

# Science

## FINDINGS

### INSIDE

*Aerial Photography and Land-Use Assessments*.....2  
*Land-Use Change on Nonfederal Lands*.....2  
*Dispersed Development on the Upswing*.....3  
*Putting the Data to Work*.....4

issue one hundred seventy two / april 2015

*“Science affects the way we think together.”*

Lewis Thomas

## A Bird’s-Eye View: Land-use Planning and Assessments in Oregon and Washington



Andrew Gray

Nonfederal forest and agricultural land declined by 4 percent between 1976 and 2006 in Washington whereas in Oregon those lands declined by 2 percent during roughly the same period.

*“If we could first know where we are, and whither we are tending, we could better judge what to do, and how to do it.”*

—Abraham Lincoln

**H**eavily trafficked freeways, new subdivisions, chemically-maintained golf courses, sprawling malls, expanding urban areas, and high-end resorts—these are just a few of the developments that have replaced forests and farms in the Pacific Northwest over the past several decades.

When forest lands and agricultural lands are developed and converted to other uses,

a number of consequences ensue. Most development reduces natural resource availability, affects wildlife habitat quality, increases the spread of invasive species, degrades water quality, complicates wildfire control, and increases infrastructure costs.

Recognizing these and other concerns, Oregon implemented state land-use planning laws in the early 1970s, and Washington followed suit 20 years later. Scientists with the U.S. Forest Service Pacific Northwest Research Station—David Azuma, a research forester (retired), and Andy Gray, a research ecologist—have looked closely at changing land-use patterns in both states, and their analyses are providing valuable information to land-use planning professionals.

### IN SUMMARY

*Developing forest lands and agricultural lands for other uses has wide-ranging implications. Land development can affect production from forest and agricultural lands, wildlife habitat quality, the spread of invasive species, water quality, wildfire control, and infrastructure costs. In its attempts to mitigate these effects, Oregon implemented statewide land-use planning laws in the early 1970s. Washington established less prescriptive laws in the 1990s. Policymakers, land managers, and various interest groups want to know the effect these laws have had on land use.*

*Scientists with the Pacific Northwest Research Station found that Oregon’s laws have been more effective in controlling wholesale land conversion, but in neither state have land-use laws affected the increases in dispersed housing.*

*The scientists also identified a nationwide need to better specify land-use assessment methods and clarify the definitions used in assessments. They used a mix of assessment techniques, but emphasized the value of aerial photography as an important tool to increase the accuracy of land-use assessments.*

*The Oregon Board of Forestry used data from the study to assess the effectiveness of its conservation policies and establish benchmarks for maximum allowable loss of forest land. In Washington, the Department of Natural Resources has shown interest in using the data to analyze housing density near intensive agriculture and associated risks of pesticide exposure, fire, and floods.*

“People have always been interested in knowing how effective these land-use policies are at controlling development, or determining where development occurs, or slowing it down in specific areas, and how that is playing out over time,” says Gray. “We have a natural experiment here in the Northwest because Oregon took one approach to county-level and statewide land-use planning and Washington didn’t implement their land-use laws until later—and they took a different approach.”

The research team also evaluated survey and assessment methods. They found that combining the information gained from field plot data, satellite images, and aerial photography greatly increased the accuracy of land-use assessments.

KEY FINDINGS	
	<ul style="list-style-type: none"> <li>• The area of nonfederal land in resource land uses (forest and agriculture) declined by 2 percent between 1974 and 2009 in Oregon and by 4 percent between 1976 and 2006 in Washington.</li> </ul>
.....	<ul style="list-style-type: none"> <li>• After land-use plan implementation in Oregon, nonfederal land converted from resource land uses decreased from 0.9 to 0.2 acres per new resident. In Washington, the loss remained at 0.4 acres per new resident.</li> </ul>
.....	<ul style="list-style-type: none"> <li>• Housing density approximately doubled on lands remaining in use as forest land in Oregon and Washington over a 30-year period.</li> </ul>
.....	<ul style="list-style-type: none"> <li>• A substantial portion of the increased housing density on forest lands was near public lands. Highest densities were near state lands in Washington and near federal lands in Oregon.</li> </ul>

## AERIAL PHOTOGRAPHY AND LAND-USE ASSESSMENTS

The Forest Service has long been responsible for surveying the nation’s public and private forests through its Forest Inventory and Analysis (FIA) program. Its large datasets are a critical resource for land-use planning professionals, in part because they show how the total area and condition of forest lands are changing over time. Extensive grids of field plots have been measured since 1928. Since the 1960s, the same plots have been surveyed at varying intervals. “As far as I’m concerned, that’s pretty much the gold standard because you have plots that are visited by professionals on the ground,

assessing land use and how those forests have changed over time,” says Gray.

The grid system, however, is limited when scientists want to get finely detailed information about a particular region or tease out landscape changes over short time periods, he points out. Luckily, technology has enabled researchers to greatly improve the accuracy and scope of their collected data.

Satellite imagery, which has been an extremely valuable tool in the data-collection process since it was introduced, produces fairly coarse imagery. “The imagery that’s available and free has a 30-meters-per-pixel resolution, and that makes it really hard to tell if you’re looking at a house or if a loss of tree cover is associated with a clearcut or a development,” says Gray.

The availability of high-resolution, digital aerial photos taken for the USDA National

Agriculture Imagery Program (NAIP) allowed Azuma and Gray to identify land use in greater detail than was previously possible. Individual roads, houses, barns, fences, and so forth are clearly visible. Photo interpreters can tell, for example, whether an area with lots of tree cover should be classified as forest land, a well-maintained park, or a housing development with heavy tree cover.

“The human brain is perfectly suited to pull all these bits of information together and help classify the area into different land uses,” says Gray. “When we get more recent data, we can easily compare with older imagery to assess real change because it’s all digital and in a GIS system.”

The NAIP has purchased new imagery for both states in 2013 and 2014, which will make it possible to assess the effect of the economic recession that began in 2008, when new housing starts significantly declined.

### *Purpose of PNW Science Findings*

To provide scientific information to people who make and influence decisions about managing land.

*PNW Science Findings* is published monthly by:

Pacific Northwest Research Station  
 USDA Forest Service  
 P.O. Box 3890  
 Portland, Oregon 97208

Send new subscriptions and change of address information to:

pnw\_pnwpubs@fs.fed.us

Rhonda Mazza, editor; rmazza@fs.fed.us  
 Cheryl Jennings, layout; cjennings@fs.fed.us

**Science Findings is online at:** <http://www.fs.fed.us/pnw/publications/scifi.shtml>

To receive this publication electronically, change your delivery preference here:

<http://www.fs.fed.us/pnw/publications/subscription.shtml>



## LAND-USE CHANGE ON NONFEDERAL LANDS

Azuma and Gray focused their studies on nonfederal lands. “Federal forests are basically designated as forest land, so land use hasn’t and won’t change,” says Gray.

Loss of private timber-producing lands is of particular concern for the forest products industry because current protections on federal forest lands have moved the source of most forest products to private or other publicly held lands. Land managers also are concerned about the impact of development on ecosystem health. Of particular concern to federal land managers is how development adjacent to public lands affects those ecosystems and complicates wildfire protection. And a growing

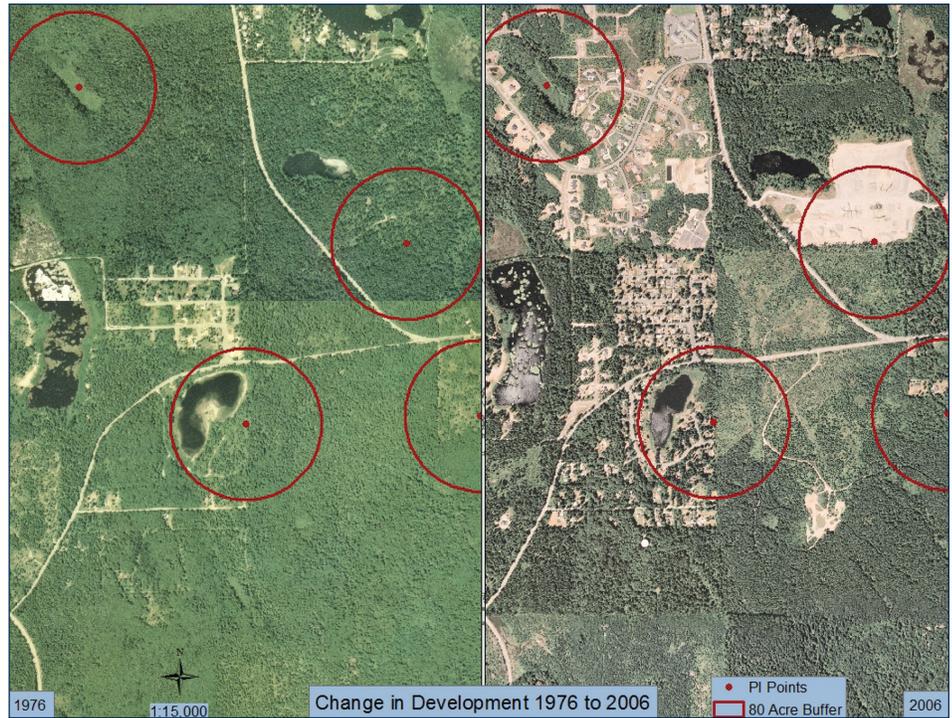
number of people are worried about the loss of quality agricultural lands.

“Given the concern about the use of fossil fuels in agriculture and transporting food from long distances, and the interest in growing food locally, there’s an interest in conserving agricultural land,” says Gray. “In western Washington, in particular, it’s the agricultural land that has declined most precipitously—a lot more rapidly than forest land. If having local food production is a goal, then our study suggests that policymakers might want to focus a little more specifically toward preventing or discouraging development on those lands.”

Their studies show that overall land use in Oregon and Washington has changed considerably since the 1970s. They conclude that nonfederal land dedicated to resource land uses declined in Oregon by 2 percent over a 35-year period (1974 to 2009) and in Washington by 4 percent over a 30-year period (1976 to 2006). Oregon lost 616,000 acres and Washington lost 1,162,000 acres of forest and agricultural lands to development.

In addition to looking at total acreage lost, the team examined the numbers in relationship to population: the number of acres converted per new resident. These data help to better correlate the rate of change with implementation of land-use planning laws. Gray explains: “While it’s true that the number of acres lost in Washington is higher than the number of acres lost in Oregon, Washington also has a much stronger economy. Their population and economy grew quite a bit more than Oregon over that same period.”

In Oregon, the area of nonfederal land converted from resource land uses decreased from 0.9 to 0.2 acres per new resident over the 35-year period. In Washington, the loss per new resident remained at a steady 0.4 acres over the 30-year period. These statistics suggest that Oregon’s stricter land-use laws are doing a better job of protecting valuable forest lands and agricultural lands from loss to development. “At least from that perspective, the Oregon approach seems to have had



An example of photointerpreted grid points used to compare change in land-use and the number of houses between 1976 and 2006 in Washington.

a much more dramatic impact in reducing development on resource lands,” says Gray.

Things got even more interesting when Azuma and Gray looked beyond wholesale changes in land use to discern patterns of

development. They systematically counted and identified structures in 80-acre circles across the two states and classified use into five categories: forest land, agricultural land, mixed agricultural and forest land, dispersed residential areas, and urban areas.

## DISPERSED DEVELOPMENT ON THE UPSWING

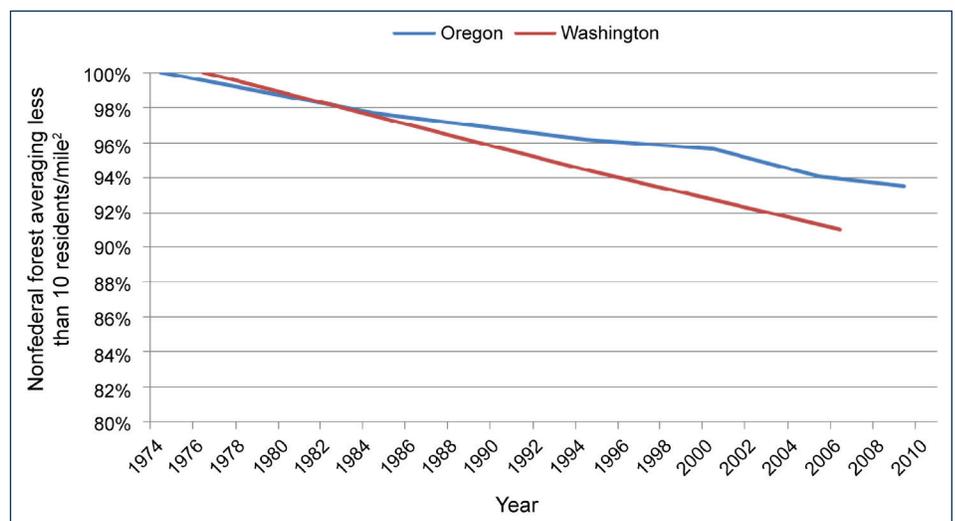
Houses standing alone or in small clusters are less rare than they were in the 1970s. Even though the overall change in land use has declined in Oregon, the rate of dispersed housing is increasing in both states. “It seems to be progressing at a fairly good clip, and the rates are fairly comparable between Oregon and Washington,” says Gray. “This suggests that the land-use policies have done a fairly good job at reducing wholesale conversion, but the problem of dispersed houses in forest land isn’t really being addressed.”

Many people enjoy living in or next to forests. Forested landscapes are aesthetically pleasing, and Northwesterners particularly enjoy easy access to hiking trails and campgrounds, waters for fishing and boating, mountains for skiing and snowboarding, and numerous other outdoor pursuits. It isn’t really surprising, then, that more and more people are building on lands close to these areas.

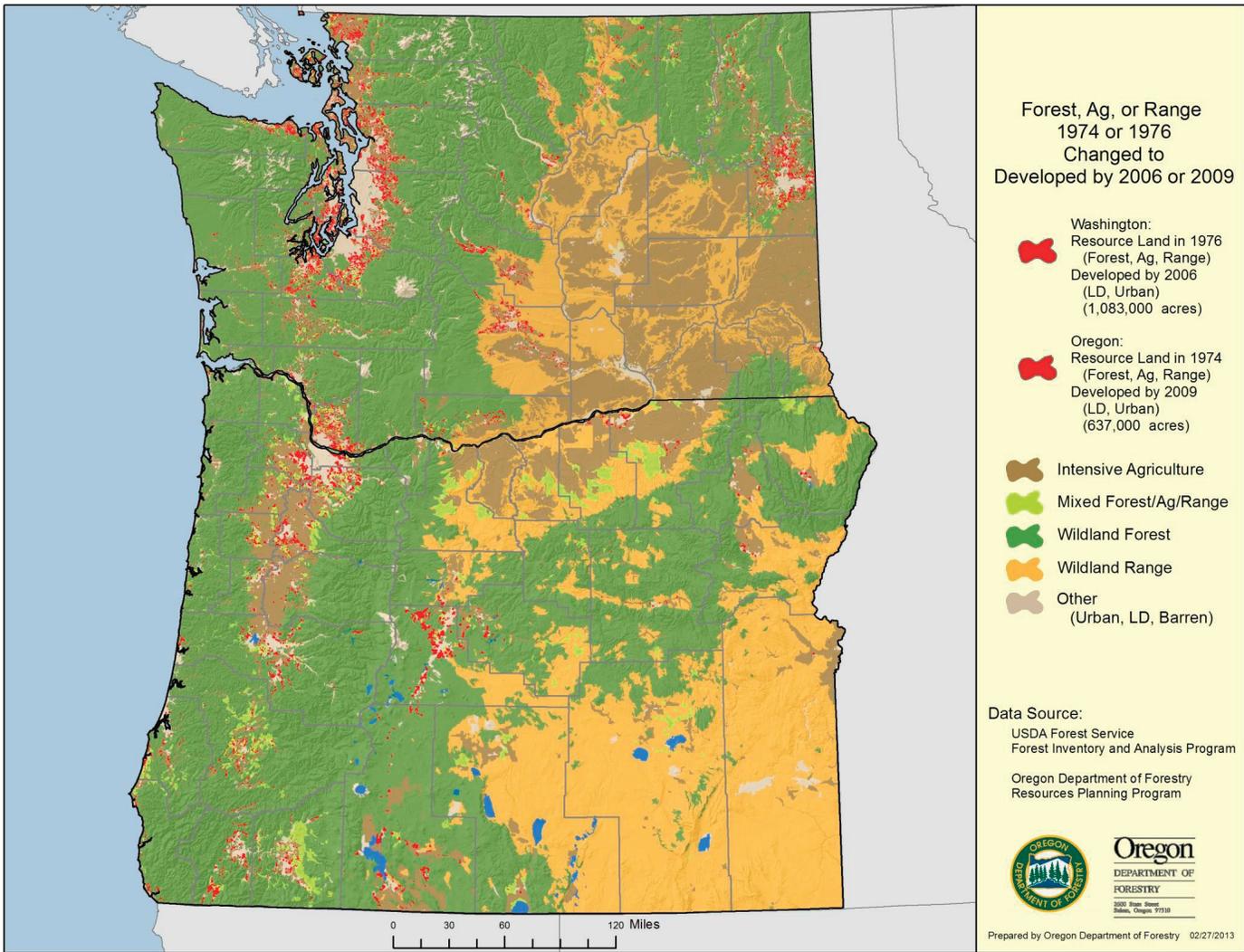
Even though federal forest lands enjoy some level of protection, initial results from the study show that when development abuts publicly held lands, those ecosystems can

be adversely affected. “There tends to be a higher incidence of invasive plants found on plots where there is more development

nearby, for example,” says Gray. “The plots also tend to be more fragmented and have less dead wood on them.”



Dispersed development has increased in both states, but more rapidly in Washington. The chart above shows nonfederal land remaining in wildland forest use with less than an average of 10 residents per square mile in Oregon (1974–2009) and Washington (1976–2006).



Areas in red were resource lands (forest, range, or agriculture) in the 1970s and now have been converted to low-density housing or urban uses.

This type of dispersed development also has implications for firefighting. “When more and more houses are dispersed within a forested area, it becomes more difficult and more expensive to try to protect houses from forest

fire,” says Gray. It also becomes more difficult to manage natural fires for their beneficial effects on forests. Fire control becomes a bit of a catch-22 for federal agencies, because

the government is responsible for preventing wildfire from burning private homes, but planning processes are under the jurisdiction of local, county, and state agencies.

## PUTTING THE DATA TO WORK

The Oregon Board of Forestry has closely partnered with the research station scientists to analyze Oregon’s survey data, which it used to assess the effectiveness of conservation policies and establish benchmarks for maximum allowable loss of forest land.

“It’s been a strong partnership,” says Gary Lettman, a forest economist with the Oregon Board of Forestry. “And the data are very strong—it’s really helped the state formulate forest policy. We haven’t had the resources that FIA does, being a small state agency, but we do have policy needs. FIA has been very cooperative in helping us meet those needs.”

Lettman is particularly grateful that the state has been able to pinpoint where land-use laws are achieving the intended objectives and where more work needs to be done. “The state’s just in the infancy of trying to address dispersed development,” he says. “Without the data, we would never have known the magnitude of the problem or the fact that the problem was in scattered structures out there, not in the wholesale development of land.”

Structure count data has also been put to use to assess Oregon’s firefighting strategies.

Washington’s Department of Natural Resources is interested in using the data to analyze housing density close to intensive for-

estry and agriculture with respect to potential pesticide exposure and added risk from fire or flooding.

Gray observed that there is currently substantial confusion in scientific and popular literature when it comes to differentiating between land use and land cover. For example, he takes issue with using the term “deforestation” to describe managed clearcuts that will eventually regenerate into forest. He believes that survey accuracy and specificity will improve as researchers adopt standard practices and language. “It ends up getting pretty confusing in a hurry when people are not clear about their definitions of land-use change,” he says.



Institute for Applied Ecology

Roads facilitate the spread of invasive species such as star thistle.

The FIA program continually monitors its methods for collecting and assessing forest survey results. The 2014 Farm Bill directs the Forest Service to use new technologies to provide more detailed and comprehensive work on land-use change, and the FIA program is working to establish consistent assessment methods across the country. In the future, the program's methods will heavily rely on aerial imagery. Although the approach will not be exactly the same as Azuma and Gray used in their studies, it will use the same kind of information on a national scale to address land-use changes over time.

*“Good plans shape good decisions. That’s why good planning helps to make elusive dreams come true.”*

—Lester Robert Bittel

## FOR FURTHER READING

Azuma, D.; Thompson, J.; Weyermann, D. 2013. Changes in development near public forest lands in Oregon and Washington 1974–2005: implications for management. Res. Pap. PNW-RP-596. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 21 p. <http://www.treearch.fs.fed.us/pubs/45205>.

### WRITER’S PROFILE

Marie Oliver specializes in science writing and developmental editing. She can be reached through her website at <http://claritywriting.com>.

<span style="font-weight: bold; font-size: 1.2em;">LAND MANAGEMENT IMPLICATIONS</span>
<ul style="list-style-type: none"> <li>• If proximity is important, new policies to conserve agricultural land might be considered given the proportionally high loss of these lands on the west side of the Cascade Range, home to the majority of Oregon and Washington residents.</li> </ul>
<ul style="list-style-type: none"> <li>• Oregon’s land-use policies have effectively reduced complete conversion of forests and agricultural lands, but the continuing increase of dispersed houses on forest land in both states suggests future development-related problems.</li> </ul>
<ul style="list-style-type: none"> <li>• Given the many approaches to land-use assessment, it is necessary to clarify definitions and specify methods to enable the accurate analysis of policy effectiveness.</li> </ul>
<ul style="list-style-type: none"> <li>• Most satellite images are lower resolution than aerial photos, which makes it more difficult to use them to reliably distinguish land cover (e.g., clearcuts vs. subdivisions) when assessing short-term changes in land use.</li> </ul>



Ben Duda, Oregon Department of Forestry

Increases in dispersed development increase the cost of protecting those homes from wildfire. Development in the wildland urban interface also makes it more difficult to use prescribed burns as a treatment option on nearby forest land.

Azuma, D.L.; Gray, A.N. 2014. Effects of changing forest land definitions on forest inventory on the West Coast, U.S.A. Environmental Monitoring and Assessment. 186: 1001–1007. <http://link.springer.com/article/10.1007/s10661-013-3434-6>.

Gray, A.N.; Azuma, D.L.; Lettman, G.J.; et al. 2013. Changes in land use and housing on resource lands in Washington State, 1976–2006. Gen. Tech. Rep. PNW-GTR-881. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 51 p. <http://www.treearch.fs.fed.us/pubs/42975>.

Kline, J.D.; Moses, A.; Azuma, D.L.; Gray, A.N. 2009. Evaluating satellite imagery-based land-use data for describing forest land development in western Washington. Western Journal of Applied Forestry. 24: 214–222. <http://www.treearch.fs.fed.us/pubs/34935>.

Lettman, G.J.; Gray, A.N.; Herstrom, A.A.; et al. 2013. Land use change on non-federal land in Oregon and Washington. Salem, OR: Oregon Department of Forestry. [http://www.oregon.gov/odf/RESOURCE\\_PLANNING/docs/land\\_use\\_in\\_OR\\_WA\\_web\\_edited.pdf](http://www.oregon.gov/odf/RESOURCE_PLANNING/docs/land_use_in_OR_WA_web_edited.pdf).



PRSRT STD  
US POSTAGE  
PAID  
PORTLAND OR  
PERMIT N0 G-40

U.S. Department of Agriculture  
Pacific Northwest Research Station  
1220 SW Third Avenue  
P.O. Box 3890  
Portland, OR 97208-3890

Official Business  
Penalty for Private Use, \$300

## SCIENTIST PROFILE



ANDREW GRAY is a research ecologist and team leader with the Pacific Northwest Research Station in Corvallis, Oregon. His current research focuses on the application of forest

inventory data. He is reconstructing changes in carbon through time by linking inventory and satellite data and improving the ability to predict tree canopy cover using tree measurements. Gray is also studying the effects of management and environment on regional patterns of species richness, estimating the extent of regional wildlife habitat from inventory plots, and determining rates and patterns of land-use change in Washington state.

*Gray can be reached at:*

USDA Forest Service  
Pacific Northwest Research Station  
Forestry Sciences Laboratory  
3200 SW Jefferson Way  
Corvallis, OR 97331

Phone: 541-750-7252  
E-mail: [agray01@fs.fed.us](mailto:agray01@fs.fed.us)

## COLLABORATORS

Gary Lettman, Oregon Department  
of Forestry