LNO Future Scenarios Grant Report

February 3, 2012

I. Proposal Background

Future Scenarios is a network-wide effort endorsed by the LTER Science Council as a flagship project to promote cutting edge research and the integration of science and policy through communication. The project will help forecast regional and inter-regional consequences of climate and land use on important ecosystems services such as biomass, carbon sequestration, wood supply, recreation and habitat (see http://intranet2.lternet.edu/content/scenarios-future-landscape-change). The Future Scenarios working group recently hosted a workshop at the Harvard Forest with the primary goal of outlining a proposal to the NSF Macrosystems competition that uses scenario planning and simulation to scale up the site-based science done at a subset of LTER sites (HFR, HUB, NTL, CWT, HJA) over broader spatial and temporal scales. The fundamental questions we seek to address are: How do national policies, economic trends, and large-scale press disturbances manifest in different ecological regions across the U.S.? What are the major social and ecological interconnections between the regions and how does the nature and strength of connectivity affect regional landscapes?

The group concluded that advancing the Future Scenarios project requires that we complete three core activities: 1) Stakeholder Outreach - engage national-level stakeholders in identifying the dominant issues and threats facing regional landscapes surrounding the focal LTER sites, (2) Policy Assessment - define the important niche that regional-scale climate and land-use change scenario planning will fill by evaluating existing national-scale policy assessments and identifying the critical omissions within that body of work that Future Scenarios can best address, and (3) Simulations - demonstrate that landscape simulations of commons scenarios that use a standardized methodology can highlight the commonalities and idiosyncrasies of LTER regions. Here we report on the activities undertaken with the support of LNO funding.

II. Stakeholder Outreach

We identified approximately 50 national leaders in forest economics, policy and management from the private sector, government agencies and the NGO community who would provide useful insight on the major drivers of forest change in the U.S. We invited these stakeholders to participate in a phone conversation and in-person meeting (dialogue) to share their knowledge and help define a set of narrative scenarios of forest change. We conducted approximately a dozen advance phone calls to scope out the core issues to be addressed in subsequent meeting with stakeholders and convened two national stakeholder dialogues.

The stakeholder dialogues were held on February 28, 2011 at The Heinz Center and on May 2, 2011 at the National Commission on Science and the Environment (NCSE), both in Washington DC. We dialogues drew twenty-six participants from non-profit organizations and federal agencies with strongest representation from the U.S. Forest Service. Each dialogue was 2 hours long and started with an overview of the future scenarios approach given by project scientists. Preparatory materials and the future scenario fact sheet for stakeholders that were developed for these dialogues are attached (Attachment 1 and enclosed powerpoint presentation).

We found it to be of great interest that only 2-3 people were familiar with the LTER program and had interacted with it in the past. There was strong interest in building connections between the conservation and management interests and long-term research. The dialogues provided a strong foundation for building that relationship and the issues and ideas recorded from the meetings offer ample fodder. From the stakeholder dialogues we produced an issue scan and summary of stakeholder briefings that reflects the viewpoints of stakeholders regarding important economic, environmental, policy and management trends at regional and national scales (Attachment 2).

II. Policy Assessment

Through a literature search, we identified 12 national scale policy and resource assessments that had direct relevance to future scenarios of forest change. Based on this literature review, we produced a brief summary of existing policy assessments and analysis of the gaps in knowledge and understanding that could be addressed through a future scenarios forest research effort (Attachment 3). We reviewed used the information from the assessment to create a matrix of potential land use and land cover attributes for five potential future scenarios: current trends, economic development, energy exploitation, climate mitigation, and landscape-scale conservation. These scenarios emerged as priorities from the issues identified by stakeholders and the gaps identified in the literature. We used these scenarios and the matrix of associated

III Model Simulations

The qualitative scenarios will be used to define land use assumptions and to parameterize spatially interactive landscape simulation models within study a series of study landscapes (5600 to 27,000 km2) dispersed throughout five forest regions: Northeast, Lake States, Southeast, Pacific Northwest and Alaska. The simulation outputs will allow the group to conduct a series of within- and across-region comparisons to evaluate how ecosystem attributes and services change in response to similar scenarios of global change along multiple social and ecological gradients, including: productivity and topography, land tenure and demographics, land-use history and policies, disturbance regimes, and climate. This approach for coupling qualitative and

quantitative scenarios has informed prescient planning and policy and generated a rich set of fundamental research questions (e.g. Schmitt Olabisi et al. 2001, Spies et al. 2007).

While landscape simulation has been successfully employed in many forested regions by our group and others, comparative assessments have been compromised due to differences in model parameterization or scenarios. We are using a common modeling platform (LANDISII; Scheller et al. 2007) and a standardized approach to parameterization, which includes: (1) an initial forest condition based on a national imputation of FIA plots; and (2) standard regionally downscaled climate models running commonly used IPCC emissions scenarios. LANDIS-II's is an open-source model with a robust user community, which lends itself to continuous adaptation and improvement.

To begin to overcome some of the difficulties with comparative scenario and simulation study and as part of the designed simulation pilot project supporting the 'Forest Scenarios' collaborative research, researchers in the University of Wisconsin-Madison (Drs. David Mladenoff and Weimin Xi) have conducted an experimental LANDIS-II simulation in the northern Wisconsin in 2011, with the support of LNO Forest Scenarios funding. The WI parameterization paralleled existing work done for the state of Massachusetts (Thompson et al 2011), which allowed direct comparison of the simulation results.

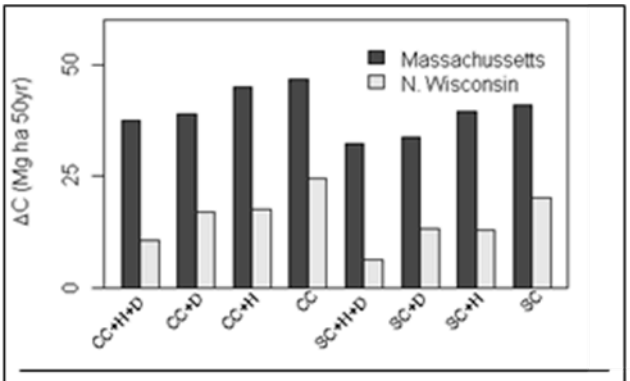

Figure 1: *In Massachusetts the impact of forest loss to development will far exceed losses due to timber harvest, while in Wisconsin the effect of these land uses are about equal.* In this pilot experiment we used LANDIS-II to project recent trends in climate and land use change using a factorial design that treated climate change (CC), forest conversion to developed uses (D), and timber harvests (H) as treatments relative to forest dynamics in a static climate (SC).

The study area for the pilot simulation in northern Wisconsin encompasses the Ashland and Rice Lake quadrangles, with a total area 1,800,000 ha. The area includes much of the Chequamegon National Forest and extends into the more agricultural areas of the southern Rice Lake quadrangle. The simulation area is divided into 10 ecoregions, and 22 tree species are included in the simulations. The forest loss in northern Wisconsin to landuse is about equal to timber harvest. Timber harvest was set at an annual rate of 0.5% for all landownerships based on past studies and group discussions. Land development rate was set an annual rate of 0.75% for private lands, and 0 for public lands based on work on 2006 National Land Cover Data. Simulations included modest wind disturbances and the model was run at an annual time step for 100 years. The climate change scenario used is the first generation Canadian Climate Center GCM (CGCM1), which predicted a 5.8 1C increase in mean annual temperature and a 20 cm increase in annual precipitation at year 2100. A control static climate scenario using 30 yr (1961 to 1991) average is simulated. A factorial design of climate change, land-use, and harvest

resulted in eight combined scenarios: (A) Climate + Harvest +Develop (B) Climate + Develop (C) Climate + Harvest (D) Climate only (E) Static Climate + Harvest + Develop (F) Static Climate + Develop (G) Static Climate + Harvest (H) Static Climate.

The outputs of biomass under the eight scenarios were analyzed and compared. The simulations showed a net positive change trend in aboveground live biomass in comparison to the current biomass throughout all simulation scenarios. Natural disturbance, timber harvesting and land development lowered landscape forest aboveground biomass compared to the control (i.e., succession only scenario) over time and changes in aboveground biomass over time were nonlinear. The results implied that five key northern tree species decreased their biomass over time and a broad re-invasion of previously available habitat for *Tsuga canadensis*, which was more widely distributed and regionally dominated in the presettlement landscape, is possible under some climate change scenarios. The simulation results indicated that succession and harvesting remain the dominant drivers with climate change and land use rapidly showing strong effects. The study demonstrated how important spatially interactive process will affect the forest biomass and suggested that active mitigation strategies to maximum carbon sequestration may have positive effects on the aboveground carbon storage on the national forest and surrounding area.

The results from the northern Wisconsin pilot study were also compared with the Massachusetts pilot simulation, and the comparative results served as supporting materials for a major Macrosystem NSF proposal (Figure 1). The results from the northern Wisconsin were presented both in 2011 Ecological Society of America Annual Meeting in Austin, and the 8th IALE World Congress held in August, 2011 in Beijing, China.

Attachment 1:

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February, 2011

Future Scenarios of Forest Change in the United States

From climate change to biomass energy policy, public lands management, shifts in ownership and land conversion, US forests face many demands that influence their resilience to change and capacity to provide critical goods and services. The Harvard Forest is teaming up with colleagues from the University of Wisconsin, the US Forest Service, the Smithsonian Conservation Biology Institute, several National Science Foundation Long-Term Ecological Research sites (LTER), and others to develop a new research proposal examining Future Scenarios of Forest Change in the United States. As part of this effort, we are convening a stakeholder dialogue to exchange ideas related to future scenarios and key socio-economic, policy, and environmental drivers of forest change in the US.

We hope that you will join us for a stakeholder dialogue on February 28th, 2011 to discuss the major drivers of forest change in the US and to help forge stronger connections between forest science and conservation, policy and management.

What: Future Scenarios of Forest Change Dialogue

When: Monday, February 28, 2011

2:00 pm to 4:00 pm

Where: The Heinz Center

900 17th Street NW, Suite 700, Washington DC

Future Scenarios of Forest Change Research Initiative

Purpose: To assess the impacts of land use, climate change, global markets, industry directions, and local landowner decisions on socio-economic and ecological conditions in forested regions

of the US; and to inform forest policy, conservation and management strategies that promote resilience and adaptability at landscape to regional scales.

Proposed Research Questions:

1. What characteristics best predict regional forest vulnerability, resilience and adaptability to climate and land use change?
2. How do national policies, economic trends, land management and conservation efforts, and large-scale press disturbances manifest in each of the major forested regions in the US?
3. What are the social and ecological thresholds that trigger large changes in forest systems?
4. What are the major socio-economic and ecological interconnections between the regions and how does this connectivity affect regional forest landscapes?

Need: The Future Scenarios of Forest Change research initiative builds on past assessments in several important ways:

1. *Downscaling and scale effects* – past assessments of climate and land use change have focused largely on effects at national or global scales or do not portray fine-grained changes in spatially explicit way. This project will downscale coarser national assessments for particular forest landscapes in the US and allow us to test specific ideas about how landscape-scale processes could mediate the impact of coarser-scale drivers in forest systems.
2. *Regional interactions* – most assessments that are regional examine forest change for one particular part of the country. This project will analyze feedbacks and interactions across regions, such as how limits on harvesting in one part of the US affect pressures for fiber in other regions.
3. *Multiple stresses* – previous efforts have used scenarios to forecast change related to specific issues, such as global warming. This project will address interactions of multiple stresses such as climate change, land use, fire, and timber harvesting.
4. *Conservation, policy & management* – many assessments do not quantify linkages between ecosystem services and specific policy and management options. This project will use detailed land use histories and model simulations to establish policy connections such as how future development and related changes in forest structure might affect State Wildlife Action Plans, climate mitigation goals, or federal Clean Water Act standards.

Approach: We will work with scientists and stakeholders to define a set of scenarios with contrasting assumptions related to at least four major themes: climate mitigation, biomass energy, global markets and large landscape-scale conservation. The scenarios will be coupled with simulation models to forecast the consequences for important ecosystems services such as

wood supply, carbon sequestration, water quantity and quality, habitat structure and biodiversity within and across four forested regions of the US. These changes will be linked to specific conservation, policy and management goals defined by stakeholders. We will coordinate with national efforts to insure that landscape analyses are informed by broader scale assessments.

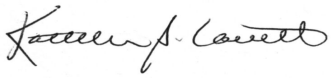
Focal Regions: New England, Southeast, Great Lakes, Pacific Northwest/Alaska.

Future Scenarios Dialogue – Bringing together Science, Conservation and Policy

We hope that you can participate in the Future Scenarios of Forest Change dialogue on February 28th at The Heinz Center to help shape the scenarios for this new research proposal. We are specifically interested in your responses to following questions:

1. What will be the most significant social, economic, and environmental drivers of forest change in the US over the next fifty to 100 years?
2. What forest management, conservation, or policy options would be most helpful to evaluate using simulation models?
3. What other assessments, initiatives, and organizations should inform this effort?

Thank you for your time and consideration. We look forward to connecting with you.



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We invite you to join scientists from the Harvard Forest, Harvard University; the US Forest Service; and the Smithsonian Conservation Biology Institute for a science and policy dialogue on:

Future Scenarios of Forest Change

Date: Monday, February 28, 2011

Time: 2:00 pm to 4:00 pm

Place: The H. John Heinz III Center for Science, Economics and the Environment

Location: 900 17th Street NW, Suite 700, Washington DC

This 2-hour conversation will bring together a select group of leading scientists, conservationists and landowner groups to exchange ideas related to the major drivers of forest change and scenarios for the future. The dialogue is part of proposed research initiative that will use scenario planning, modeling and conservation & policy analysis to expand our understanding of the regional and inter-regional implications of land use and climate change for the nation's public and private forests.

The development of scenarios that address major challenges and needs in conservation and forest management is central to this emerging effort and is the focus of the dialogue on February 28th.

Please RSVP to klambert01@fas.harvard.edu by February 10, 2011.

An agenda and additional materials will be provided in advance to dialogue participants.

This meeting is convened by the Harvard Forest, Harvard University (http://harvardforest.fas.harvard.edu/) as part of a future scenarios working group of the Long-Term Ecological Research Network (www.lternet.edu) and is hosted with The H. John Heinz III Center for Science, Economics and the Environment (www.heinzctr.org).

For questions or comments, please contact:
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www.wildlandsandwoodlands.org

Attachment 2:

Future Scenarios of Forest Change Stakeholder Dialogues

Summary & Issue Scan

February 28 & March 2, 2011

Washington DC

I. Attendees – February 28, 2011 – The Heinz Center

Keith	Argo	National Woodland Owners Association
Dunbar	Carpenter	Smithsonian Conservation Biology Institute
Cliff	Duke	Ecological Society of America
Gerald	Gray	American Forests
Jerry	Greenberg	American Forest Foundation
Tim	Male	Defenders of Wildlife
Jonathan	Mawdsley	The Heinz Center
V. Alaric	Sample	Pinchot Institute
Jonathan	Thompson	Smithsonian Conservation Biology Institute
Rebecca	Turner	American Forests
Tim	Warman	National Wildlife Federation
Allison	Welde	Sustainable Forestry Initiative

Attendees – March 2, 2011 – The National Commission on Science & the Environment

David	Blockstein	National Council for Science & the Environment
Sarah	Chappell	National Council for Science & the Environment
Christopher	Michael Clark	USEPA
Dave	Cleaves	USDA Forest Servce
John	Dennis	National Park Service

Jennifer	Jenkins	USEPA
Kathy	Fallon Lambert	Harvard Forest, Harvard University
James	Levitt	Harvard Forest/Lincoln Institute
Chris	Liggett	Acting Deputy Director, Ecosystem Management USDA FS
Stephen	Prisley	Virginia Tech
Greg	Reams	USDA Forest Service
Meg	Roessing	USDA FS - Forest Management
Peter	Saundry	National Council for Science & the Environment
Tom	Spies	OSU/USFS
Jonathan	Thompson	Smithsonian Conservation Biology Institute
Boyrs	Tkacz	USDA - Insects & Disease
David	Wear	USDA Forest Service
Zhiliang	Zhu	USGS

II. Overview

Jonathan Mawdsley of The Heinz Center welcomed the group on February 28 and Peter Saundry, Executive Director of the National Commission on Science and the Environment welcomed the group on May 2. Kathy Fallon Lambert opened the meetings by offering that this meeting represented an effort to reach out and engage non-governmental organizations and government agencies at the outset of a potential new research project. The need for front-end stakeholder engagement is recognized with the ecological research community and the LTER (Long-Term Ecological Research) Network and the ideas and input from this group will be important to shaping the focus and research questions of the Future Scenarios proposal.

Overviews of the proposed Future Scenarios of Forest Change project were given by David Foster, Director of the Harvard Forest, Tom Spies of Oregon Stateu University, and Jonathan Thompson, Research Ecologist with the Smithsonian Conservation Biology Institute. The presentations were followed by questions from the attendees, a discussion of major drivers of forest change and existing forest/climate assessments and brainstorming of prospective

partnerships moving forward. The key issues and ideas from the discussions are distilled here in their original form and without verification or major editing.

III. Issue Scan

Summary and Issue Scan - February 28 Dialogue

Land ownership

- Land stewardship – important to consider the different stewardship approaches of different ownership categories and how this will shift as land ownership changes.

- Conservation of privately owned lands - may be important to consider the effects of reinforcing social networks of private forest owners (e.g., impact of COVERTS programs or lack of such programs in advancing conservation).

Global markets & competition of land

- Changes in global agricultural commodities will be a major driver of lands use change. For example, continental-scale commodity crop failures have been a boon for American farmers. The effects of the entire globe struggling to feed itself and the position of America to take up slack will lead to increasing competition for land use. Competition from agricultural land-use is a big potential driver.

- Challenges in producing wood-based ethanol may negatively impact agricultural conservation programs.

- Converting riparian forest zone to corn production will become a big shift. Riparian zone and wildlife corridor data will be hard to get in national databases. Decline of soil conservation programs.

- Possibility of agricultural redevelopment of forest lands due to agricultural expansion/displacement caused by climate pressure and draught in places like the Southwest.

- NRCS database on land conservation might be useful. Past research looking at land use effects of biofuel crops has suggested that CRP lands are not being re-enrolled in the program– soil conservation still achieved but with biofuel crops.

- Other big landscape drivers: competition for land due to population, leading to forest fragmentation and landscape hardening – not on the radar in North America, driven by global trends.

Technology

- Consider how to factor in major, unpredictable technology changes (e.g. decline in demand for paper/wood pulp, or potential mandate for cellulosic ethanol).

Climate change

- Secondary effects of climate change: How should we be adapting for its effect on biodiversity, water quality etc.

- How might subsidiary/indirect changes be worked in? e.g. skiing becomes untenable industry in New England.

Land Use Planning

- Fragmentation and parcelization of land ownership a big issue. Many jurisdictions have lax regulation, weak land use planning, and poor land use-related documentation.

Inter-regional dynamics

- Profound impact of decline in Northwestern forest industry on forest industry in the Southeast.

Policy/management relevance

- The proposal has potential to answer a number of good, spatial, policy-relevant questions. A great example/ideal is Bruce Babcock's work at Iowa State. Envisioning things like doubling of corn price is something few people do. Policy targets and communication strategy important, particularly when it can address specific policy proposals.

- NWF priorities: habitat, climate solutions, and outdoor recreation. Different groups have interest in different suites of environmental goods and services. Tailoring to different groups is important.

- NWF Climate & Energy Program wants to expand scenario modeling ability for energy land use in the West. Also looking for gaps in agency policy-making for landscape futures.

Governance shifts – conservation & management

- In the past conservation has been done by establishing large public land systems (e.g. USFS), but expansion of such national networks is not on the table. As a result, new models, like cooperative management, will become more important.

- Landscape Conservation Cooperatives are a very important rising trend. But there are LCC pitfalls – policy relevance is questioned and not well understood by public, politicians.

- New conservation models necessary, old ones don't work, especially with climate change, thus the interest in LCCs. Dept. Interior, BLM, Fish & Wildlife, landscape conservation cooperatives for wildlife, and others could potentially be interested in this type of work. Interest will be driven by desire to prepare for climate change.

- There is large uncertainty about large-scale land conservation, but worth including in modeling exercise.

Ecosystem service markets

- Ecosystem services markets will emerge, but perhaps differently than envisioned as many states and regions continue to develop their own carbon trading and offset programs after failure of national climate change legislation, e.g., California trading in global carbon markets.

- Example of emerging ecosystem service markets to pay close attention to is metropolitan watershed management authorities paying landowners for conservation services. A $40m project in Portland is an example. In the West this will come up with an emphasis on water quantity.

Questions/comments

- Definitions of forest will be an issue. Nuanced differences between forests, woodlands, open lands, urban forests etc. [Several people seconded this issue].

- There is a need to understand the different types and values of different of forests and develop metrics for these.

- How far will the analyses be taken? Just biophysical effects? Or looking at specific outcomes for specific things like water quality or habitat? How will you make model results usable and relevant to segmented interest groups? Will the analyses be taken a step deeper for specific ecosystem goods and services?

- If someone is looking at a region with a particular question, will they be able to interpret the products of this exercise? How translatable will the products be?

Potential partnerships and data sources

- American Farmland Trust – assessment of farmland conversion to development
- Consortium to map all conservation easements in U.S.
- Interagency Woody Biomass group –weak spatially; best stuff coming from Oak Ridge
- Sustainability Roundtables
- Yale School of Forestry & Environmental Studies

- Land Trust Alliance
- NatureServ
- Lincoln Institute
- NWF Climate and Energy Program
- Potential collaboration with Dennis Ojima of Colorado State University
- Potential interest/collaboration with Wisconsin group trying to pull together climate change impacts on landscape
- Climate Science Centers also on the rise and may be potentially interested partners.
- LCCs – Landscape Conservation Cooperatives will be an important stakeholder group
- USFS's program assessing national trends (led by Rich Golden), could be useful in assessing potential drivers.

Summary and Issue Scan - March 2 Dialogue

Comments related to RPA and other assessments/scenario efforts

- RPA: A congressionally mandated assessment of multiple natural resources; national inventory and forecast system. Forecasting the future of FIA plots is one component. Uses a scenarios modeling approach; tied into global scenarios e.g. GCMs. Assessment is plot-based and has a national, wall-to-wall emphasis. There is a role for synthesis, case-studies, and projects with focal regions and landscapes that are spatially explicit.
- Think about using equivalent scenarios to those used in RPA and other efforts.
- There is a scaling issue and this project might help address local, landscape, and, regional scale questions of policy and management. RPA is more regional to national.
- Somewhere in between the scale of individual national forests and the national-regional scale of RPA is a sweet-spot, in terms of scale, for this type of scenario modeling approach that could help inform management and policy.
- This project can go beyond simply running LANDIS on a bunch of landscapes – it should take a synthetic approach, incorporating RPA, national climate assessments etc. to characterize futures and inform decision making.
- RPA is widely used, but many are unfamiliar with the details and mechanics and EPA uses RPA to inform and interact with the State Department in its negotiation on global environmental change issues.

Large scale land conservation and shifting governance approaches

- Large scale conservation is a priority for the Secretary of Agriculture. New planning rules encourage looking beyond traditional boundaries and developing common objectives across public and private lands. This approach has been used most often in the east of Mississippi where ownerships and jurisdictions are smaller and the landscape is dominated by private ownership. USFS State & Private Forestry has been active in this area for years.
- There is growing recognition of the need for an 'all forested lands' approach – many drivers don't recognize arbitrary boundaries. This is very necessary to address today's problems. Department of Interior Landscape Conservation Cooperatives program a potential partner.
- The urban-rural gradient is important for the focal landscapes. EPA is excited about and involved with the ULTRAs, especially regarding climate change and its effects on ecosystem and ecosystem services in urban areas. EPA is partnering with Portland, Boston and one other in focal landscapes from this project.

Land ownership/Industrial forestlands

- Urbanization of the landscape continues to be an important driver.

- The influence of landownership and tax policy are powerful forces.
- Tax-policy is driving ownership and fragmentation patterns.
- People have argued that industry land ownership slowed urbanization in the past.
- The decline of industry forestland ownership was an unforeseen development.
- Could tax incentives bring industrial timber production back from overseas?
- What is the future of TIMO/REIT-owned land and how will that impact the landscape?
- Today's commercial land ownership is much more fluid, with more churn. Could a timberland bubble lead to de-capitalization of timberland in south?
- Land ownership patterns have implications for the ability to respond to potential changes in markets for wood products (e.g. biofuels mandates).
- The primary drivers of forest change over the past century have had little to do with actual forest policy (e.g., passage of the Weeks Act) and more with tax policy and socioeconomic trends. There was some discussion and debate about this statement.
- High churn in land ownership may lead to high flexibility.
- Conversion of lands for recreation is a potential driver, on the margin.
- Demand for land to produce agricultural commodities is increasing and seems to be driving changes in CRP enrollment.
- Include scenarios to look at the effects of tax policy on easements and land ownership patterns.

Population changes

- Population growth and migration is an important a driver e.g. climate change can be explained as a function of population growth, rising income, and rising consumption.
- Population count and income have been found to be the greatest drivers of landscape change.
- Some of these assumptions related to technology and micro-demography effects (e.g. the effect of internet on population distribution) are often put forth, but most have never been tested.
- Influence of combined federal and state fiscal policies – e.g. public debt issues potentially effecting programs like conservation restrictions that have shaped the landscape in the past.
- What are the disproportion impacts of both climate and policy changes on people of different incomes and how do they respond to things differently? What might be the effects of structural changes in government?

Ecosystem services as a framework and potential market-based driver

- Ecosystem services are a good way to frame the results of the project, but actual emergence of ecosystem service markets is unlikely.
- Competition for land for croplands will be an important driver.
- Renewable portfolio standards and energy development are other potential drivers. For example, if EPA determines that biofuels (including woody biomass) qualify as

renewable energy sources and are therefore eligible for tax credits, the demand for biomass harvesting will likely increase.
- There has been much controversy over agricultural conservation land being taken out of program for biofuels development.
- Do ecosystem service incentives actually drive landscape change, or do they just make a difference at the margins? Perhaps this will change land management, but not land cover.
- There is tension between different management goals, like long term carbon stabilization versus carbon maximization, and this will differ in different places.
- The Canadians found that forests can go quickly from a carbon sink to source with the pine beetle and other major disturbances. The future scenarios project will be about projections, rather than predication. For example, with the risk of pine beetle outbreaks, the events are predictable, but the magnitude is much more difficult, especially with climate change.
- How are tipping points factored into scenarios? e.g. climate-socioeconomic interactions.

Stakeholder engagement & communication

- Stakeholder buy-in is necessary.
- USFS has been taking a more collaborative approach e.g. the Southern Forest Futures project.
- Southern Forests Futures project: a regional project under the RPA umbrella, but generated by many local stakeholders. The project was not just about science, but about building an audience from the beginning and building it over time.
- Local, stakeholder-based approach becoming popular. Meet early and often. Increase buy-in and support for policies can be generated by giving people a seat at the table.
- It is surprising what can emerge from public meetings. It helps focus the attention of the science. Otherwise scientists will just study whatever questions have available data.
- Many lessons learned from the Southern Forests Futures project. Would do it again.
- Get stakeholders to talk about the scenarios.
- Communication is important, not just with the public, but also with land managers.
- The approach to public outreach depends on the questions being asked.
- Expert audience versus local stakeholders.
- National-level versus local.
- What proportion of the award/product is policy versus science? This may affect what drivers are examined and which stakeholders are involved.
- Consider building a delivery system for the results. This isn't just about building scenarios, but about being able to use them well. Being able to scale scenarios up and down would be helpful. Make the products both useful and usable.

National Forests and climate planning

- Performance and accountability scorecards have been sent to all National Forests. There is a portfolio of different management mechanisms to deal with stressors and assess

impacts on ecosystem services. It's good to emphasize climate change as part of a stressor complex, rather than as a singular problem. National Forests, BLM, and LCCs in a region are starting to find each other to work on problems together. This project could be helpful for them.

- Recommend connecting with LCC coordinators. They're getting heavy emphasis from DOI.

Water issues

- RPA does water assessment, including the influence of climate change.
- Look at the trajectory of inter-jurisdictional arrangements and agreements, and inter-basin transfers.

Suggestions for more sources of information:

- National Water Quality Assessments.
- LCC and CSEs [unsure of the second acronym].
- Cooperative Ecosystem Assessments.
- National Insect Risk Assessment.
- EPA report on biofuels just released. The next one will be more modeling focused.
- Interagency adaptation task force – vulnerability assessments. A new program whose specific task will soon be clarified.
- State forest assessments.
- State wildlife plans.
- Forests on the Edge; Forest threat assesment centers (insect & disease, regional).

Attachment 3:

Policy Assessment for Forest Scenarios Research

Draft March, 2011; Final January 5, 2012

Climate, land-use and associated disturbances (e.g., air pollution, invasive species, fire) are transforming U.S. forests in complex ways at multiple scales. Understanding the ecological characteristics and processes that control ecosystem response to large-scale global change presses is an urgent challenge for scientists, decision makers and managers. While the ability to forecast ecological futures is improving (Moorcroft 2006), socio-ecological systems often exhibit nonlinear dynamics, reciprocal feedbacks, resilience and surprises (Lui et al. 2007). In addition, forests across the U.S. exhibit intra- and inter-regional differences and connections that are critical to understand for meaningful projections at regional and national scales. Integrated scenarios of future change with consistent regional-scale simulation modeling can help address the overarching question: What factors account for the response of forest ecosystems to large-scale environmental presses and disturbances, and explain variability in landscape dynamics and vulnerability to global change?

It is clear from existing forest resource assessments that this green infrastructure still occupies a vital space in the socio-ecological and economic fabric of the U.S. From wood to wildlife and from clean air and water to climate mitigation, the 300 million hectares of U.S. forest produce goods and services that are fundamental to human prosperity. Evaluating this forest's future at local to national scales under a range of potential environmental and socio-economic conditions is both a critical task for society and a daunting scientific undertaking that will yield fundamental ecological insights. Information from global and national assessments and stakeholder input can be used to develop a suite of scenarios that drive a consistent spatially-explicit model at regional and landscape scales in order to: (1) advance understanding of the relative and interactive effects of multiple broad-scale disturbances associated with climate and land-use change; (2) determine how the relative influence of broad-scale presses varies within and across regions with differing socio-ecological gradients; and (3) improve the ability to anticipate regional vulnerability, resilience and adaptability to global change by identifying the ecological and social thresholds and cumulative effects that trigger large changes in systems. Scenario planning offers a tool for understanding consequences of change in complex systems under conditions of high uncertainty. It will be used here to: (1) identify major anticipated drivers of ecological change at multiple scales, thereby enhancing the quality of modeling and analyses; (2) engage leaders of complementary regional to global assessments and ecological observatories in meaningful collaboration; and (3) ensure that our science yields relevant products for decision makers, managers, the media and major scientific programs.

Given the complexities and uncertainties of future changes and interactions, and the critical need to incorporate landscape to regional scales in addressing continental-scale processes, one of the most promising approaches couples stakeholder-informed scenarios of plausible future change with spatially-interactive models. This approach has proven to be a powerful research protocol that can inform policy and management at local and regional (cf. Spies et al. 2007, Schmitt Olabisi 2010) to global scales (cf. Millennium Assessment 2005, IPCC 2007). Several national climate and forest assessments are underway, including the USFS forest assessment mandated by the Forest and Rangeland Renewable Resources Planning Act (RPA; e.g., Smith et al. 2009), the USEPA Global Change Research Program Integrated Climate and Land Use Scenarios project (USEPA 2009), and the USGS carbon and greenhouse gas assessment for the U.S. (Zhu et al. 2010). Forest scenarios efforts should draw on these assessments and address important gaps. For example, the RPA uses USFS Forest Inventory and Analysis (FIA) plot data to develop county trends and projections for forest resources (e.g., ownership, timber removals), but is not spatially explicit at a resolution that supports analysis of fine-scale processes and their influence on landscape-scale responses to land use and climate change. The EPA analysis of housing density under various IPCC scenarios relies on a single set of national assumptions for housing area requirements (ha/unit), limits impact analysis to change in impervious surface, and does not explicitly consider the combined effects of climate and land-use change. The USFS Forests on the Edge analyses use a similar approach (Stein et al. 2005, White et al. 2009). The USGS assessment of carbon stocks under different climate and land-use scenarios at the EPA Ecoregion II level (Omernik 1987) focuses on scenarios related to climate mitigation and their consequences for carbon pools and greenhouse gas fluxes, with limited emphasis on other ecosystem services (Zhu et al. 2010). *Forest Scenarios* will address the major research questions articulated here and complement the information generated by these and other national-level assessments. Based on this preliminary review of existing assessments and policy documents, forest change scenarios should address at least four dominant themes: (1) economic development, (2) energy exploitation (e.g., bioenergy), (3) climate mitigation and adaptation, and (4) landscape scale conservation. Table 1 provides an overview of the factors from the literature that should be used to define the specifics for each of these scenarios.

Table 1: Scenario Matrix: based on a review of published resource assessments

Scenario	Preliminary Assumptions	
Current Trends	FC	• Base case population and housing density; housing allocated to reflect historic patch size.[1,2] • Forest conversion based on recent trends.[3] • Forest protection based on recent trends.[4]
	FM	• Timber harvest levels on public and private lands based on recent trends. [5,6]
Economic development	FC	• High-end population and housing density; housing allocated to mimic sprawl patterns.[1] • Forestland owned by financial interests (e.g., TIMOs) subdivided with amenity-based development along water courses, trails and protected areas.[7] • Private forestland developed in response changing population patterns.[2] • Some CRP lands converted back to cropland in response to land competition for food. [8]
	FM	• Timber harvest decreased in areas with increased settlement densities.[9] • Harvest on public lands set at maximum allowable harvest levels.[10] • Fire management shifted in response to housing development near public lands.
Energy exploitation	FC	• High-end population and housing density; housing allocated to reflect historic patch size.[1,2] • Biomass contribution to total energy supply increased from 1% to 3%.[11] • Private forestland retained to reflect increased economic return associated with biomass utilization.[12] • Some CRP lands converted to plantations for biofuel production.[8]
	FM	• Forest management maximized for woody biomass production.[13] • Biomass harvesting allocated based on county-level maps of viable timber and biomass availability.[12] • Other lands managed to meet demands for pulp, lumber, and other wood products.[5,6] • CRP land managed for short rotation woody biofuels (e.g., willow and hybrid poplar).[8]
Climate mitigation	FC	• Base case population; housing allocated to mimic low-impact, cluster patterns.[1] • Avoided deforestation - forest conversion reduced from current trends.[14,15] • Afforestation - marginal agricultural lands converted to forest.[14,15] • Reforestation - forested wetlands previously converted to agriculture are restored.[14,15] • Land use on public lands remains unchanged.
	FM	• Harvest rotation length increased to at least 45 years in private lands.14,15 • Clearcutting of natural forests reduced from current trends.5,6 • Plantations managed intensively to increase carbon density.14,15 • Fuel treatments applied in fire-prone landscapes consistent with fire policies.16 • Management of water supply watersheds modified in response to water quantity/quality changes.17
Landscape scale conservation	FC	• Base case population; housing allocated to simulate compact, low-impact development.1 • Rate of forest conservation doubled from recent trends up to 70% of forests.18 • Protected lands configured to conserve large landscapes and maximize connectivity, refugia and migration corridors.19
	FM	• More "No-harvest" wildland reserves established on public and private lands based on published conservation plans.[18] • Timber harvest based on current trends with distribution modified based on distance from reserves.[5,6]
USEPA 2009[1]; Thompson et al. In press.[2]; NLCD, Homer et al. 2004[3]; PAD-US 2009[4]; Alig et al. 2003[5]; Smith et al. 2009[6]; Brookings 2006[7]; Baker and Galik 2009[8]; Butler et al. 2010[9]; Federal Allowable Sale Quantities (ASQs) and USFS Forest Plans[10]; EIA 2010[11]; Milbrandt 2005[12]; Evans et al. 2010[13]; Zhu et al. 2010[14]; Canadell and Raupach 2008[15]; Hurteau et al. 2008[16]; Barten and Ernst 2004[17]; Foster et al. 2010[18]; Mawdsley et al. 2009[19].		

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