

Science

FINDINGS

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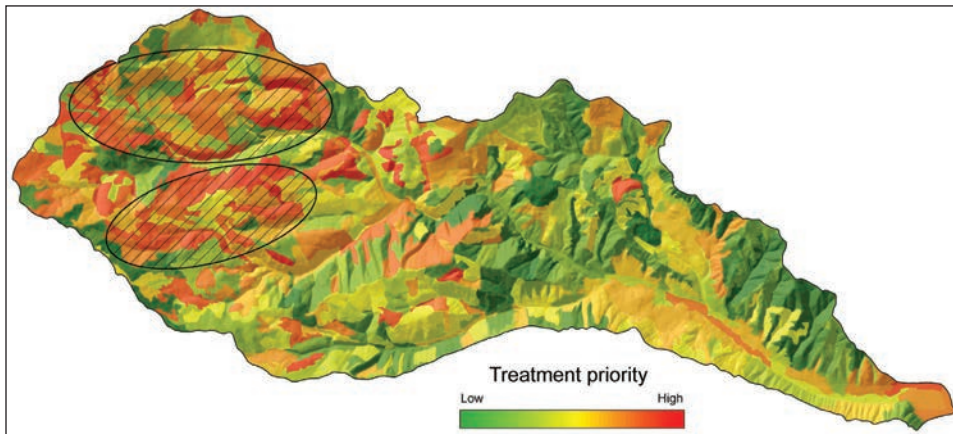
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“Science affects the way we think together.”

Lewis Thomas

Restoration Planning on the Okanogan-Wenatchee National Forest: Prescriptions for Resilient Landscapes



The Ecosystem Management Decision Support system allows users to integrate management concerns for multiple resources in a repeatable process. The ovals on the mapped output above indicate potential treatment areas where restoration projects might achieve multiple restoration goals in the Nile Creek subwatershed on the Okanogan-Wenatchee National Forest.

*“... we want a tool to confront us
with the implications of what we
think we know.”*

—Daniel Botkin

In eastern Washington, the 4-million-acre Okanogan-Wenatchee National Forest is experiencing uncharacteristically severe fires, insect infestations, disease epidemics, habitat loss, and massive erosion from flood events. Given current conditions and finite resources to correct them, forest managers have sought tools for efficiently evaluating large landscapes and prioritizing restoration and protection areas. They have been working with scientists from the Pacific Northwest (PNW) Research Station to use Ecosystem Management Decision Support (EMDS) to do just that.

Keith Reynolds, a research forester with the research station, has directed development of

the EMDS software since 1994. The current version supports an integrated approach to landscape evaluation and planning that teases apart two questions: What is the state of the system? And, what are reasonable responses to mitigate revealed problems?

“EMDS has two major components: a logic model and a decision model,” Reynolds explains. “The logic model evaluates a landscape’s potential for wildfires, forest diseases, and insect infestations, and for providing adequate wildlife habitats and other conditions. Then it produces strength-of-evidence scores that reveal the degree of support for these simultaneous conditions. Those scores are fed into a decision model that generates priorities for restoration or protection. Land managers can then spatially formulate and compare a variety of landscape prescriptions and treatment options before they invest in their implementation.”

IN SUMMARY

Human settlement and land management have radically altered the composition and structure of eastern Washington forests. Restoring high-functioning landscapes and habitat patterns have broad implications for the future sustainability of native species, ecosystem services, and ecosystem processes. Many land managers and scientists have turned their attention to whole landscapes to decipher key changes in the terrestrial and aquatic systems. A goal is to formulate landscape-level prescriptions for re-establishing broad functionality and resilience to disturbances and changing climate.

Recognizing the need to simplify and expedite the process of landscape evaluation, a team of scientists and managers at the Pacific Northwest Research Station and the Okanogan-Wenatchee National Forest piloted the first application of the Ecosystem Management Decision Support (EMDS) software in support of a restoration project in eastern Washington. By interpreting and synthesizing large volumes of information about complex, multifaceted problems, EMDS enabled the team to (1) transparently evaluate departures of key landscape patterns and processes from historical and climate change reference conditions, and (2) formulate and compare landscape restoration prescriptions before implementing them.

EMDS is currently being implemented throughout 4 million acres of the Okanogan-Wenatchee National Forest. It is also being used in other restoration projects throughout the Northwest and internationally.

Built atop the ArcGIS platform (a geographic information system), the EMDS application for the Okanogan-Wenatchee evaluates departures of current landscape pattern and disturbance vulnerability conditions and compares them with those that would likely occur under historical and future climate conditions.

Paul Hessburg, a research ecologist with PNW, notes: “We’re interested in learning how vegetation patterns and disturbance processes interact under past, current, and future climate conditions. This comparison helps us to better understand the land-climate-vegetation-disturbance systems we inherited, and how they have changed. Because the climate is changing, we’re also trying to find out how these systems will adapt to the predicted temperature and precipitation regimes of the mid- to late-21st century. This will help managers create patterns of forest structure and composition that are more resilient in the future climate.”

KEY FINDINGS	
• Application of decision support systems can expedite and document landscape evaluations and aid in development of prescriptions for landscape restoration and protection.	
• Environmental assessments implemented in logic models provide essential, unambiguous information about ecosystem states and processes, and are a useful starting point for applying adaptive ecosystem management to areas or regions.	
• The Ecosystem Management Decision Support (EMDS) application for the Okanogan-Wenatchee National Forest improved communication within its interdisciplinary team by giving members a concrete framework and equal footing for evaluating and prioritizing restoration management opportunities for their areas of expertise.	
• EMDS allowed for better integration across resource disciplines, yielded repeatable landscape evaluation and decisionmaking processes, and enabled the interdisciplinary team to identify priority areas for restoration treatments that could achieve several linked objectives.	

Purpose of PNW Science Findings

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

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WORKING TOGETHER IN EASTERN WASHINGTON

For the past 20 years, PNW and Okanogan-Wenatchee scientists have jointly conducted research and development that could be used to inform forest management. In 2010, they developed a forest restoration strategy, which was revised in 2012. The strategy defines ecological restoration objectives in light of key 20th-century landscape changes and 21st-century climate change, such as improving wildlife habitat connectivity for listed and sensitive species and breaking up patterns of high-severity fire risk, and outlines steps toward achieving these objectives. The overarching goal of the strategy is to reconnect the patterns and processes of the broad regional landscape, by prioritizing local landscape conditions based on the significance of changes to them, and then restoring priority local landscapes.

In support of the strategy, Hessburg and lead forest program managers worked with a district interdisciplinary team to pilot the first implementation of an EMDS application for restoring Nile Creek (20,500 acres) and two adjacent subwatersheds. During the 20th century, large western larch, ponderosa pine, and Douglas-fir trees around Nile Creek were selectively harvested. These species had thrived when frequent low- and mixed-severity fires were the norm. After logging

and a century of fire suppression, dense and multilayered stands of shade-tolerant Douglas-fir and grand and subalpine firs developed. In the 1980s and 1990s, defoliating western spruce budworm and several tree-killing bark beetles infested these species, increasing fuel accumulation and heightening the risk of large wildfires.

The team evaluated the departure of current landscape conditions in Nile Creek from the pre-management-period (ca. 1900) range of variation in spatial patterns, and from the future range of variation associated with a drier, warmer 21st-century climate. Using a fire-spread model (FlamMap), the team also examined Nile Creek’s current fuelbeds and potential wildfire behavior and then compared them with historical and future ranges of fire behavior conditions to characterize landscape-level changes in potential fire behavior.

Hessburg explains, “We fed local wind directions and speeds into FlamMap and used more than 150,000 simulated fires to determine how fires would spread locally and where fire runs might be large and with long flames. We applied these outputs to our EMDS model, which enabled managers to identify areas of concern—where they could treat fuels to interrupt the most exaggerated fire behavior.”

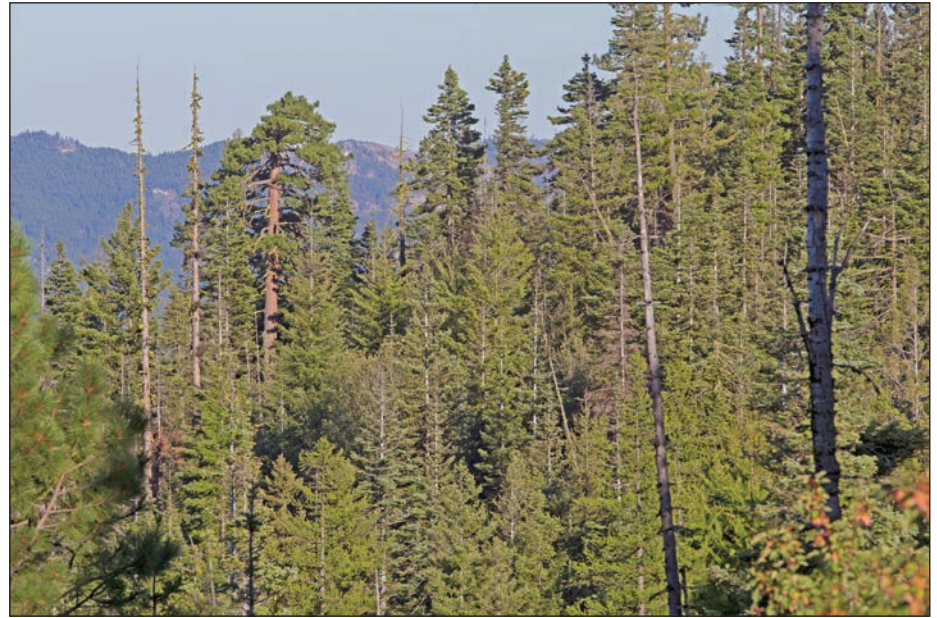
In eastern Nile Creek, surface and canopy fuel treatments, which favored open-canopy ponderosa pine patches to protect downstream communities in the wildland-urban interface, were found to be inconsistent with historical reference conditions, but were much better adapted to model-predicted future climate conditions. In the western portion of the Nile Creek subwatershed, the team found large areas of intermediate-aged, multilayered Douglas-fir forest with high surface-fuel loadings. Hessburg observes: “The results are typically pretty intuitive. But if surprising results are encountered, or if model output doesn’t make sense, the analysis team can drill down into the model results and determine if there are data or modeling errors, or a truly surprising result.”

Using EMDS, the team compared alternative management scenarios based on historical and future conditions, and determined how much progress each scenario could make toward improving habitat conditions and reducing insect, disease, and fire risks. The final product was a refined map of planned landscape treatment areas in Nile Creek that showed where treatments for multiple resource benefits were needed, and how the treatments would affect each resource and habitat the model was evaluating.

Although restoring the historical habitat patterns and functionality of the Nile watershed would improve vegetation conditions, the team determined that it would not produce the most resilient future conditions. As a result, the team planned for prescribed burning projects in the eastern half of the subwatershed that reduced vulnerability to crown fires and protected downstream communities, as well as understory thinning and burning projects in the western half that reduced vulnerability to large wildfires and budworm defoliation, improved vegetation resilience to climate warming, and decreased fragmentation by increasing landscape patch sizes. Several implemented projects based on these analyses have now moved the Nile Creek landscape toward conditions that resemble a hybrid of historical and future reference conditions.



A comparison of forest density and structure from Mission Peak southwest of Wenatchee, Wash. The 1934 photo shows an open canopy of pine and mixed conifer forest conditions on the ridge tops and southerly aspects, while the 2010 photo shows densely layered canopy conditions and bark beetle mortality in these same locations.



A typical dense, multilayered mixed conifer patch in the eastern Washington Cascade Mountains. Note the relict ponderosa pine tree in the mid-ground (a remnant of a former forest); dead western larch—killed by dwarf mistletoe and inter-tree competition—fir-engraver bark beetle mortality, and western spruce budworm defoliation in the foreground; and a glut of pole-sized trees that have grown into the understory during the period of fire exclusion.

SIMULTANEOUS PROBLEM SOLVING—CONSISTENT AND TRANSPARENT

In the past, much of what was discussed in project-level planning was based on field reconnaissance notes, professional judgment, hand-drawn maps, or grease pencil drawings on Mylar aerial photo overlays. Bill Gaines, a wildlife ecologist who was part of the interdisciplinary team working with

Reynolds and Hessburg, recalls: “In previous landscape assessments, we didn’t have a consistent, repeatable, well-tracked process we could carry from one watershed to another and have confidence that we were looking at the same things in the same way, making it difficult to compare results across landscapes. We also didn’t have a tool for objectively

evaluating landscape conditions and documenting and weighing our evaluation assumptions. This resulted in a lot of conflict among resource managers who wanted their particular focal areas to receive a higher priority for protection or treatment. Now they have an equal place at the table.”

Reino Sarlin (1934) and John Marshall (2010)

John Marshall

With EMDS, the team was better able to integrate concerns for multiple resources, simultaneously emphasizing wildlife and aquatic habitat conditions, landscape and patch-scale fire behavior, vegetation and fuels patterns, and road and aquatic interactions, leading to restoration opportunities for all of these resources. Hessburg observes, “EMDS can integrate myriad landscape conditions as facets of the same stone. For example, if you want to change a habitat condition, let’s say for white-headed woodpecker, the fuelbed, forest structure, and fire behavior also change. EMDS allows us to track those linked changes in conditions.”

Richy Harrod, Deputy Fire Staff Officer on the Okanogan-Wenatchee National Forest, observes: “Before EMDS, each environmental impact statement or assessment stood on its own. It was hard to look at the cumulative effects for a larger area or to compare projects. With EMDS, after you complete your landscape evaluation, you can move through the NEPA [National Environmental Policy Act] process more efficiently—in essence, doing a single large landscape evaluation allows you to plan for and implement multiple projects. Also, EMDS allows us to integrate resource concerns better at broader scales to prioritize places for treatment that we might not otherwise choose using any other method.”

James Dickinson, a forester and ecologist working for both the forest and the PNW Research Station, describes the previous intractability of landscape analysis: “We used to assess hundreds of variables for each analysis with simple graphical overlays. Looking at several variables at any given time is challenging. Being able to consistently compare many variables and evaluate tradeoffs is powerful.” Hessburg agrees: “Before EMDS, people did this in their heads. Nobody could keep track of all the moving parts, and often the most vocal or best prepared person at the table defined the projects that were implemented.”

EMDS is being implemented on all seven districts of the Okanogan-Wenatchee, and district specialists are being trained to run the model, work through analysis, and apply results. “Although the initial start-up cost and time investment are higher than districts are used to, once they develop the capability for using EMDS, it accelerates the NEPA process and produces efficiencies that weren’t previously available,” notes Jim Bailey, a district fire manager.



Based on the EMDS project in the Nile Creek subwatershed, crew mark small Douglas-fir and grand fir in-growth for removal.



After thinning, many of the treatment areas received prescribed burns to reduce surface and ladder fuels. Repeated burning favors the survival of medium- and large-sized trees with thick bark and that are well spaced from neighboring trees.

FASTER, SMARTER, EASIER TO USE

EMDS is being used for a variety of applications, such as to evaluate the environmental impacts of an extensive road network on the Tahoe National Forest, to manage wetlands in the northern Netherlands, and to support land-use planning and local forestry decisions about carbon sequestration

in China. The U.S. Fish and Wildlife Service has recently recommended using a process like the forest restoration strategy and toolkit when restoring ecological patterns and processes of east-side forest landscapes that support northern spotted owl habitat and its recovery.

As the forest and the station proceed with the forest restoration strategy, they are involving conservation groups, local timber companies, and other government agencies. For example, they are helping The Nature Conservancy use EMDS where it wants to assess multi-owner landscapes, work across boundaries, and implement multi-owner landscape prescriptions and stewardship.

EMDS is also being used internationally to assess the suitability of siting industrial parks. Reynolds recalls: “In another case, we built a customized system to help the U.S. Army Corps of Engineers decide how to best allocate its budget for meeting national priorities, such as energy independence, water quality, and jobs.”

A nonprofit consortium hosted at the University of Redlands has taken on long-term development of EMDS, and a new Web-served version is expected in the next major upgrade. Dickinson explains: “This architecture provides fantastic analytical flexibility and capacity we didn’t have before. For example, using other online tools, like the Forest Vegetation Simulator (FVS), we can simulate current stand treatments and future decadal development of landscape patterns. FVS gives us the future stand conditions to plug into sequential decadal maps, and EMDS can evaluate landscape progress toward restoration goals off into the future.”

Another EMDS upgrade is also in the works. “EMDS can help us view current conditions, compare them with past and future reference conditions, and decide on a set of actions to restore the landscape,” notes Gaines. “But it doesn’t automatically tell us how this set

FOR FURTHER READING

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LAND MANAGEMENT IMPLICATIONS

- Decision support systems allow managers to strategically alter large-scale fire behavior, enhance the sustainability of key wildlife habitat networks, restore ecosystem functions, reduce the impacts of roads on aquatic habitats, and decrease risk to human communities.
- Forest managers can use the refined maps EMDS produces to identify areas on the landscape most in need of restoration or protection.
- EMDS helps managers efficiently evaluate how various landscape treatment options would affect fish habitats, insect and disease risks, landscape patterns, and the flammability of the larger landscape, and determine the degree to which each option could make progress toward integrated restoration goals.
- Decision models provide a bridge from assessment to planning by helping managers rationally prioritize ecosystem maintenance and restoration activities.

of actions affects the landscape. We have to apply the treatments to the data table in the model by hand and then re-evaluate the restored conditions. It is painstaking work, but we are pioneering landscape prescription development. In a future upgrade, Redlands will develop a more automated method to implement and compare different treatment scenarios.”

Along with information about the state of the natural system, Harrod says managers are concerned about the feasibility, efficacy, and social acceptability of their decisions: “Choosing a treatment option based on ecological or other resource aspects is fine, but if you can’t afford to implement it, there’s no

value in that choice. This approach allows us to consider those things.”

Hessburg concludes: “With each application, EMDS gets smarter, more transparent, and easier to use. When we find aspects that need improvement—and there are many—we prioritize our needs and route that information back to Reynolds and the Redlands group. Dickinson brings the analysis problems into the lab, we solve them together and implement the solutions in the model, and he takes the revised model back to the forest.”

“Problems can become opportunities when the right people come together.”
—Robert South, English clergyman, 1634–1716.

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