natural disturbances, IMAP partners and other users can chose reference conditions as necessary.

Substantial work occurring elsewhere in the United States, particularly that sponsored by the Western Forestry Leadership Coalition (WFLC - http://www.wflccenter.org/index.php) may provide important information to help answer Topic E questions. IMAP work should be coordinated with WFLC to prevent duplication of efforts.

General Methods IMAP generates wall-to-wall GIS data and associated databases displaying current vegetation cover class and structure stage. The same classes are outputs of the TELSA and VDDT models that can be used to project potential future vegetation conditions under different management scenarios and to estimate the range of historical vegetation and disturbance conditions. The vegetation classes used in IMAP were specifically designed to capture vegetation conditions that relate to canopy fuels and ground fuels. Since GNN data represent inventory plots imputed to 30 meter pixels, inventory plot data can be used to assign average canopy fuel conditions (e.g. canopy bulk density, canopy base height, canopy tree height) to every 30 meter grid cell. While the data may not be of sufficient resolution for accurate use at the grid cell scale, average canopy fuels values can readily be developed for VDDT model state classes within strata of watershed and ownership/allocation. Plot data can also be used to cross-walk VDDT model state classes to fuel characteristics classification system (FCCS) (Sandberg et al. 2001, Berg 2007) classes. In addition, surface fuel model (Anderson 1982, Scott and Burgan 2005) can be assigned if information about understory vegetation is available. These fuel attributes allow a variety of fire simulation models to use IMAP data, including FARSITE (Finney 1998), FLAMMAP (Finney), the Fire and Fuels Extension to FVS (FVS-FFE) (Beukema et al. 1997), and others.

The vegetation classes used in IMAP were also designed to for interpreting susceptibility of forests and other vegetation types to insect outbreaks. Hemstrom et al. (2007) used similar classes to simulate potential future outbreaks of mountain pine beetle, western pine beetle, spruce budworm, and other species in the Blue Mountains. Since the FVS model allows inclusion of insect attack in stand-scale simulations of inventory and other plot data (Dixon 2002), insect susceptibility and potential tree mortality can be estimated for IMAP vegetation classes using inventory plots assigned to each forest vegetation class.

Several of the questions in Topic E imply evaluation of relative risks. Risk assessment is a formal method that requires explicit specification of the values at stake, probabilities for desirable or undesirable outcomes, and change in value for each outcome (Landis 2004, O'Laughlin 2005, Ager et al. 2006). IMAP data can be used to evaluate current risk of wildfire or insect outbreak using methods described for question E1a to calculate current fuel or insect hazards, then applying risk analysis methods assess the probability that severe or intense disturbances might affect important values and the consequences in reducing those values to some unacceptable level (e.g. Ager et al. 2006, Ager et al. 2007, Kerns and Ager 2007). Evaluation of "unnatural" intensity or severity of natural disturbances relies on comparison to a selected natural reference condition. Since VDDT models that simulate historical conditions are standard IMAP products, current or potential future natural disturbance risks can be compared to historical disturbance regimes and vegetation conditions. Unnatural conditions could be defined as those outside some selected historical range of conditions taken to represent natural conditions. Alternatively, natural disturbances could be taken to mean those disturbances that might occur under current climatic conditions, but without the influence of human-related influences. If this is the chosen basis for "natural" conditions, all human-mediated influences should be removed from simulations, including wildfire suppression.

Specific Methods

E1a. How many acres of Oregon and Washington wildland are currently in conditions that may result in high-severity or unnaturally intense insect and disease outbreaks and wildfires?

Existing vegetation data cover type and structure classes can be cross-walked to canopy and ground fuel conditions within watershed and ownership/allocation strata. The FVS-FFE can then be used to estimate flame length and potential wildfire behavior under particular fire weather conditions (e.g. 90^{th} percentile fire weather). Proportion of area within each watershed and ownership/allocation stratum could then be mapped in categories to show where in the landscape the potential for severe wildfire is currently highest. Evaluation of "unnatural" severity or intensity requires comparison to some standard accepted as "natural." Most partner agencies use a range of historical conditions as the reference and assign conditions outside some historical range as "unnatural" (http://www.landfire.gov/background.php).

The potential for insect outbreaks could be similarly assessed using insect extensions to the FVS model. Unfortunately, only a few insect outbreak types are available in FVS for Oregon and Washington. Insect outbreak potential could be compared to annual aerial surveys of insect activity currently conducted by several partner agencies to check both the accuracy of landscape wide condition assessments from IMAP data and to understand where outbreaks currently exist. Some field people have been using GNN imputed plot data at the 30m pixel scale to develop insect risk maps without lumping pixel data into vegetation cover type and structure class strata (personal communication, Helen Maffei, Deschutes National Forest) and report substantial utility from this process. In general, however, GNN data are of limited or unknown utility at the pixel scale.

Risk assessment methods could be used to evaluate relative risks across landscapes given current conditions for both wildfire and insect/disease outbreaks.

E1b. How many acres of Oregon and Washington wildland have been treated to reduce these hazards?

IMAP does not attempt to track management treatments. Partner agencies provide individual accomplishment reporting records that are summarized annually by state as part of the National Fire Plan (http://www.forestsandrangelands.gov/NFP/index.shtml).

E2a. What Oregon and Washington wildland areas are likely to experience unnaturally intense insect and disease outbreaks and wildfires in the future?

IMAP simulation models can be used to explore potential future vegetation and natural disturbance conditions in the future under different management scenarios at either the mid- to broad scales using VDDT or the fine scale using TELSA. Mid- and broad scale simulation projections include area disturbed, kind of disturbance, wildfire severity class (high, mixed, and low), insect species involved in outbreaks, and vegetation cover type and structure class within watersheds and ownership/allocation classes. Fine scale simulations include the same attributes but include projections of where disturbances might occur and vegetation conditions for stands. Due to increased complexity, computing requirements, and data requirements, fine scale simulations are optional and performed on an as-needed basis. Simulation results can be compared to either current or historical conditions, depending on the definition of "natural" used in the analysis.

E2b. How does this differ from historical patterns?

This question mirrors E2a, but specifies historical patterns as the basis for comparison to current or simulated future conditions for natural disturbances. IMAP produces simulated historical conditions for each study area using VDDT models and assumed historical disturbance regimes. Differences between historical and current (or potential future) vegetation and disturbance conditions could be displayed as departure from historical ranges, as suggested by (Hann et al. 1997, Hann and Bunnell 2001, Keane, 1996 #198, Keane et al. 2002) and as used in Fire Regime Condition Class assessments (see www.landfire.gov).

E2c. How might different management strategies affect these disturbances?

IMAP state and transition models are explicitly designed to simulate potential future natural disturbances based on alternative management scenarios. Managers and others can specify the kinds, timing, and landscape area affected by a variety of management activities. Management activities can preferentially occur in different vegetation state classes and at different rates among strata of watersheds and ownership/allocation. Model outputs can be summarized into area disturbed, proportion of area disturbed, kind of disturbance, disturbance severity (for wildfire), and other characteristics. Maps and graphical displays can be constructed to show natural disturbance amounts and trends by vegetation state class, watershed, and ownership/allocation (Hann et al. 1997, Hessburg et al. 1999, Hemstrom et al. 2007).

E3. What are the likely landscape-scale effects of pre- and post-fire management (i.e., thinning, fuels management, salvage) on ecosystem processes and components, including fish and wildlife habitats values?

IMAP models are designed to provide information on many kinds of management activities (including thinning, fuel management, salvage, and others) on both natural disturbances and vegetation conditions. Any ecosystem process or component that can be linked to a combination of vegetation cover type, structure class, growth and development, and natural disturbance can be interpreted from IMAP models and data. Because IMAP models are calibrated with FVS and inventory plots, this includes processes and components that can be modeled with FVS or related to inventory plot data in some other way. For some ecosystem processes, the linkage (primary production stored in trees, for example) is straight forward. For other processes, the linkage is indirect, weak, or missing (nutrient cycling, for example). Many of these topics are being addressed in an on-going research effort; the Fire and Fire Surrogate Study (http://frames.nbii.gov/metadata/projects/Fire_and_Fire_Surrogate_Study_(FFS).html). Wildlife and fish habitat values (discussed in more detail under the questions in Topic D) can also be assessed as long as linkage to IMAP vegetation cover types, structure classes, or disturbances can be built. IMAP builds mid-scale (e.g. strata of ownership/allocations within watersheds) models and data as standard products. Fine-scale modeling that tracks stands will be necessary for ecosystem process questions at stand scales. TELSA (or similar) models can be constructed from mid-scale IMAP models on a case-by-case and as-needed basis and are, therefore, optional. Unfortunately, since many of the base relations between pre- and post-fire treatments and ecosystem processes have not been documented, fully answering this question is a long-term research issue. In the shorter term, existing knowledge could be tied to a case-study area using IMAP data and models.

E4. What are likely trade-offs between short term loss of wildlife habitat values from management designed to reduce unnaturally intense disturbances and long term damage to habitat from unnaturally intense disturbances?

The benefits and impacts of various management approaches to wildlife habitat can be evaluated by building management scenarios that reflect different management approaches (e.g. no active management, active fuel treatment, or increase multi-story old forest). Models can be run for decades or longer to examine the synergistic effects of different management approaches and natural disturbances on wildlife habitat over the short term (e.g. several years to a decade) and long term (e.g. several decades or more). Results can be compared to historical or some other baseline condition defined as natural and the trends of change in wildlife habitat as a function of management scenario can be displayed through maps, graphics, or tables (see for example (Hemstrom et al. 2007).

E5a. Where do opportunities currently exist to improve forest health and generate sustainable outputs of important forest values through active management?

IMAP existing condition vegetation data can be used to display areas in a large landscape that currently are susceptible to wildfire or insect/disease outbreaks. Those areas with highest susceptibility might be good place to examine for opportunities to improve conditions or reduce risks, especially if they have other favorable features (e.g. wildlife habitat values, economic potential, etc.). Different management scenarios simulated into the future will produce varying patterns of susceptibility to disturbance across landscapes. The longer-term effects of management activities on vegetation and disturbance conditions will reveal whether or not the proposed management activities can be sustained at planned levels while maintaining desired resource conditions across broad landscapes and within individual watersheds and ownership/allocation classes. The modeling process and outputs allow managers and others to assess the likelihood of achieving and sustaining particular conditions, including the flow of economic products.

E5b. How much difference might active management make in landscape wildlife habitat, forest products, and other resource values compared to passive management?

Active management is a particular set of management activities applied at a specific rate within strata of watersheds and ownership/allocation. Consequently, active management can be defined in a large number of ways. Once defined, however, active management can be developed as one or more management scenarios in either VDDT or TELSA models. Simulations can be run for many years or decades to allow examination of the short and long term effects of active management on landscape values. Likewise, passive management can be defined as a much more limited set of management activities applied to any or all watershed and ownership/allocation strata. Outputs from simulation runs of active and passive management scenarios can be compared to examine effects on a large variety of resource values as implied by potential future conditions of vegetation condition and disturbances. Hemstrom et al. (2007) describe an example of this analysis in a landscape near La Grande, OR.

E5c. How might landscape priorities be developed and displayed that integrate trade-offs between disturbance risks, wildlife habitat and other landscape values, and social/economic benefits?

Managers and other might describe important landscape issues in terms that could be linked to IMAP vegetation classes, management activities, and natural disturbances. Several of these issues or attributes could be combined in a weighted index that represents integrated priorities. Reynolds and Hessburg (2005), for example, provide decision support methods that could be used to integrate IMAP model outputs with resource values to display areas across landscapes that might be good opportunities for collaboration or focus of scarce funding. Some IMAP partners currently use their methods and could include current and potential future conditions as input to a decision support framework.

E6a. How might different mixes of wildfire, fuels management, and fire suppression provide alternative landscape economic, social, and ecological benefits?

IMAP models are designed to allow gaming with different management alternatives and scenarios. A variety of management activities, timing, and intensities could be included in several different management scenarios. The short and long term effects of those scenarios on resources of interest, including flow of forest products, fire risks in the wildland-urban interface, wildlife habitat trends, and others, could be compared among scenarios to select those that might provide a desirable mix of outcomes given treatment and other constraints. A decision support system, such as that described by Reynolds and Hessburg (2005), could help managers and others sort through the many possible outcomes for those that may be most promising.

E6b. What might the economic trade-offs be for different management approaches to wildfire, fuels management, and fire suppression?

Most management agencies have good estimates about per-unit-area treatment costs in various parts of the landscapes they manage. Those costs could be assigned to treatments that might be included in alternative management scenarios. IMAP simulation model outputs include area treated and could include not only the effects of various treatments on wildfire risks and resource values but the costs associated with treating fuels and fire suppression. If ancillary data about transportation costs and the economic value of biomass and other products were included, economic trade-offs to different kinds of treatment could be evaluated at several scales from watersheds and ownership/allocation strata to broad landscapes.

Table 12. Matrix of data, applications, spatial scale, and other information required to answer Topic E questions. Question statements are abbreviated forms of those in text body.

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
E1a. Where are current hazards for unnaturally intense or severe natural disturbances?	No[11]	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional	Who?	• Forested lands only • Requires development of FVS runs representing historical or "natural" conditions • FVS modules for some important insects may not be available
	Yes[12]	GNN and other existing vegetation GIS data	Analysis with GIS and other tools	Ownership & allocation classes within watersheds and larger landscapes		• May use combinations of GNN and other data – unknown variability when combined • Pixel-scale GNN data may not be reliable when used at scales finer than VDDT modeling strata.
E1b. How many acres have been treated to reduce these hazards?	No	• Inventory plots • Agency records	Database analysis	• Statewide • Regional	• National Fire Plan • Individual agencies	• Not an IMAP product • Annual estimates at the State scale available through the National Fire Plan website
E2a. Where are potential future hazards for unnaturally intense or severe natural disturbances?	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forest lands only • Requires development of alternative management scenarios for the future and FVS prescriptions/runs to match • Requires development of FVS runs representing historical or "natural" conditions • FVS modules for some important insects may not be available
	Yes	GNN and other existing	VDDT projections	VDDT modeling strata within		• Requires development of alternative management scenarios for the future

[11] Data and models are not part of standard IMAP deliverables. FIA data analysis apart from that used to calibrate state and transition models is not a standard part of IMAP, but FIA data could be used to answer the question at the given scale.
[12] Standard data and models are developed for historical conditions and current management as part of normal IMAP work. Users need to develop and run their own model scenarios to represent different management or policy approaches.

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
		vegetation GIS data		watersheds and larger landscapes		and VDDT prescriptions/runs to match • Ability to run future scenarios is standard, but only historic and current management scenarios are built as standard products. • Risk assessment methods require additional development and linkage to VDDT outputs
E2c. How do current and future hazards differ from historical patterns?	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forest lands only • Requires development of FVS runs representing historical or "natural" conditions • Requires development of alternative management scenarios for alternative treatment approaches and FVS prescriptions/runs to match • FVS modules for some important insects may not be available
	Yes	GNN and other existing vegetation GIS data	VDDT projections	VDDT modeling strata within watersheds and larger landscapes		• Requires development of alternative management scenarios for the future and VDDT prescriptions/runs to match • Ability to run future scenarios is standard, but only historic and current management scenarios are built as standard products. • Risk assessment methods require additional development and linkage to VDDT outputs • Stand modeling could be used for selected areas and fine-scale analysis to examine patch metrics and landscape patterns if data were available
E2d. How might different management strategies affect future hazards?	No	Inventory plots	Inventory database analysis with	• County groupings • Statewide • Regional		• Forest lands only • Requires development of alternative management scenarios for alternative

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
			FVS and other tools			treatment approaches and FVS prescriptions/runs to match • FVS modules for some important insects may not be available
	Yes	GNN and other existing vegetation GIS data	VDDT projections	VDDT modeling strata within watersheds and larger landscapes		• Requires development of alternative management scenarios for the future and VDDT prescriptions/runs to match • Ability to run future scenarios is standard, but users need to develop their own treatment scenarios. • Risk assessment methods require additional development and linkage to VDDT outputs • Stand modeling could be used for selected areas and fine-scale analysis to examine patch metrics and landscape patterns if data were available
E3. How might fuel treatments and pre- and post fire treatments affect important resources?	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forest lands only • Requires development of alternative management scenarios for alternative treatment and salvage approaches and FVS prescriptions/runs to match • FVS modules for some important insects may not be available
	Yes	GNN and other existing vegetation GIS data	VDDT projections	VDDT modeling strata within watersheds and larger landscapes		• Requires development of alternative fuel treatment and salvage scenarios for the future and VDDT prescriptions/runs to match • Ability to run future scenarios is standard, but users need to develop their own future management scenarios. • Risk assessment methods require additional development and linkage to VDDT outputs

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
						• Stand modeling could be used for selected areas and fine-scale analysis to examine patch metrics and landscape patterns if data were available
E4. What are short and long term trade-offs between fuel treatments and wildfire and important wildlife habitats?	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forest lands only • Requires development of alternative fuel treatment and salvage approaches and FVS prescriptions/runs to match • FVS modules for some important insects may not be available • Requires linkage to important plot-scale wildlife habitat models • Patch metrics not available
	Yes	GNN and other existing vegetation GIS data	VDDT projections	VDDT modeling strata within watersheds and larger landscapes		• Requires development of alternative fuel treatment and salvage scenarios and VDDT prescriptions/runs to match • Ability to run future scenarios is standard, but users need to develop their own future management scenarios. • Risk assessment methods require additional development and linkage to VDDT outputs • Stand modeling could be used for selected areas and fine-scale analysis to examine patch metrics and landscape patterns if data were available
E5a. Where are opportunities to improve forest health while sustaining outputs of important forest products?	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forest lands only • Requires development of alternative forest health treatment scenarios and FVS prescriptions/runs to match • FVS modules for some important insects may not be available
	Yes	GNN and other	VDDT	VDDT modeling		• Requires development of alternative

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
		existing vegetation GIS data	projections	strata within watersheds and larger landscapes		forest health treatment scenarios and VDDT prescriptions/runs to match • Ability to run scenarios is standard, but users need to develop their own future management scenarios. • Stand modeling could be used for selected areas and fine-scale analysis
E5b. How might active and passive management differ in terms of economic products and other important resources?	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forest lands only • Requires development of alternative active and passive management scenarios and FVS prescriptions/runs to match • FVS modules for some important insects may not be available
	Yes	•GNN and other existing vegetation GIS data •Roads, haul costs, and other economic data	VDDT projections and linked economic analysis	VDDT modeling strata within watersheds and larger landscapes		• Requires development of alternative active and passive management scenarios and VDDT prescriptions/runs to match • Ability to run scenarios is standard, but users need to develop their own management scenarios. • Stand modeling could be used for selected areas and fine-scale analysis
E5c. How might integrated landscape priorities be developed and displayed?	No	VDDT outputs linked to wildlife habitats, fire risks, insect risks, economic opportunities	Integrated opportunity analysis	VDDT modeling strata within watersheds and larger landscapes		• Process to do integrated opportunity analysis not currently part of IMAP • Decision support tools (e.g. EMDS) may be needed • Additional developmental work needed
E6a. How might different mixes of wildfire, fuels management, and fire suppression provide alternative landscape economic, social, and ecological benefits?	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forest lands only • Requires development of alternative management scenarios and FVS prescriptions/runs to match • FVS modules for some important insects may not be available
	Yes	VDDT outputs	•VDDT	VDDT modeling		• Requires development of alternative

Question	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
		linked to wildlife habitats, fire risks, insect risks, economic opportunities, other attributes	projections •Database and other analyses	strata within watersheds and larger landscapes		active and passive management scenarios and VDDT prescriptions/runs to match • Ability to run scenarios is standard, but users need to develop their own management scenarios. • Stand modeling could be used for selected areas and fine-scale analysis
E6b. What might the economic trade-offs be for different management approaches to wildfire, fuels management, and fire suppression?	No	Inventory plots	Inventory database analysis with FVS and other tools	• County groupings • Statewide • Regional		• Forest lands only • Requires development of alternative management scenarios and FVS prescriptions/runs to match • FVS modules for some important insects may not be available
	Yes	•VDDT outputs •Roads, haul costs, and other economic data	•VDDT projections •Database and other analyses	VDDT modeling strata within watersheds and larger landscapes		• Requires development of alternative management scenarios and VDDT prescriptions/runs to match • Ability to run scenarios is standard, but users need to develop their own management scenarios. • Stand modeling could be used for selected areas and fine-scale analysis

Table 13. Products generated to answer Topic E questions. Question statements are abbreviated forms of those in text body.

Products	***Standard?***	***Description***	***General Applications***	***Specific Applications***
Maps and databases showing the current locations and relative degree of natural disturbance hazards	Yes[13]	Spatial and tabular data showing the current distribution of existing wildfire and insect/disease hazards by watershed and ownership-allocation strata. The finest scale of resolution is ownership and land allocation strata within watersheds. Maps can be color coded to show proportion of landscape strata in different hazard conditions.	• Illustrate current hazard conditions across mid to broad-scale landscapes. • Compare hazards across geographic area and ownership-allocation strata. • Identify locations of hazard concentrations for discussions about treatment priorities. • Baseline monitoring data for comparison to future re-measured or re-mapped conditions.	• All – Describing current wildfire and insect/disease outbreak hazards for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors • ODFW – Reporting for Conservation Strategy Elements; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements, monitoring and adaptation
Maps and databases showing the potential future locations, amounts, of natural disturbance hazards	No[14]	Spatial and tabular data showing the potential future distribution of wildfire and insect/disease hazards by watershed and ownership-allocation strata. The finest scale of resolution is ownership and land allocation strata within watersheds. Maps can be color coded to show proportion of landscape strata in different hazard conditions.	• Trade-off evaluation of the effects of different management scenarios on natural disturbance hazards in the future. • Trade-off evaluation of short term versus longer term impacts and benefits of different management approaches. • Evaluation of potential future fire and other natural disturbance risks to important landscape features. • Baseline monitoring data for comparing anticipated trends to trends measured in the course of monitoring.	• All - Describing potential future natural disturbance hazards under different management approaches (e.g. active vs. passive) for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors • ODFW – Reporting for Conservation Strategy Elements; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements, monitoring and adaptation

[13] Standard products developed for historical conditions and current management as part of normal IMAP work. Users need to develop and run their own model scenarios to represent different management or policy approaches.
[14] Products that are not part of standard IMAP deliverables, but that could be generated from IMAP products through user analysis. Products describing potential future conditions depend on user-specific scenarios and model simulations.

Products	Standard?	Description	General Applications	Specific Applications
Maps and databases showing the departure of current wildfire and insect/disease hazards compared to simulated HRV	Yes	Spatial and tabular data showing the departure of current wildfire and insect/disease hazards compared to simulated historical conditions by watershed and ownership-allocation strata. The finest scale of resolution is ownership and land allocation strata within watersheds. Maps can be color coded to show proportion of landscape strata with different levels of departure conditions.	• Illustrate current hazard conditions across mid to broad-scale landscapes. • Compare hazards across geographic area and ownership-allocation strata. • Identify locations of hazard concentrations for discussions about treatment priorities. • Baseline monitoring data for comparison to future re-measured or re-mapped conditions.	• All – Describing current wildfire and insect/disease outbreak hazards for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors • ODFW – Reporting for Conservation Strategy Elements; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements, monitoring and adaptation
Maps and databases showing current departure of natural disturbances from simulated HRV	No	Spatial and tabular data showing the departure of potential wildfire and insect/disease hazards compared to simulated historical conditions by watershed and ownership-allocation strata. The finest scale of resolution is ownership and land allocation strata within watersheds. Maps can be color coded to show proportion of landscape strata with different levels of departure conditions.	• Illustrate potential future hazard conditions across mid to broad-scale landscapes under different management approaches. • Compare potential future hazards across geographic area and ownership-allocation strata. • Identify locations of potential future hazard concentrations for discussions about treatment priorities. • Baseline monitoring data for comparing anticipated trends to trends measured in the course of monitoring.	• All – Describing current wildfire and insect/disease outbreak hazards for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors • ODFW – Reporting for Conservation Strategy Elements; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements, monitoring and adaptation
Maps and databases showing the effects of different fuel treatment and pre- and post-fire treatments	No	Spatial and tabular data showing the potential effects different fuel treatment and pre- and post-fire treatment scenarios on future wildfire, insect/disease outbreak, and wildlife habitat and other resource values. The finest scale of resolution is ownership and land allocation strata within watersheds.	• Illustrate potential future hazard conditions across mid to broad-scale landscapes under different management approaches. • Compare potential future hazards across geographic area and ownership-allocation strata. • Compare short and long term trade-offs of fuel treatments and pre- and post-fire treatments on other resources • Identify locations of potential future hazard concentrations for discussions about treatment priorities.	• All – Describing current wildfire and insect/disease outbreak hazards for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors • ODFW – Reporting for Conservation Strategy Elements; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements, monitoring and adaptation

Products	Standard?	Description	General Applications	Specific Applications
			• Baseline monitoring data for comparing anticipated trends to trends measured in the course of monitoring.	
Maps and databases showing the effects of passive versus active management	No	Spatial and tabular data showing the potential effects of passive and active management scenarios on sustainable production of forest products, wildlife habitats, and other resource values. The finest scale of resolution is ownership and land allocation strata within watersheds. Maps can be color coded to show proportion of landscape strata with different levels of departure conditions.	• Illustrate potential future wildlife habitat, forest product potentials, and other important landscape conditions across mid to broad-scale landscapes under different management approaches. • Compare short and long term trade-offs of passive and active management on important resource conditions and sustainable production • Identify landscape areas where either passive or active management might have undesirable effects on other resources and economic products. • Baseline monitoring data for comparing anticipated trends to trends measured in the course of monitoring.	• All – Describing current wildfire and insect/disease outbreak hazards for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors • ODFW – Reporting for Conservation Strategy Elements; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements, monitoring and adaptation

Products	***Standard?***	***Description***	***General Applications***	***Specific Applications***
Maps and databases showing the effects integrated landscape opportunities and risks	No	Spatial and tabular data showing where an integration of current or simulated future conditions might produce either risks or opportunities. These data could be used in prioritizing collaborative efforts or scarce management resources. The finest scale of resolution is ownership and land allocation strata within watersheds.	• Illustrate where particular management approaches might accomplish several resource objectives and generate positive economic activity at once. • Illustrate where particular management approaches might lead to larger landscape risks (e.g. wildfire or insect outbreaks) that could negatively affect important habitats or other resource values. • Provide information for prioritizing where scarce management resources might accomplish the most bang for the buck. • Illustrate the relative values of different management approaches in achieving integrated resource objectives	• All – Describing current wildfire and insect/disease outbreak hazards for planning and public involvement purposes • ODF – Reporting for Oregon Board of Forestry Indictors • ODFW – Reporting for Conservation Strategy Elements; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies elements, monitoring and adaptation

TOPIC F: Invasive Species

F1. How many acres of Oregon and Washington wildland are currently affected by non-native insects and diseases and invasive plants and animals?

F2. Is Oregon and Washington successful in excluding or containing the worst invasive species threats to the state's forests?

F3a. Where might invasive species be most likely to have adverse effects on Oregon and Washington's forests in the future?

F3b. How might alternative management strategies and climate change assumptions affect invasive species risks across Oregon and Washington's forested landscapes?

Background:

To be written.

Methodology Description:

Methods have not yet been developed.

Question F1.

Question F2.

Question F3.

Question F4.

Table 14. Matrix of data, applications, spatial scale, and other information required to answer Topic F questions. Question statements are abbreviated forms of those in text body.

Question	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/ Contact	Limitations & Considerations
F1 through F4.	FIA forest inventory	FIA database analysis with FVS[15]	• County groupings • Statewide • Regional	ODF – Forest Health?	•
	GNN and other existing vegetation GIS data	GIS analysis	VDDT modeling strata within watersheds and larger landscapes	ODF – Forest Health?	•

[15] FVS = Forest Vegetation Simulator

Table 15. Products generated to answer Topic F questions. Question statements are abbreviated forms of those in text body.

Products	*Description*	*General Applications*	*Specific Applications*
F1 through F4.	From FIA data analysis		Oregon Board of Forestry and Washington Board of Natural Resources
	From GNN and other vegetation map data analysis		USDA Forest Service R6, USDI Bureau of Land Management, and Washington Department of Natural Resources

TOPIC G: Forest Products

G1. What is the location and capacity of existing wood products mills and processing plants, including biomass?

G2. How will this likely change over time under various management and policy scenarios?

G3. How will changes in those locations/capacities influence the ability to economically manage forests within Oregon's timbersheds, to provide biomass for energy production, to maintain and enhance rural economies, provide and to provide revenues to state and local government for public services?

Background: Oregon's forest products industry continues to enhance and diversity Oregon's economy and provides economic values to both rural and urban communities. With low interest rates and high demand for housing in the U.S., in Oregon's forest products industry prospered. Of late, the industry has faltered in response to falling housing demand. While, Oregon still remains the leader in lumber production in the United States, industry infrastructure continues to erode in eastern Oregon. Currently, Oregon's forest sector, including indirect economic effects, about 10 percent of the State's economic base, but this is declining. A large share of these economic benefits occurs in more rural areas of the State, areas with high unemployment rates and other economic problems. In addition to ameliorating economic and social problems in rural areas, healthy rural economies benefit urban areas because of the economic interdependence between the two. It is therefore important to understand the health and sustainability of Oregon's forest products sector and its prospects for continuing to produce the economic values that Oregonians have come to expect from their forests.

A viable forest industry is also vital to efforts to restore Oregon's forests and provide additional sources of biomass energy. It may not be economically feasible to restore forests overstocked with trees on federal forestlands without harvesting some merchantable material in a way that leaves the largest, most fire resistant trees. While removing small trees for biomass energy may not by itself make economic sense, restoring forest health and providing merchantable logs to local mills at the same time may make these operations feasible, even with turbulent lumber and plywood market. However, a healthy and vibrant forest industry infrastructure will be necessary to restore overstocked forests and provide biomass energy in a cost-effective manner. Many obstacles to meeting these multiple objectives have been removed. The major remaining obstacle is to ensure access to dependable fuel supplies. Many believe this can only be accomplished with landscape scale, long term stewardship contracts. IMAP may provide the landscape level background information necessary for federal agencies to enter into these long term stewardship contracts.

Timber-related sectors can be divided into three manufacturing sectors. The first sector includes industries that manufacture solid wood products, including secondary products such as millwork or wood furniture; the second sector includes pulp and paper manufacturing; and the third and still developing sector provides energy from wood fiber, either independently or co-located with other wood product manufacturing facilities. The basic manufacturing sectors purchase logs from logging contractors and other firms provide a wide range of services to wood and paper product manufacturers and to grow and protect Oregon's timber supply.

Methodology Description: Two different approaches would be used to answer questions about forest products production: 1) Using the next Oregon and Washington forest product mill studies and 2) using market driven supply and demand models developed by OSU.

The forest product mill studies would provide information about the location and capacity of existing wood products mills and biomass energy plants and the flow of wood fiber harvest through primary timber-processing or biomass energy production. Described would be industry structure, capacity, operations, condition, and raw material preferences. In addition, investment in industry infrastructure would be measured with two metrics:

- Annually tabulate gross investment in equipment and structures for the lumber and wood products industry, the biomass industry and for the paper and allied products industry, and
- Inventory industry production capacity, technologies used in production, and investment in specific technologies for both depreciation replacement and new investment; this information would be updated every five years with the Oregon and Washington mill studies.

The list of processing centers in the market driven supply and demand models developed by OSU would be updated using the mill studies and other information. Biomass would be an addition to the OSU models, but updated mill studies and other reports would provide information necessary for that rapidly developing market sector.

How the forest products industry, including the biomass energy production sector, will change over time and how these changes affect the ability to economically manage Oregon's forests, to provide biomass for energy production, to maintain and enhance rural economies, and to provide revenues to state and local government for public services would be answered by using the OSU models in conjunction with VDDT modeling work. Different baseline and policy scenarios types would be run which would reflect:

- Changes that directly affect the private forest product values such as carbon markets, energy markets, and lumber markets changes, and
- Changes that affect the public forests such harvest levels, fuel reduction programs, and the BLM Western Oregon Plan Revision.

Management/policy changes will cause both supply and demand effects due to the interaction of public and private supplies in the regional forest products market. The OSU models are best suited for modeling private forests outputs because it would both supply and demand interactions in determining harvest and treatment levels. Private harvest levels would then be brought into VDDT to determine landscape level ecological and other nonmarket changes.

For public forests, harvest level impacts of a policy change could be determined via other more spatial models such as VDDT and then brought into the market model to get the market interaction and subsequent private harvest response, which would then go into VDDT to help determine the output of wildlife habitat and other nonmarket values.

Modeling biomass supply and demand would involve building an addition to the OSU models. Most likely biomass facilities would be linked to current milling facilities to make use of residuals. On the eastside with the capacity so spread out and the potential loss of some existing facilities, the biomass supply decision could change model solutions, perhaps making long distance log hauls uneconomical. The model employed would be like the FIA BIOSUM (Fried et al. 2005), but with forecasted biomass supply and endogenous sawtimber markets. Many other factors would to be simultaneously considered such as lumber and plywood residues which would be available at the milling centers for which biomass mills would have to compete with the pulp mills.

Table 16. Matrix of data, applications, spatial scale, and other information required to answer Topic G questions. Question statements are abbreviated forms of those in text body.

Data	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/Contact	Limitations/Considerations
G1. What is the location and capacity of existing wood products mills and processing plants, including biomass?	Yes	Oregon and Washington mill studies	Input into OSU Timber Supply Models	• Exact mill location information is available • Economically feasible locations for new mills can be identified.	• Oregon Mill Study: Gary Lettman • Washington Mill Study: Phil Aust	• Oregon mill study information will not be available until 2009 • Other information can be used to update data sets in the interim.
G2. How will this likely change over time under various management and policy scenarios?	Yes	Oregon and Washington mill studies	Input into OSU Timber Supply Models	• Exact mill location information is available • Economically feasible locations for new mills can be identified.	• Oregon Mill Study: Gary Lettman • Washington Mill Study: Phil Aust	• Oregon mill study information will not be available until 2009; other information can be used to update data sets in the interim.
		VDDT model output	Input into OSU Timber Supply Models	• Output from VDDT will be from modeling unit parameters: owner group, potential vegetation, stand size, etc.	• VDDT Modeling - PNW/Miles Hemstrom • Timber Supply Modeling: - OSU/Darius Adams	• Links between VDDT models and the OSU timber supply models are not yet completed
		Timber supply model output	Input into regional and local community economic models	• Exact mill locations are available so outputs can feed directly into local community models where they are available	• Timber Supply Modeling: - OSU/Darius Adams • Local Community and Regional Economic Models: ODF/Gary Lettman	• Local community economic models are available only for Tillamook, Coos Bay, John Day, and Enterprise. • Information parsing production, employment, and income into rural/urban forest dependent/not dependent will soon be available from ODF work on indicators of forest sustainability
G3. How will changes in those locations/	Yes	Oregon and Washington	Input into OSU Timber Supply	• Exact mill location information is	• Oregon Mill Study: Gary Lettman	• Oregon mill study information will not be available until

Data	Standard?	Data	Models and Other Analysis Tools	Scale & Scope	Lead Agency/Contact	Limitations/Considerations
capacities influence the ability to economically manage forests within Oregon's timbersheds, to provide biomass for energy production, to maintain and enhance rural economies, provide and to provide revenues to state and local government for public services?		mill studies	Models	available • Economically feasible locations for new mills can be identified.	• Washington Mill Study: Phil Aust	2009; other information can be used to update data sets in the interim.
		VDDT model output	Input into OSU Timber Supply Models	• Output from VDDT will be from modeling unit parameters: owner group, potential vegetation, stand size, etc.	• VDDT Modeling - PNW/Miles Hemstrom • Timber Supply Modeling: - OSU/Darius Adams	• Links between VDDT models and the OSU timber supply models are not yet completed
		Timber supply model output	Input into regional and local community economic models	• Exact mill locations are available so outputs can feed directly into local community models where they are available	• Timber Supply Modeling: - OSU/Darius Adams • Local Community and Regional Economic Models: ODF/Gary Lettman	• Local community economic models are available only for Tillamook, Coos Bay, John Day, and Enterprise. • Information parsing production, employment, and income into rural/urban forest dependent/not dependent will soon be available from ODF work on indicators of forest sustainability
		Biomass modeling	Addition to OSU Timber Supply Model	• Exact locations of existing mills and biomass energy production facilities are available • Economically feasible locations for new plants can be identified		
		Transportation networks	GIS and other database analysis	• Estimates of haul costs to mill locations	• ODF – Gary Lettman • WADNR - ??	

Table 17. Products generated to answer Topic G questions.

Products	***Description***	***General Applications***	***Specific Applications***
Spatial and tabular data on current mill locations and mill capacity	Locations of current forest products mills, including those specializing in biomass located in spatial data and associated transportation network data.	• Analysis of current milling capacity across mid to broad-scale landscapes. • Analysis of economic values of forest products including transportation costs • Analysis of where in mid to broad scale landscapes forest products might help pay for treatment costs • Baseline monitoring data for comparison to future re-measured or re-mapped mill locations and types.	• Land management agencies - evaluation of economic potentials for forest products that might help pay for treatment costs. • ODF – Reporting for Oregon Board of Forestry Indictors • WADNR – Reporting
Spatial and tabular data on potential future mill locations and mill capacity	Locations of potential future forest products mills, including those specializing in biomass located in spatial data and associated transportation network data.	• Analysis of future milling capacity across mid to broad-scale landscapes. • Analysis of future economic values of forest products including transportation costs • Analysis of where in mid to broad scale landscapes forest products might help pay for treatment costs in the future • Aids for economic development – areas where mills might be most economically viable in the future • Baseline monitoring data for comparison to future re-measured or re-mapped mill locations and types.	• Land management agencies - evaluation of economic potentials for forest products that might help pay for treatment costs. • ODF – Reporting for Oregon Board of Forestry Indictors • WADNR – Reporting

Products	Description	General Applications	Specific Applications
Spatial and tabular data on potential future flows of forest products	Spatial and tabular data on both long-term sustained yield and market driven flows of forest products given different land management policies. Integration of forest products from both public and private forest lands.	• Economic analyses of potential future timber product flow under sustained yield and market driven assumptions. • Evaluation of effects of land management policies on local economic and social conditions • Evaluation of the potential future ability of management activities to pay for themselves given economic conditions and supply/demand.	• Land management agencies - evaluation of economic potentials for forest products that might help pay for treatment costs. • ODF – Reporting for Oregon Board of Forestry Indictors • ODFW – Reporting for Conservation Strategy Elements; monitoring and adaptation • WDFW – Reporting for Comprehensive Wildlife Conservation Strategies

Chapter 2 - Performing Analyses to Answer User Group Questions

Answering User Group questions requires assembling the data, models, and other information – as described in Chapter 1 – and performing model runs, data analyses, reporting, and other tasks to generate answers. In this chapter, we describe the steps that could be taken to make answers from information. Our assumption is that the IMAP Partnership collaborates to build a common set of data, models, and information but that individual Partners may have differing needs for answers to particular User Group questions, timelines for answering questions, and resources to answer questions. Consequently, we designed this chapter to be somewhat like a grocery; answers to questions are packages that contain specific ingredients and cost a particular amount. We suggest Users wanting to answer the questions think of the process as assembling a dinner menu from these ingredients to suit their individual needs.

We developed a set of estimated costs for translating IMAP models, data, and information into answers for IMAP User Group questions (Table 19). For each question, we listed the likely information source, level of uncertainty for answers, the IMAP partner (or other entity) most likely to be the lead for answering the question, date and cost for delivering supporting information, an estimated date by which the answer could be delivered assuming beginning the analysis process by the start of federal FY2009, the specific analysis required and estimated cost for the analysis, and whether the cost applies to Oregon, Washington, or both This individualistic approach to answering the questions may not take full advantage of cost savings and synergies possible from collaboration. For example, several Users might want the same questions answered and in approximately the same time frame. They might share expenses and reduce individual costs. Such collaboration is for the Users to decide; we can not make those decisions. In addition, the cost and time estimates in this chapter are general guidelines designed to help Users estimate ball-park resources needed to answer questions. We based these cost and delivery time estimates on our combined history with IMAP analyses (Appendix B); they are our best ball park estimates.

Deliverables and Costs for answering User Group Questions

Table 17. Deliverables and costs for answering User Group Questions. These estimates apply for each State (Oregon and Washington). Either costs or time required for doing both States should be doubled unless noted. These are only ball-park estimates. More accurate costs should be calculated for work items selected for completion. Abbreviations: ODF – Oregon Department of Forestry, WDNR – Washington Department of Natural Resources, ODFW – Oregon Department of Fish and Wildlife, WDFW - Washington Department of Fish and Wildlife, RES – research institution, BLM – Oregon/Washington Bureau of Land Management, IMAP– IMAP partners, OWEB – Oregon Watershed Enhancement Board, ODA - Oregon Department of Agriculture, WDA – Washington Department of Agriculture, FHP – USDA Forest Service Forest Health Protection program.

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
A1. How much wildland is there?	Development analysis – ODF methods	low	ODF	OR – available	OR – no additional cost	OR - 9/30/2010	OR - no additional cost (Lettman/Kline project)	$0	
				WA – 2010	WA - need?	WA - need?	WA – (if needed) Wildland development		$43,976
A2. Where is wildland currently being developed for other uses?	Development analysis – ODF methods	low	ODF	OR – available	OR – no additional cost	OR - 9/30/2010	OR - no additional cost (Lettman/Kline project)	$0	
				WA – 2010	WA - need?	WA - need?	WA – (if needed) Wildland development from A1 (no additional cost)		$0
A3. What areas of wildland are likely to be developed in the future?	Development analysis – ODF methods	moderate	ODF	OR – available	OR – no additional cost	OR - 9/30/2010	OR - no additional cost (Lettman/Kline project)	$0	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
				WA – 2010	WA - need?	WA - need?	WA – (if needed) Wildland development from A1 (no additional cost)		$0
A4. How might alternative management policies affect where wildland development occurs in the future?	Development analysis – ODF methods	moderate	ODF+RES	R&D needed	OR – no additional cost	OR - one example study area - Sept. 2010	RES R&D level 1	$48,599	
					WA - need?	WA - one example study area - Sept. 2010	RES R&D level 1		$48,599
	VDDT models	moderate - high	IMAP			OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	0	
						WA - need?	VDDT modeling from B1 a&b (no additional cost)		$0
A5. How might wildland development and fragmentation affect potential wildfire behavior and risk in the future?	ODF development analysis	moderate	ODF+R6+ RES	R&D needed	OR – no additional	OR - one example study area - Sept. 2010	RES R&D level 1	$48,599	
			WDNR+ ODF+R6+ RES		WA – (Lettman)	WA - one example study area - Sept. 2010	RES R&D level 1		$48,599
	VDDT models	moderate - high	IMAP			OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	
						WA - need?	VDDT modeling from B1 a&b (no additional cost)		$0

Question	**Information source**	**Answer Uncertainty**	**Responsible Partner**	**Data/Model Delivery date**	**Data/Model Cost**	**Analysis Delivery Date**	**Analysis Cost Component**	**OR Cost**	**WA Cost**
A6. How might wildland development and fragmentation affect potential ecosystem services including carbon sequestration and potential to generate forest products in the future?	ODF development analysis	moderate	ODF+R6+ RES	R&D needed	OR – no additional cost	one example study area - Sept. 2010	RES R&D level 1	$48,599	
			WDNR+ ODF+R6+ RES		WA – (Lettman)	one example study area - Sept. 2010	RES R&D level 1		$48,599
	VDDT models	moderate - high	IMAP			OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	
						WA - need?	VDDT modeling from B1 a&b (no additional cost)		$0
B1a. What is the current mix and spatial distribution of vegetation cover types and stand structural stages?	GNN vegetation Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	no additional cost	9/30/2010	OR - GIS modeling	$22,908	
				WA – GNN delivery 9/30/09	no additional cost	WA – Need?	WA - GIS modeling		$22,908
B1b. How might different management approaches and natural disturbances alter the mix and spatial distribution of vegetation cover types and stand structural stages in the future?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	$45,000			$0	
				WA – GNN delivery 9/30/09	$45,000				$0
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery by IMAP 1/1/2010	$540,000	OR - 9/30/2010	VDDT modeling	$164,772	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
				WA – VDDT delivery by IMAP 9/30/2010	$540,000	WA – Need?			$164,772
B1c. What are the current effects of vegetation conditions on important ecosystem services including carbon sequestration and potential to generate forest products?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	no additional cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery by IMAP 1/1/2010	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?	VDDT modeling from B1 a&b (no additional cost)		$0
	FVS calibration of VDDT forest product yield streams	moderate	R6+ODF+ PNW	FVS data available	No additional cost	OR - 9/30/2010	Forest product analysis	$43,976	
			R6+WDNR+ PNW	FVS data available	No additional cost	WA – Need?	Forest product analysis		$43,976

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
B1d. How might different management approaches and natural disturbances alter important ecosystem services including carbon sequestration, and potential to generate forest products in the future?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – no additional cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery 1/1/2010	OR – VDDT model development cost from B1a&b (no additional cost)		VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1a&b (no additional cost)		VDDT modeling from B1 a&b (no additional cost)		$0
	FVS calibration of VDDT forest product yield streams	moderate	R6+ODF+ PNW	FVS data available	No additional cost	OR - 9/30/2010	Forest product analysis from B1c (no additional cost)	$0	
			R6+WDNR+ PNW	FVS data available	No additional cost	WA – Need?	Forest product analysis from B1c (no additional cost)		$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
B2. What integrated strategies and opportunities (e.g. increased carbon sequestration) could be used to achieve policy goals such as improving vegetation health and the sustainability of resource outputs, enhancing local economies, and maintaining desired vegetation characteristics?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – no additional cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery 1/1/2010	OR – VDDT model development cost from B1b. (no additional cost)		VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1b. (no additional cost)		VDDT modeling from B1 a&b (no additional cost)		$0
	FVS calibration of VDDT forest product yield streams	moderate	R6+ODF+ PNW	FVS data available	No additional cost	OR - 9/30/2010	Forest product analysis from B1c (no additional cost)	$0	
			R6+WDNR+ PNW	FVS data available	No additional cost	WA – Need?	Forest product analysis from B1c (no additional cost)		$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
C1a. What are the current mid-and broad scale amount, composition, and pattern of habitat for key wildlife species?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – no additional cost	WA – Need?			$0
	BIOMAPPER/ similar models or VDDT state class link to BBN models	moderate - high	ODF or R6+ ODFW	BIOMAPPER development	$87,952	OR - 9/30/2010	Wildlife habitat modeling	$87,952	
				BIOMAPPER development	$21,988	WA – Need?	Wildlife habitat modeling		$87,952
C1b. How might different management approaches, natural disturbances, and climate change alter the mid- and broad scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – no additional cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery 1/1/2010	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?	VDDT modeling from B1 a&b (no additional cost)		$0
	Wildlife habitat models	moderate - high	R6+ODF+R6	R6 focal species BBN models available - 9/30/2010	No additional cost	OR - 9/30/2010	Wildlife habitat modeling from C1b (no additional cost)	$43,976	
				R6 focal species BBN models available - 9/30/2010	No additional cost	WA – Need?	Wildlife habitat modeling from C1b (no additional cost)		$43,976
C1c. How might future changes in habitat amount, composition, and pattern affect mid- and broad scale population trends for key wildlife species?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – no additional cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery 1/1/2010	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?	VDDT modeling from B1 a&b (no additional cost)		$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
	Wildlife habitat models	moderate - high	R6+ODF+R6	R6 focal species BBN models available - 9/30/2010	No additional cost	OR - 9/30/2010	Wildlife habitat modeling from C1b (no additional cost)	$0	
				R6 focal species BBN models available - 9/30/2010	No additional cost	WA – Need?	Wildlife habitat modeling from C1b (no additional cost)		$0
C2a. What are the current fine scale (e.g. several watersheds and larger) amount, composition, and pattern of habitat for key wildlife species?	GNN vegetation+ Local vegetation	moderate - high	IMAP	Wall to wall stand-scale polygon data	One study area polygon modeling package			$21,758	
				Wall to wall stand-scale polygon data	One study area polygon modeling package				$21,758
	VDDT models	moderate - high	IMAP			OR - Need?	Fine-scale spatial (TELSA) modeling , one study area	$66,286	
						WA – Need?	Fine-scale spatial (TELSA) modeling , one study area		$66,286
	Spatial wildlife models	moderate - high	OR – ODFW+R6			OR - Need?	Fine-scale wildlife modeling , one study area	$41,676	
			WA – WDFW+ WDNR+R6			WA – Need?	Fine-scale wildlife modeling , one study area		$41,676

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
C2b. How might different management approaches, natural disturbances, and climate change alter the fine scale mix and spatial distribution of amount, composition, and pattern of habitat for key wildlife species change in the future?	GNN vegetation+ Local vegetation	moderate - high	IMAP	Wall to wall stand-scale polygon data	One study area polygon modeling package from C2a (no additional cost)			$0	
				Wall to wall stand-scale polygon data	One study area polygon modeling package from C2a (no additional cost)				$0
	Spatial vegetation models (TELSA)	moderate - high	IMAP			OR - Need?	Fine-scale spatial (TELSA) modeling , one study area from C2a (no additional cost)	$0	
						WA – Need?	Fine-scale spatial (TELSA) modeling , one study area from C2a (no additional cost)		$0
	Spatial wildlife models	moderate - high	OR – ODFW+R6			OR - Need?	Fine-scale wildlife modeling , one study area from C2a (no additional cost)	$0	
			WA – WDFW+ WDNR+R6			WA – Need?	Fine-scale wildlife modeling , one study area from C2a (no additional cost)		$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
C2c. How might future changes in habitat amount, composition, and pattern affect fine scale population trends for key wildlife species?	GNN vegetation+ Local vegetation	moderate - high	IMAP	Wall to wall stand-scale polygon data	One study area polygon modeling package from C2b (no additional cost)			$0	
				Wall to wall stand-scale polygon data	One study area polygon modeling package from C2b (no additional cost)				$0
	Spatial vegetation models (TELSA)	moderate - high	IMAP			OR - one example study area - Sept. 2010	RES R&D level 2 from C2b (no additional cost)	$0	
						WA - one example study area - Sept. 2010	RES R&D level 2 from C2b (no additional cost)		$0
	Fine-scale habitat relations	R&D needed	OR - ODFW+ ODF+RES			OR - one example study area - Sept. 2010	RES R&D level 2	$117,622	
			WA – WDFW+ WDNR+ RES			WA - one example study area - Sept. 2010	RES R&D level 2		$117,622

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
D1a. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function at present?	GNN vegetation+ Local vegetation	moderate - high	IMAP	Wall to wall stand-scale polygon data	IMAP data + OWEB funded work (no additional cost)			$0	
	Spatial vegetation/ management/ disturbance models (TELSA)	moderate - high	OWEB			OR - 9/30/2010	Fine-scale spatial (TELSA) modeling , two study areas (no additional cost - funded by OWEB)	$0	
D1b. How might upland landscape vegetation patterns and disturbances affect riparian habitats, water quantity and quality, river dynamics, and floodplain function in the future under different management approaches and natural disturbance regimes changes?	GNN vegetation+ Local vegetation	moderate - high	IMAP	Wall to wall stand-scale polygon data	IMAP data + OWEB funded work (no additional cost)			$0	
	Spatial vegetation/ management/ disturbance models (TELSA)	moderate - high	OWEB			OR - 9/30/2010	Fine-scale spatial (TELSA) modeling , two study areas (no additional cost - funded by OWEB)	$0	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
D2a. How do vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales at present?	GNN vegetation+ Local vegetation	moderate - high	IMAP	Wall to wall stand-scale polygon data	IMAP data + OWEB funded work (no additional cost)			$0	
	Spatial vegetation/ management/ disturbance models (TELSA)	moderate - high	OWEB			OR - 9/30/2010	Fine-scale spatial (TELSA) modeling , two study areas (no additional cost - funded by OWEB)	$0	
D2b. How might vegetation patterns and disturbances in upland and riparian habitats influence fish and wildlife species habitat values, distributions, and abundances at mid- and broad spatial and temporal scales in the future?	GNN vegetation+ Local vegetation	moderate - high	IMAP	Wall to wall stand-scale polygon data	IMAP data + OWEB funded work (no additional cost)			$0	
	Spatial vegetation/ management/ disturbance models (TELSA)	moderate - high	OWEB			OR - 9/30/2010	Fine-scale spatial (TELSA) modeling , two study areas (no additional cost - funded by OWEB)	$0	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
D3a. What are the current production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas?	GNN vegetation+ Local vegetation	moderate - high	IMAP	Wall to wall stand-scale polygon data	IMAP data + OWEB funded work (no additional cost)			$0	
	Spatial vegetation/ management/ disturbance models (TELSA)	moderate - high	OWEB			OR - 9/30/2010	Fine-scale spatial (TELSA) modeling , two study areas (no additional cost - funded by OWEB)	$0	
	Sediment & debris routing model (Benda/Reeves)	moderate - high	ODF+ ODFW+ RES			OR - 9/30/2010	R&D level 2	$117,622	
D3b. What might the future production, recruitment, retention, and function of large woody debris in the terrestrial and aquatic riparian areas be under different management approaches and natural disturbance regimes?	GNN vegetation+ Local vegetation	moderate - high	IMAP	Wall to wall stand-scale polygon data	IMAP data + OWEB funded work (no additional cost)			$0	
	Spatial vegetation/ management/ disturbance models (TELSA)	moderate - high	OWEB			OR - 9/30/2010	Fine-scale spatial (TELSA) modeling , one study area from C2a (no additional cost - funded by OWEB)	$0	
	Sediment & debris routing model (Benda/Reeves)	moderate - high	ODF+ODFW + RES			OR - 9/30/2010	R&D level 2 from D3a (no additional cost)	$0	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
E1a. How many acres of Oregon and Washington wildland are currently in conditions that may result in high-severity or unnaturally intense insect and disease outbreaks and wildfires?	Annual aerial survey data for insects/disease	low	R6 Forest Health Protection + ODF	OR – available	OR – no additional cost	Available	Available (no additional cost)	$0	
			R6 Forest Health Protection + WDNR	WA – available	WA – no additional cost	Available	Available (no additional cost)	$0	
	Current wildfire departure from historic conditions	moderate - high	LANDFIRE	OR&WA - available	no additional cost	Available	Available (no additional cost)	$0	
E1b. How many acres of Oregon and Washington wildland have been treated to reduce these hazards?	land management agency treatment data	low - moderate	Land management agencies	OR – tabular data available? Spatial data not available.	Tabular data – no additional cost?	Tabular analysis of existing data	Tabular: Non-spatial data analysis	$21,758	
				WA – tabular data available? Spatial data not available.	Tabular data – no additional cost?	Tabular analysis of existing data			$21,758
E2a. What Oregon and Washington wildland areas are likely to experience unnaturally intense insect and disease outbreaks and wildfires in the future?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – no additional cost	WA – Need?			$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery 1/1/2010	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?	VDDT modeling from B1 a&b (no additional cost)		$0
E2b. How does this differ from historical patterns?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – no additional cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery 1/1/2010	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?	VDDT modeling from B1 a&b (no additional cost)		$0
E2c. How might different management strategies affect these disturbances?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – no additional cost	WA – Need?			$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery 1/1/2010	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?	VDDT modeling from B1 a&b (no additional cost)		$0
E3. What are the likely landscape-scale effects of pre- and post-fire management (i.e., thinning, fuels management, salvage) on ecosystem processes and components, including fish and wildlife habitats values?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost			$0	
				WA – GNN delivery 9/30/09	WA – no additional cost				$0
	VDDT models	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost			$0	
				WA – GNN delivery 9/30/09	WA – no additional cost				$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
	Fire and Fire Surrogates data	low - moderate	Joint Fire Sciences	On-going Fire&Fire Surrogates study (no additional cost)	R&D needed to apply JFS studies to example landscape	one example study area, OR or WA	R&D effort level 2	$117,622	
E4. What are likely trade-offs between short term loss of wildlife habitat values from management designed to reduce unnaturally intense disturbances and long term damage to habitat from unnaturally intense disturbances?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – VDDT model development cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010		VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?		VDDT modeling from B1 a&b (no additional cost)		$0
	Wildlife habitat models	moderate - high	R6	R6 focal species BBN models available - 9/30/2010	No additional cost	OR - 9/30/2010	Wildlife habitat modeling from C1b (no additional cost)	$0	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
				R6 focal species BBN models available - 9/30/2010	No additional cost	WA – Need?	Wildlife habitat modeling from C1b (no additional cost)		$0
E5a. Where do opportunities currently exist to improve forest health and generate sustainable outputs of important forest values through active management?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – VDDT model development cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010		VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?		VDDT modeling from B1 a&b (no additional cost)		$0
	FVS calibration of VDDT forest product yield streams	moderate	R6+ODF+ PNW	FVS data available	No additional cost	OR - 9/30/2010	Forest product analysis from B1c (no additional cost)	$0	
			R6+WDNR+ PNW	FVS data available	No additional cost	WA – Need?	Forest product analysis from B1c (no additional cost)		$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
E5b. How much difference might active management make in landscape wildlife habitat, forest products, and other resource values compared to passive management?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – VDDT model development cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery 1/1/2010	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?	VDDT modeling from B1 a&b (no additional cost)		$0
	FVS calibration of VDDT forest product yield streams	moderate	R6+ODF+ PNW	FVS data available	No additional cost	OR - 9/30/2010	Forest product analysis from B1c (no additional cost)	$0	
			R6+WDNR+ PNW	FVS data available	No additional cost	WA – Need?	Forest product analysis from B1c (no additional cost)		$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
E5c. How might landscape priorities be developed and displayed that integrate trade-offs between disturbance risks, wildlife habitat and other landscape values, and social/economic benefits?	GNN vegetation+ Local vegetation	moderate - high	IMAP	R&D needed	R&D needed	One landscape study area, OR or WA 9/30/2010	Integrated risk and opportunity analysis for test landscape: R&D level 1	$49,000	
E6a. How might different mixes of wildfire, fuels management, and fire suppression provide alternative landscape economic, social, and ecological benefits?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – VDDT model development cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model delivery 1/1/2010	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010	VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT delivery 9/30/2010	WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?	VDDT modeling from B1 a&b (no additional cost)		$0
	FVS calibration of VDDT forest product yield streams	moderate	R6+ODF+ PNW	FVS data available	No additional cost	OR - 9/30/2010	Forest product analysis from B1c (no additional cost)	$0	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
			R6+WDNR+ PNW	FVS data available	No additional cost	WA – Need?	Forest product analysis from B1c (no additional cost)		$0
	Wildlife habitat models	moderate - high	R6	R6 focal species BBN models available - 9/30/2010	No additional cost	OR - 9/30/2010	Wildlife habitat modeling from C1b (no additional cost)	$0	
				R6 focal species BBN models available - 9/30/2010	No additional cost	WA – Need?	Wildlife habitat modeling from C1b (no additional cost)		$0
E6b. What might the economic trade-offs be for different management approaches to wildfire, fuels management, and fire suppression?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – VDDT model development cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010		VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?		VDDT modeling from B1 a&b (no additional cost)		$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
	FVS calibration of VDDT forest product yield streams	moderate	R6+ODF+ PNW	FVS data available	No additional cost	OR - 9/30/2010	Forest product analysis from B1c (no additional cost)	$0	
			R6+WDNR+ PNW	FVS data available	No additional cost	WA – Need?	Forest product analysis from B1c (no additional cost)		$0
F1a. What are the current distribution and amount of wildlands affected by non-native insects and diseases and invasive plants and animals?	Non-native invasive species inventory	unknown	ODA, WDA	unknown	unknown	unknown	unknown	?	
F1b. How might different management approaches, natural disturbances, and climate change affect future amount and distribution of area potentially affected by non-native insects and diseases and invasive plants and animals?	Non-native invasive species relations with habitats Non-native invasive species inventory	unknown	ODA, WDA	unknown	unknown	unknown	unknown	?	
F2. Have management policies been successful in excluding or containing the worst invasive species threats to wildlands?	Non-native invasive species inventory and monitoring data	unknown	ODA, WDA	unknown	unknown	unknown	unknown	?	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
F3. Where might invasive species be most likely to have adverse effects on wildlands in the future?	Non-native invasive species relations with habitats Non-native invasive species inventory	unknown	ODA, WDA	unknown	unknown	unknown	unknown	?	
G1. What is the location and capacity of existing wood products mills and processing plants, including biomass?	mill location data	low	ODF, WDNR	available	available	available	Analysis exists (no additional cost)	$0	
G2. How will this likely change over time under various management and policy scenarios?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – VDDT model development cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010		VDDT modeling from B1 a&b (no additional cost)	$0	
				WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?		VDDT modeling from B1 a&b (no additional cost)		$0

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
	FVS calibration of VDDT forest product yield streams	moderate	R6+ODF+ PNW	FVS data available	No additional cost	OR - 9/30/2010	Forest product analysis from B1c (no additional cost)	$0	
			R6+WDNR+ PNW	FVS data available	No additional cost	WA – Need?	Forest product analysis from B1c (no additional cost)		$0
	Timber supply model	low	ODF	FIA data available	No additional cost		OR - Timber supply model integration and simulation. R&D level2 .	$117,622	
			WDNR	FIA data available	No additional cost		WA - Timber supply model integration and simulation. R&D level 2.		$117,622
G3. How will changes in those locations/capacities influence the ability to economically manage forests within Oregon's timbersheds, to provide biomass for energy production, to maintain and enhance rural economies, provide and to provide revenues to state and local government for public services?	GNN vegetation+ Local vegetation	moderate - high	IMAP	OR – GNN delivery 9/30/09	OR – no additional cost	OR - 9/30/2010		$0	
				WA – GNN delivery 9/30/09	WA – VDDT model development cost	WA – Need?			$0
	VDDT models	moderate - high	IMAP	OR – VDDT model development cost from B1a&b (no additional cost)	OR - 9/30/2010		VDDT modeling from B1 a&b (no additional cost)	$0	

Question	Information source	Answer Uncertainty	Responsible Partner	Data/Model Delivery date	Data/Model Cost	Analysis Delivery Date	Analysis Cost Component	OR Cost	WA Cost
				WA – VDDT model development cost from B1a&b (no additional cost)	WA – Need?		VDDT modeling from B1 a&b (no additional cost)		$0
	FVS calibration of VDDT forest product yield streams	moderate	R6+ODF+ PNW	FVS data available	No additional cost	OR - 9/30/2010	Forest product analysis from B1c (no additional cost)	$0	
			R6+WDNR+ PNW	FVS data available	No additional cost	WA – Need?	Forest product analysis from B1c (no additional cost)		$0
	Timber supply model	low	ODF	FIA data available	No additional cost	OR - 9/30/2010	OR - Timber supply model integration and simulation. R&D level 2 from G2. no additional cost	$0	
			WDNR	FIA data available	No additional cost	WA – Need?	WA - Timber supply model integration and simulation. R&D level 2 from G2. no additional cost		$0
	Local economic studies	low	ODF	Local economic data available?	No additional cost?	OR - 9/30/2010	OR - R&D level 1 to link local economic data to timber supply.	$48,599	
			WDNR	Local economic data available?	No additional cost?	WA – Need?	WA - R&D level 1 to link local economic data to timber supply.		$48,599

Appendix A - DRAFT Interagency Mapping & Assessment Project User Group Charter

Version 4.0 November 19, 2007

Sponsors	Policy User Group Co-chairs	Kick Off Date	Committee Type Sunset Date
USFS/BLM/ODF/ *OSU/WDNR/WDFW*	*Shawne Mohoric– Federal Agency* *Angus Brodie – Washington DNR (alternate with OR rep yearly)*	*October 13, 2006*	**Ad Hoc** January, 1, 2011

Vision	That the Interagency Mapping and Assessment Project (IMAP) meets agency partner and users objectives, is appropriately staffed and funded, and that its work is in line with the goals, policies, and legal mandates of participating agencies and will be of significant value to users for policy and technical analyses. The IMAP project will produce consistent, landscape-wide vegetation mapping across Oregon and Washington. The project will also produce a series of land use and other needed maps, and land use, vegetation, wildlife, and socioeconomic models that can be used to assess current conditions and trends and implications of alternative policies and management actions. This effort will be ongoing, adapting to changing agency planning and assessment needs.

Goals	• To achieve the vision by ensuring that landscape level, multi-owner, data and integrated analysis tools are available for use by agency staffs, policy makers, and other potential users. The IMAP User Group will serve as a review body for program development and implementation to help insure that IMAP delivers credible, consistent vegetation data, and associated models and tools to allow public agency managers and other users to assess environmental consequences of policies and potential management actions in a consistent fashion across ownerships and large landscapes. • To ensure technical review and quality control of all IMAP products. The User Group will refer technical-related matters to a Technical Team. The IMAP Technical Team is an interagency group of scientists that will coordinate and review IMAP technical work to ensure that IMAP produces scientifically credible and cost-effective data, modeling tools, and analysis. It will serve as a technical sounding board for a variety of data, mapping, and modeling issues related to IMAP and will help integrate IMAP with Coastal Landscape Analysis and Modeling Study and other assessment work. The User Group will provide input for the Technical Team, including input necessary to insure that products are of the highest quality and meet agency and user needs.
Background Drivers	• *State and Federal agencies are currently updating forest plans and assessments, which need to be landscape-level, multi-resource, and multi-owner.* • Policy makers and the managers who implement policy objectives need tools to both evaluate alternatives and to display potential outcomes, while accurately accounting for the wide variety of values people expect from both public and private lands. The most helpful tools are easy to use and provide a robust representation of the social, economic and environmental implications of vegetative succession, management, and natural disturbances. • *Agency resources for assessment and planning are limited, shrinking, and unlikely to significantly increase in the future.* • *Over 21 million acres of Oregon's forestlands are overstocked, in Fire Condition Class II or III, and subject to catastrophic wildfire, drought stress, and insect and disease outbreaks, which impact forest productivity, air quality, and the safety of rural communities.* • *Washington faces similar issues, but with one major difference. Washington State Forests constitute a much larger proportion of the forested landscape than do Oregon State Forests.* • Forest industry infrastructure, needed to help treat unhealthy

	forests and provide economic and social stability for rural communities, is in danger of disappearing in eastern Oregon and Washington. • Federal, state, and local initiatives could result in on-going, long-term forest health and fuel reduction projects, benefiting local, state and national constituencies. • Oregon policy makers are currently reviewing Oregon's land use laws and their effectiveness in meeting Oregonian's needs.
Success Indicators	1. Robust tools are developed in a timely manner for State and Federal agencies and other partners to use in forest planning and forest policy development. 2. Research and modeling results are distributed to policy makers and interested publics through printed and web-based reports and through forums. 3. Databases, maps, models, and other tools developed are used in forest planning, forest and land use policy development, and in other analyses. 4. Institutional capacity is developed to continue to develop and improve landscape-level, multi-ownership databases, models and other assessment and monitoring tools.

Milestones & Deliverables (bold)	2006 • October: Review draft **Charter & MOU** developed by User Group • October: Review objectives, resources needed, and **budget** requirements 2007 • February: Continue discussion of IMAP work to date and User Group Charter • July: Finalize **CHARTER** • July: Strategic issues and indicators identified, "**critical path**" developed • July: Identify **needed analyses** and **indicators** and **alternatives** to model • July: Continue **resource discussions** • July: Review projects 2008 • February: Update and publish **study plan** drafted by staff • February: Planning and resources • July: Review projects • July: Finalize **MOU** 2009 • February: Planning and resources • July: Review projects 2010 • February: Planning and resources • July: Review projects • October: Public **symposium** and publish **Assessment of Oregon's Forests**

Commitment	A first meeting was held on October 13, 2006 at which progress-to-date was reviewed and this charter, a draft Memorandum of Understanding, and budgets were reviewed. The User Group will meet semi-annually or as needed to help resolve issues and provide review for IMAP goals, objectives, staffing, funding, timelines and similar issues. The first meeting of any calendar year would focus on project review and direction; the second meeting of any calendar year will emphasize planning and resources. The User Group will refer technical issues to the Technical Team, which will meet as necessary to review these issues and submit recommendations to the User Group. The User Group accepts responsibility to: Keep stakeholders, policy makers, and technical partners informed and engaged when appropriate. Work to ensure that IMAP has sufficient resources to successfully complete goals and objectives. Facilitate decisions at the appropriate level on a timely basis to address key barriers and to facilitate taking advantage of promising opportunities. Monitor, inform, and coordinate with the others working on local, statewide, regional, and national indicators and assessments. Make decisions on recommendations from the Technical Team. The Technical Team accepts responsibility to: Review technical issues referred by the User Group in a timely fashion and submit recommendations to the User Group for approaches to solve technical issues. Suggest any additional technical issues that may arise during Technical Team meetings to the User Group for review and discussion.
Stakeholders	Forest Landowners Forest Products Industry Consultants Power Companies Local Governments/Districts Environmental and NGO groups Community groups Congressional staff State Agencies Federal Agencies Tribal Governments The Governors' Offices The Legislatures Universities and research centers Citizens
Group Norms, Decision Making Process, and Decision	The User Group will strive to make decisions and recommendations by consensus. Failure to participate will not be grounds for blocking consensus. If consensus cannot be attained, the co-chairs may elect to use other decision-making methods. Communication is through meetings, meeting summaries, in published documents and by email.

Communication	Meeting frequency will be biannually; additional meetings will be set by the group as needed. User Group and Technical Team meetings will be open to the public and members of the public will have opportunities to provide comments to the User Group and Technical Team. Only User Group members designated though this charter will participate in decision-making. The co-chairs may appoint subcommittees and direct technical analyses for specific aspects of the group's work. The User Group will appoint membership to the Technical Team. Opportunity for informal input from non-User Group members will be provided at each meeting. Stakeholders and other interested parties are welcome to attend all meetings and to interact with User Group members through written and/or oral comments between meetings. Representatives of User Group organizations may be invited to participate in technical advisory committees to the User Group. Meetings summaries and other information about IMAP and the User Group will be posted and maintained by the Region 6 Office at: http://www.reo.gov/ecoshare/mapping/index-issues.asp.
Selection of Co-chairs	One co-chair shall be a Federal agency User Group member annually appointed by the federal agency members. One co-chair shall be a User Group member representing the State agencies and selected by the User Group annually and alternating between the states of Oregon and Washington.
Membership	User Group Members Jaime Barbour – USFS PNW Research Station Jerry Beatty – Western Wildland Environmental Threat Assessment Center Angus Brodie – Washington Dept. Natural Resources Steve Hobbs – Oregon Board of Forestry/OSU College of Forestry Ted Lorensen – Oregon Dept. Forestry Shawne Mohoric – USFS Region 6 John Pierce – Washington Dept. Fish & Wildlife Kim Titus – Bureau of Land Management Cindi West -- USFS PNW Research Station Rod Krahmer -- Oregon Department of Fish and Wildlife Tribal Representative to be determined Committee Staff – David Morman, Oregon Department of Forestry Technical Support – Miles Hemstrom, USFS PNW; Melinda Moeur, USFS R6; Jim Alegria, BLM; Gary Lettman, ODF

Appendix B. Cost assumptions for analyses or products to answer User Group questions.

VDDT modeling package

Item	days/ units	cost per day/unit	total cost
Modeling analyst	60	$350	$21,000
office space	60	$58	$3,480
travel	2	$500	$1,000
computer	60	$20	$1,200
subtotal			$26,680
overhead @15%			$4,002
total			$30,682

Wildlife habitat modeling package

Item	days/ units	cost per day/unit	total cost
Modeling analyst	20	$350	$7,000
office space	20	$58	$1,160
travel	2	$500	$1,000
computer	20	$20	$400
subtotal			$9,560
overhead @15%			$1,434
total			$10,994

Forest products analysis package

Item	days/ units	cost per day/unit	total cost
Modeling analyst	20	$350	$7,000
office space	20	$58	$1,160
travel	2	$500	$1,000
computer	20	$20	$400
subtotal			$9,560
overhead @15%			$1,434
total			$10,994

Wildland development analysis package			
Item	**days/ units**	**cost per day/unit**	**total cost**
Modeling analyst	20	$350	$7,000
office space	20	$58	$1,160
travel	2	$500	$1,000
computer	20	$20	$400
subtotal			$9,560
overhead @15%			$1,434
total			$10,994

R&D effort - level 1			
Item	**days/ units**	**cost per day/unit**	**total cost**
lead scientist	30	$450	$13,500
analyst/assistant	130	$200	$26,000
office space	20	$58	$1,160
travel	2	$500	$1,000
computer	30	$20	$600
subtotal			$42,260
overhead @15%			$6,339
total			$48,599

Fine Scale spatial modeling package			
Item	**days/ units**	**cost per day/unit**	**total cost**
Modeling analyst	130	$350	$45,500
office space	130	$58	$7,540
travel	4	$500	$2,000
computer	130	$20	$2,600
subtotal			$57,640
overhead @15%			$8,646
total			$66,286

Fine Scale spatial wildlife modeling package			
Item	**days/ units**	**cost per day/unit**	**total cost**
Modeling analyst	60	$350	$21,000
office space	60	$58	$3,480
travel	2	$500	$1,000
computer	60	$20	$1,200
subtotal			$26,680
overhead @15%			$4,002
total			$30,682

R&D effort - level 2			
Item	**days/ units**	**cost per day/unit**	**total cost**
lead scientist	60	$450	$27,000
analyst/assistant	260	$200	$52,000
office space	260	$58	$15,080
travel	6	$500	$3,000
computer	260	$20	$5,200
subtotal			$102,280
overhead @15%			$15,342
total			$117,622

GIS modeling package			
Item	**days/ units**	**cost per day/unit**	**total cost**
Modeling analyst	60	$350	$21,000
office space	60	$58	$3,480
travel	2	$500	$1,000
computer	60	$20	$1,200
subtotal			$26,680
overhead @15%			$4,002
total			$30,682

Polygon modeling package			
Item	**days/ units**	**cost per day/unit**	**total cost**
Modeling analyst	40	$350	$14,000
office space	40	$58	$2,320
travel	2	$500	$1,000
computer	80	$20	$1,600
subtotal			$18,920
overhead @15%			$2,838
total			$21,758

Non-spatial data analysis package			
Item	**days/ units**	**cost per day/unit**	**total cost**
Modeling analyst	40	$350	$14,000
office space	40	$58	$2,320
travel	2	$500	$1,000
computer	80	$20	$1,600
subtotal			$18,920
overhead @15%			$2,838
total			$21,758

Appendix C - Answering User Group Questions for Oregon State-wide Assessment

IMAP data, models, and analyses are designed to provide information for many of the Oregon Indicators of Sustainable Forest Management. The IMAP User Group Questions are framed around many of the same landscape and resource management issues and, in fact, provide more detailed interpretations of what the Oregon Indicators may mean to important resources, including wildlife habitats, forest products, and disturbance risks. The IMAP process also addresses potential future trends for the Indicators. It should allow managers and decision makers to explain trends in Indicators in the future given different policy scenarios. Decision makers could understand the ramifications of policy on an integrated set of future Indicator conditions. The models, data, and scenarios also comprise an explicit conceptual model about how landscapes, vegetation, management activities, natural disturbances, and human values are connected. They can be used to select important attributes for monitoring and to establish the basis for adaptive management. Adaptive management cannot take place unless net consequences are known. The Indicators and analysis of them via IMAP are a way of understanding consequences of management policies and their relationship to net public benefit. Understanding projected trends provides a mechanism for selecting thresholds at which basic assumptions or management policies need to be reviewed.

Our draft timeline for answering User Group questions for Oregon is based on several assumptions:

1. Information produced by the project is ultimately to answer User Group Questions.
2. Specific sets of the Questions will be of interest to various IMAP partners, depending on partner needs.
3. In the next two years, those Questions relating to the Oregon Indicators of Sustainable Forest Management are specifically of interest to the Oregon Board of Forestry, with the objective of producing a State-wide report by 2010-2011.
4. An analysis and reporting effort would begin August 1, 2008 with the development of a small set (e.g. 3-4) of policy/management scenarios that would be analyzed across Oregon.
5. IMAP models, data, and other supporting information will be finished on schedule so that analysis can begin in early February, 2009.

Given these assumptions, we believe an analysis can be performed to answer User Group questions and, consequently, many of the Indicators of Sustainable Forest Management adopted by the Oregon Board of Forestry (Table 20). Using only the User Group questions that do not contain a research component, we estimate the costs to be about $350,000 to perform necessary analyses and about $150,000 to write the report. We did not include the questions that will require research and development because we did not know if those could be delivered on time. These cost estimates reflect the amount of and kind of work we think might be needed to produce a state-wide report and might be more or less depending on collaboration and in-kind work done. Production of a report would require quickly starting the analysis process, beginning with those IMAP study areas that have completed models and data.

Table 20. Answering User Group questions relating to Oregon Indicators of Sustainable Forest Management for a State-wide assessment in 2010-2011.

Indicator		User Group question	IMAP answer by 2010?	Notes
Strategy A: Promote a sound legal system, effective and adequately funded government, leading-edge research, and sound economic policies.	A.a. Ability to measure and report on all other Oregon sustainable forest management indicators	All	P[1]	To the extent that IMAP deals with specific indicators, the answers to questions are measurable and repeatable.
	A.b. Development and maintenance of sustainable forest management knowledge	All	P	To the extent that IMAP deals with specific indicators, the data and models developed represent documented conceptual models and information for future users.
	A.c. Compliance with forestry regulations	NA	NA	IMAP does not specifically address forestry regulations.
Strategy B: Ensure that Oregon's forests provide diverse social and economic outputs and benefits valued by the public in a fair, balanced, and efficient manner.	B.a. Forest-related revenues supporting state and local government public services	G1, G2, G3	P	IMAP provides linkage to the forest products industry and economics through Darius Adam's work. This is still in the research phase and not yet implemented.
	B.b. Forest-related employment and wages	G1, G2, G3	P	IMAP provides linkage to the forest products industry and economics through Darius Adam's work. This is still in the research phase and not yet implemented.
	B.c. Forest ecosystem services contributions to society	B1c, B1d, B2	Y – carbon P - others	IMAP provides linkage to ecosystem services for carbon sequestration. Information for others ecosystem services could be provided to the extent that ecosystem services can be linked to modeled state classes.

[1] Y = answers could be generated state-wide. P = IMAP data and models provide information to inform answers, but may require additional information, tools, or interpretation. L = IMAP may provide indirect inferential information or no information for question. NA = IMAP will not provide information for question.

Indicator		User Group question	IMAP answer by 2010?	Notes
	B.d. Forest products sector vitality	G1, G2, G3	P	IMAP provides linkage to the forest products industry and economics through Darius Adam's work. This is still in the research phase and not yet implemented.
Strategy C: Maintain and enhance the productive capacity of Oregon's forests to improve the economic well-being of Oregon's communities.	C.a. Area of non-federal forestland and development trends	A1, A2, A3, A4	Y	IMAP links to development rate and zoning work done through ODF. Current and potential future development are being modeled. Work is still in research phase.
	C.b. Timber harvest trends compared to planned and projected harvest levels and the potential to grow timber	A6, B1c, G1, G2, G3	Y	IMAP provides linkage to the forest products industry and economics through Darius Adam's work. This is still in the research phase and not yet implemented.
Strategy D: Protect, maintain, and enhance the soil and water resources of Oregon's forests.	D.a. Water quality of forest streams	D1a, D1b	P	IMAP riparian modeling research has the potential to relate water quality/quantity to upland and riparian disturbances, roads, and management activities. Still in research phase. Two example areas may be available by 2010.
	D.b. Biological integrity of forest streams	D1a, D1b, D2a, D2b, D3a, D3b	P	IMAP riparian modeling research has the potential to relate water quality/quantity to upland and riparian disturbances, roads, and management activities. Still in research phase. Two example areas may be available by 2010.

Indicator		User Group question	IMAP answer by 2010?	Notes
	D.c. Forest road risks to soil and water resources	D1a, D1b, D2a, D2b, D3a, D3b	P	IMAP riparian modeling research has the potential to relate water quality/quantity to upland and riparian disturbances, roads, and management activities. Still in research phase. Two example areas may be available by 2010.
Strategy E: Contribute to the conservation of diverse native plant and animal populations and their habitats in Oregon's forests.	E.a. Composition, diversity, and structure of forest vegetation	B1a, B1b	Y	IMAP data on current and potential future vegetation cover types and structural classes may be used as surrogates for diversity.
	E.b. Extent of area by forest cover type in protected area categories	B1a, B1b	Y	IMAP includes vegetation cover types as base data and projections. Protected areas are part of ownership/allocation strata.
	E.c. Forest plant and animal species at risk	C1a, C1b, C1c, C2a, C2b, C2c	Y – mid scale P – fine scale	IMAP provides wall-to-wall data and models for key habitats and species at mid-scales. Fine scale work in research phase. One example areas may be available by 2010, if funded.
Strategy F: Protect, maintain, and enhance the health of Oregon's forest ecosystems, watersheds, and airsheds within a context of natural disturbance and active	F.a. Tree mortality from insects, diseases, and other damaging agents	E1a, E2b, E2a, E2b, E2c	Y	Mid-scale analysis of current and potential future risks from insects, disease, wildfire, and other risks is a basic, wall-to-wall product.
	F.b. Invasive species trends on forestlands	F1, F2, F3a, F3b	L	Invasive plant species are included in VDDT models wherever the species are an important part of mid-scale disturbance dynamics, but not tracked where they do not.

Indicator		User Group question	IMAP answer by 2010?	Notes
management.	F.c. Forest fuel conditions and trends related to wildfire risks	E1a, E1b, E2a, E2b, E2c, E5a, E5b, E5c	Y	Fuel conditions and risks are a key mid-scale analysis that IMAP data and models are designed to address.
Strategy G: Enhance carbon storage in Oregon's forests and forest products.	G.a. Carbon stocks on forestlands and in forest products	B1c, B1d, B2	Y	Current and potential future carbon sequestration can be addressed by linking carbon in biomass to VDDT model state classes. Requires VDDT calibration with FVS.

Table 20. Timeline for answering User Group questions for Oregon.

Task Name	Start	Finish	Predecessors	Resource Names
IMAP Project	**Mon 8/8/05**	**Fri 8/19/16**		
Develop Data, Models	**Thu 9/1/05**	**Mon 9/27/10**		
Project startup processes	**Thu 9/1/05**	**Fri 12/30/05**		
Blue Mountains project area	**Mon 10/3/05**	**Fri 6/30/06**		
Oregon East Cascades North and South project areas	**Mon 10/2/06**	**Fri 9/26/08**		
SW OR geographic area	**Tue 10/2/07**	**Fri 9/25/09**		
NW OR geographic area	**Tue 10/2/07**	**Fri 12/25/09**		
W Washington geographic area	**Wed 10/1/08**	**Mon 9/27/10**		
Answer User Group Questions for Oregon	**Fri 8/1/08**	**Thu 9/30/10**		
Develop Forest Management Policy scenarios	Fri 8/1/08	Fri 1/30/09		IMAP Users Group
Run policy scenarios - Blue Mountains	**Mon 2/2/09**	**Fri 4/24/09**	**18,86**	
Translate policy scenarios into VDDT scenarios	Mon 2/2/09	Fri 2/20/09	86	modeling analyst-GS-12,scientist
Review and adjust VDDT models	Mon 2/23/09	Fri 3/13/09	88	scientist,modeling analyst-GS-12
Run VDDT models	Mon 3/16/09	Fri 4/3/09	89	modeling analyst1,junior scientist
Analyze results	Mon 4/6/09	Fri 4/24/09	90	modeling analyst-GS-12,scientist
Run policy scenarios - East Cascades	**Mon 4/27/09**	**Fri 7/17/09**	**49,86**	
Translate policy scenarios into VDDT scenarios	Mon 4/27/09	Fri 5/15/09	91	scientist,modeling analyst-GS-12
Review and adjust VDDT models	Mon 5/18/09	Fri 6/5/09	93	modeling analyst2,junior scientist
Run VDDT models	Mon 6/8/09	Fri 6/26/09	94	modeling analyst2,junior scientist
Analyze results	Mon 6/29/09	Fri 7/17/09	95	modeling analyst-GS-12,scientist
Run policy scenarios - SW Oregon	**Mon 9/28/09**	**Fri 12/18/09**	**58,86**	
Translate policy scenarios into VDDT scenarios	Mon 9/28/09	Fri 10/16/09	58	scientist,modeling analyst-GS-12
Review and adjust VDDT models	Mon 10/19/09	Fri 11/6/09	98	scientist,modeling analyst-GS-12
Run VDDT models	Mon 11/9/09	Fri 11/27/09	99	scientist,modeling analyst-GS-12
Analyze results	Mon 11/30/09	Fri 12/18/09	100	modeling analyst-GS-12,scientist
Run policy scenarios - NW Oregon	**Mon 12/28/09**	**Fri 3/12/10**	**67,86**	
Translate policy scenarios into VDDT scenarios	Mon 12/28/09	Fri 1/15/10	67	modeling analyst-GS-12,scientist
Review and adjust VDDT models	Mon 1/18/10	Fri 2/5/10	103	modeling analyst-GS-12,scientist
Run VDDT models	Mon 2/8/10	Fri 2/26/10	104	modeling analyst-GS-12,scientist
Analyze results	Mon 3/1/10	Fri 3/12/10	105	wildlife biologist/modeler,modeling anal
Write Report - Answering User Group Questions for Oregon	Mon 3/15/10	Thu 9/30/10	106	scientist,modeling analyst-GS-12
On-Going Maintenance of Data, Models	**Mon 8/8/05**	**Fri 8/19/16**		

References

Ager, A., M. Finney, and A. McMahan. 2006. A wildfire risk modeling system for evaluating landscape fuel treatment strategies. Pages 149-162 *in* Fuels Management—How to Measure Success: Conference Proceedings. March 28-30, 2006, Portland, OR. RMRS-P-41. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ft. Collins, CO.

Ager, A. A., M. A. Finney, B. K. Kerns, and H. Maffei. 2007. Modeling wildfire risk to northern spotted owl (Strix occidentalis caurina) habitat in Central Oregon, USA. Forest Ecology and Management **246**:45-56.

Anderson, H. E. 1982. Aids to determining fuel models for estimating fire behavior. Gen. Tech. Rep. INT-122. United States Department of Agriculture Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Bachelet, D., R. P. Neilson, J. Lenihan, and R. J. Drapek. 2001. Climate change effects on vegetation distribution and carbon budget in the United States. Ecosystems **4**.

Barrett, T. M. 2004. Estimation procedures for the combined 1990s periodic forest inventories of California, Oregon, and Washington. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Baxter, C. V., C. A. Frissell, and F. R. Hauer. 1999. Geomorphology, logging roads, and the distribution of bull trout spawning in a forested river basin: implications for management and conservation. Transactions of the American Fisheries Society Article **128**:854-867.

Benda, L., D. Miller, K. Andras, P. Bigelow, G. Reeves, and D. Michael. 2007. NetMap: a new tool in support of watershed science and resource management. Forest Science **53**:206-219.

Benda, L., N. L. Poff, C. Tague, M. A. Palmer, J. Pizzuto, S. Cooper, E. Stanley, and G. Moglen. 2002. How to Avoid Train Wrecks When Using Science in Environmental Problem Solving. BioScience **52**:1127-1136.

Berg, E. 2007. Characterizing and classifying complex fuels - a new approach. Canadian Journal of Forest Research **37**:2381-2382.

Bettinger, P., D. Graetz, A. Ager, and J. Sessions. 2004. The SafeD Forest Landscape Planning Model. Pages 41-63 *in* J. L. Hayes, A. A. Ager, and R. J. Barbour, editors. Methods for integrated modeling of landscape change: Interior Northwest Landscape Analysis System. Gen. Tech. Rep. PNW-GTR-610. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Bettinger, P., J. Sessions, and K. Boston. 1997. Using tabu search to schedule timber harvests subject to spatial wildlife goals for big game. Ecological Modelling **94**:111-123.

Beukema, S. J., J. A. Greenough, D. C. E. Robinson, W. A. Kurz, E. D. Reinhardt, N. L. Crookston, and A. R. Stage. 1997. An introduction to the fire and fuels extension to FVS. General Technical Report INT-GTR-373, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT, Fort Collins, CO.

Bisson, P. A., B. E. Rieman, C. Luce, P. F. Hessburg, D. C. Lee, J. L. Kershner, G. H. Reeves, and R. E. Gresswell. 2003. Fire and aquatic ecosystems of the western USA: current knowledge and key questions. Forest Ecology and Management **178**:213-229.

Bufton, J. L., J. B. Garvin, J. Cavanaugh, F.;, L. A. Ramos-Izquierdo, T. D. Clem, and W. B. Krabill. 1991. Airborne lidar for profiling of surface topography. Optical Engineering **30**:72-78.

Chee, Y. E. 2004. An ecological perspective on the valuation of ecosystem services. Biological Conservation **120**:549-565.

Daily, G. C. 1997. Introduction: what are ecosystem services. Pages 1-10 *in* G. C. Daily, editor. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington DC.

Dixon, G. E. c. 2002. Essential FVS: A User's Guide to the Forest Vegetation Simulator. Department of Agriculture, Forest Service, Forest Management Service Center, Fort Collins, CO.

Dwire, K. A., and J. B. Kauffman. 2003. Fire and riparian ecosystems in landscapes of the western USA. Forest Ecology and Management **178**:61-74.

Finney, M. A. An overview of FlamMap fire modeling capabilities.*in* P. L. B. Andrews, Bret W. (comps.), editor. Fuels Management—How to Measure Success: Conference Proceedings. 28-30 March 2006, Portland, OR. RMRS-P-41. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Finney, M. A. 1998. FARSITE: Fire Area Simulator—Model Development and Evaluation. Res. Pap. RMRS-RP-4. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden,UT.

Fleece, W. C. 2002. Modeling the delivery of large wood to streams with light detection and ranging (LIDAR) data. Pages 71-83 *in* W. F. S. Laudenslayer Jr., Patrick J.; Valentine, Bradley E.; Weatherspoon, C. Phillip; Lisle, Thomas E., editor. Proceedings of the Symposium on the Ecology and Management of Dead Wood in Western Forests, Reno, NV. USDA Forest Service Gen. Tech. Rep. PSW-GTR-181. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Fried, J. S., G. Christensen, D. Weyermann, R. J. Barbour, R. Fight, B. Hiserote, and G. Pinjuv. 2005. Modeling opportunities and feasibility of siting wood-fired electrical generating facilities to facilitate landscape-scale fuel treatment with FIA BioSum. Pages 195-204 *in* M. Bevers and T. M. Barrett, editors. Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium; October 7-9, Stevenson, WA. PNW-GTR-656. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Hann, W. J., and D. L. Bunnell. 2001. Fire and land management planning and implementation across multiple scales. International Journal of Wildland Fire **10**:389-403.

Hann, W. J., J. L. Jones, M. G. Karl, P. F. Hessburg, R. E. Keane, D. G. Long, J. P. Menakis, C. H. McNicoll, S. G. Leonard, R. A. Gravenmier, and B. G. Smith.

1997. Landscape dynamics of the basin. Pages 337-1055 *in* T. M. Quigley and S. J. Arbelbide, editors. An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Hemstrom, M. A., J. Merzenich, A. Reger, and B. Wales. 2007. Integrated analysis of landscape management scenarios using state and transition models in the upper Grande Ronde River Subbasin, Oregon, USA. Landscape and Urban Planning **80**:198-211.

Hessburg, P. F., B. G. Smith, S. D. Kreiter, C. A. Miller, R. B. Salter, C. H. McNicoll, and W. J. Hann. 1999. Historical and Current Forest and Range Landscapes in the Interior Columbia River Basin and Portions of the Klamath and Great Basins, Part I: Linking Vegetation Patterns and Landscape Vulnerability to Potential Insect and Pathogen Disturbances. General Technical Report PNW-GTR-458, USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Hirzel, A. H. 2000. Biomapper 1.0. A New Software to Compute Habitat-Suitability Maps Laboratory for Conservation Biology, University of Lausanne, Lausanne, Switzerland.

Johnson, D. H., and T. A. O'Neil, editors. 2001a. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Johnson, D. H., and T. A. O'Neil. 2001b. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Keane, R. E., R. A. Parsons, and P. F. Hessburg. 2002. Estimating historical range and variation of landscape patch dynamics: limitations of the simulation approach. Ecological Modelling **151**:29-49.

Kerns, B. K., and A. Ager. 2007. Risk assessment for biodiversity conservation planning in Pacific Northwest forests. Forest Ecology and Management **246**:38-44.

Landis, W. G. 2004. Ecological Risk Assessment Conceptual Model Formulation for Nonindigenous Species. Risk Analysis **24**:847-858.

Max, T. A., H. T. Schreuder, J. W. Hazard, D. D. Oswald, J. Teply, and J. Alegria. 1996. The Pacific Northwest Region vegetation and inventory monitoring system. Research Paper PNW-RP-493, U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

McGarigal, K., and B. J. Marks. 1995. FRAGSTATS: spatial pattern analysis program for quantifying landscape structure. Gen. Tech. Rep. PNW-GTR-351. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Neilson, R. P. 1995. A model for predicting continental-scale vegetation distribution and water balance. Ecological Applications **5**:362-385.

O'Laughlin, J. 2005. Conceptual model for comparative ecological risk assessment of wildfire effects on fish, with and without hazardous fuel treatment. Forest Ecology and Management **211**:59-72.

Ohmann, J., and M. J. Gregory. 2002. Predictive mapping of forest composition and structure with direct gradient analysis and nearest neighbor imputation in coastal Oregon, U.S.A. Canadian Journal of Forestry **32**:725-741.

Olson, D. L. 2000. Fire in riparian zones: A comparison of historical fire occurrence in riparian and upslope forests in the Blue Mountains and southern Cascades of Oregon. MS. University of Washington, Seattle, WA.

Reeves, G. H., K. M. Burnett, and E. V. McGarry. 2003. Sources of large wood in the main stem of a fourth-order watershed in coastal Oregon. Can. J. For. Res. **33**:1363-1370.

Reynolds, K. M., and P. F. Hessburg. 2005. Decision support for integrated landscape evaluation and restoration planning. Forest Ecology and Management **207**:263-278.

Sandberg, D. V., R. D. Ottmar, and G. H. Cushon. 2001. Characterizing fuels in the 21st Century. International Journal of Wildland Fire **10**:381-387.

Scott, J. H., and R. E. Burgan. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Sessions, J., K. N. Johnson, J. F. Franklin, and J. T. Gabriel. 1999. Achieving sustainable forest structures on fire prone landscapes while pursuing multiple goals. Pages 210-255 *in* W. L. B. D.J. Mladenoff, editor. Spatial Modeling of Forest Landscape Change. Cambridge University Press, Cambridge, United Kingdom.

Tabacchi, E., D. L. Correll, R. Hauer, G. Pinay, A.-M. Planty-Tabacchi, and R. C. Wissmar. 1998. Development, maintenance and role of riparian vegetation in the river landscape. Freshwater Biology **40**:497-516.

Westoby, M., B. Walker, and I. Noy-Meir. 1989. Opportunistic management for rangelands not at equilibrium. Journal of Range Management **42**:266-274.

Wisdom, M. J., R. S. Holthausen, B. C. Wales, C. D. Hargis, V. A. Saab, D. C. Lee, W. J. Hann, T. D. Rich, M. M. Rowland, W. J. Murphy, and M. R. Eames. 2000. Source habitats for terrestrial vertebrates of focus in the interior Columbia basin: broad-scale trends and management implications. General Technical Report PNW-GTR-485, USDA Forest Service, Pacific Northwest Research Station, ortland, Oregon.

Wondzell, S. M., M. A. Hemstrom, and P. A. Bisson. 2007. Simulating riparian vegetation and aquatic habitat dynamics in response to natural and anthropogenic disturbance regimes in the Upper Grande Ronde River, Oregon, USA. Landscape and Urban Planning **80**:249-267.