Assessment and Management of Dead-Wood Habitat

Joan Hagar

Open-File Report 2007–1054

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia 2007

For product and ordering information:
World Wide Web: http://www.usgs.gov/pubprod
Telephone: 1-888-ASK-USGS

For more information on the USGS—the Federal source for science about the Earth,
its natural and living resources, natural hazards, and the environment:
World Wide Web: http://www.usgs.gov
Telephone: 1-888-ASK-USGS

Suggested citation:
Hagar, Joan, 2007, Assessment and management of dead-wood habitat: USGS Administrative Report 2007-1054, p. 1-32.

Contents

Figures

Assessment and Management of Dead-Wood Habitat: State of the Science Report to BLM in Support of the Western Oregon Plan Revisions

Joan Hagar

Introduction

The Bureau of Land Management (BLM) is in the process of revising its resource management plans for six districts in western and southern Oregon as the result of the settlement of a lawsuit brought by the American Forest Resource Council. A range of management alternatives is being considered and evaluated including at least one that will minimize reserves on O&C lands. In order to develop the bases for evaluating management alternatives, the agency needs to derive a reasonable range of objectives for key issues and resources. Dead-wood habitat for wildlife has been identified as a key resource for which decision-making tools and techniques need to be refined and clarified. Under the Northwest Forest Plan, reserves were to play an important role in providing habitat for species associated with dead wood (U.S. Department of Agriculture Forest Service and U.S. Department of the Interior Bureau of Land Management, 1994). Thus, the BLM needs to: 1) address the question of how dead wood will be provided if reserves are not included as a management strategy in the revised Resource Management Plan, and 2) be able to evaluate the effects of alternative land management approaches.

Dead wood has become an increasingly important conservation issue in managed forests, as awareness of its function in providing wildlife habitat and in basic ecological processes has dramatically increased over the last several decades (Laudenslayer et al., 2002). A major concern of forest managers is providing dead wood habitat for terrestrial wildlife. Wildlife in Pacific Northwest forests have evolved with disturbances that create large amounts of dead wood; so, it is not surprising that many species are closely associated with standing (snags) or down, dead wood. In general, the occurrence or abundance of one-quarter to one-third of forest-dwelling vertebrate wildlife species, is strongly associated with availability of suitable dead-wood habitat (Bunnell et al., 1999; Rose et al., 2001). In Oregon and Washington, approximately 150 species of wildlife are reported to use dead wood in forests (O'Neil et al., 2001). Forty-seven sensitive and special-status species are associated with dead wood (Appendix A). These are key species for management consideration because concern over small or declining populations is often related to loss of suitable dead-wood habitat (Marshall et al., 1996). Primary excavators (woodpeckers) also are often the focus of dead-wood management, because they perform keystone functions in forest ecosystems by creating cavities for secondary cavity-nesters (Martin and Eadie, 1999; Aubry and Raley, 2002). A diverse guild of secondary cavity-users (including swallows, bluebirds, several species of ducks and owls, ash-throated flycatcher, flying squirrel, bats, and many other species) is unable to excavate dead wood, and therefore relies on cavities created by woodpeckers for nesting sites. Suitable nest cavities are essential for reproduction, and their availability limits population size (Newton, 1994). Thus, populations of secondary cavity-nesters are tightly linked to the habitat requirements of primary excavators.

Although managers often focus on decaying wood as habitat for wildlife, the integral role dead wood plays in ecological processes is an equally important consideration for management. Rose et al. (2001) provide a thorough review of the ecological functions of dead wood in Pacific Northwest forests, briefly summarized here. Decaying wood functions in: soil development and productivity, nutrient cycling, nitrogen fixation, and carbon storage. From ridge tops, to headwater streams, to estuaries and coastal marine ecosystems, decaying wood is fundamental to diverse terrestrial and aquatic food webs. Wildlife species that use dead wood for cover or feeding are linked to these ecosystem processes through a broad array of functional roles, including facilitation of decay and trophic interactions with other organisms (Marcot, 2002; Marcot, 2003). For example, by puncturing bark and fragmenting sapwood, woodpeckers create sites favorable for wood-decaying organisms (Farris et al., 2004), which in turn create habitat for other species and facilitate nutrient cycling. Small mammals that use down wood for cover function in the dispersal of plant seeds and fungal spores (Carey et al., 1999). Resident cavity-nesting birds may regulate insect populations by preying on overwintering arthropods (Jackson, 1979; Kroll and Fleet, 1979). These examples illustrate how dead wood not only directly provides habitat for a large number of wildlife species, but also forms the foundation of functional webs that critically influence forest ecosystems (Marcot, 2002; Marcot, 2003). The important and far-reaching implications of management of decaying wood highlight the need for conservation of dead-wood resources in managed forests. Consideration of the key ecological functions of species associated with dead wood can help guide management of dead wood in a framework consistent with the paradigm of ecosystem management (Marcot and Vander Heyden, 2001; Marcot, 2002.)

As more information is revealed about the ecological and habitat values of decaying wood, concern has increased over a reduction in the current amounts of dead wood relative to historic levels (Ohmann and Waddell, 2002). Past management practices have tended to severely reduce amounts of dead wood throughout all stages of forest development (Hansen et al., 1991). The large amounts of legacy wood that characterize young post-disturbance forests are not realized in managed stands, because most of the wood volume is removed at harvest for economic and safety reasons. Mid-rotation thinning is used to “salvage” some mortality that might otherwise occur due to suppression, so fewer snags are recruited in mid-seral stages. Harvest rotations of 80 years or less truncate tree size in managed stands, and thus limit the production of large-diameter wood. As a consequence of these practices, dead wood has been reduced by as much as 90% after two rotations of managed Douglas-fir (Rose et al., 2001). Large legacy deadwood is becoming a scarce, critical habitat that will take decades to centuries to replace. Furthermore, management continues to have important direct and indirect effects on the amount and distribution of dead wood in forests. Current guidelines for managing dead wood may be inadequate to maintain habitat for all associated species because they largely focus on a single use of dead wood (nesting habitat) by a small suite of species (cavity-nesting birds), and may under represent the sizes and amounts of dead wood used by many wildlife species (Rose et al., 2001, Wilhere, 2003).

Current BLM Approach to Management of Dead Wood

Current management direction for BLM forestlands in western Oregon comes from a Record of Decision (ROD) and Resource Management Plan (RMP) prepared by each of the districts following adoption of the Northwest Forest Plan (USDA Forest Service and USDI

Bureau of Land Management 1994). In these documents, which reflect a strong emphasis on late-successional forests, the agency states two broad goals related to ecological principles for forest management. The first is "to maintain late-successional and old-growth species habitat and ecosystems on federal lands." The second goal is to "maintain biological diversity associated with native species and ecosystems in accordance with laws and regulations." In addition, the common objective for wildlife management across all districts is to "enhance and maintain biological diversity and ecosystem health to contribute to healthy wildlife populations." Management actions and directions in the RMP's emphasize federally listed threatened and endangered (T&E) species, state-listed species, and bureau special-status species (see Appendix A for list of species).

All districts specifically address management of standing and down coarse wood by land use as allocated by the Northwest Forest Plan, although levels of detail and management direction for dead-wood habitats differ slightly for each district. Current RMPs rely heavily on the model developed by Neitro et al. (1985) to provide guidelines for snag retention in harvest units. The Klamath Falls Resource Area uses this model to set snag-retention levels sufficient to support 60% of potential populations of cavity-nesting birds, whereas the other five districts aim for 40% of potential populations. The model developed by Nietro et al. was a useful step in the evolution of management of dead wood for wildlife, but has become outdated with the availability of new information (Rose et al., 2001). Revisions of the western Oregon resource management plans afford the BLM an opportunity to update approaches to assessing and managing dead wood for wildlife habitat, as well as for the maintenance of ecosystem processes.

Methods and Tools for Dead-Wood Management

Managers confront two fundamental questions with regard to dead wood: 1) How much dead wood is needed? and 2) How should dead wood be spatially distributed? Answers to these questions also include consideration of characteristics of dead wood, including size, decay stage, and tree species. Furthermore, managers need to manage dead wood at various spatial and temporal scales, from planning an individual, stand-level project, to long-term recruitment of dead wood at the landscape scale. Finally, forest managers have to balance objectives for multiple resources, including both timber harvest and wildlife habitat, when considering amounts and distribution of dead wood. Tools are needed to help set objectives and provide guidelines for amounts and distribution of dead wood to meet management goals. The following sections discuss the tools that have been used and that are currently available to address these questions.

Tools related to managing dead wood on federal lands in the Pacific Northwest that were first developed in the 1970s and 1980s focused on the question of how much dead wood is needed to provide habitat for dead-wood-dependent wildlife (Thomas et al., 1979; Raphael, 1983; Nietro et al., 1985). The best known and most widely used of these tools is the Biological Potential Model (BPM) for cavity-nesting birds in west-side Douglas-fir developed by Nietro et al. (1985). This model provides a simple approach to dead-wood management that focuses on a single wildlife guild (woodpeckers) and does not incorporate variability among regions or habitat types. It is appealing because it relates snag density to a population parameter, although the underlying relationships are based on questionable assumptions (Rose et al., 2001). Managers have been using this approach for 15 years and continue to use it to set guidelines for snag retention on BLM forestlands.

In spite of these advantages, the BPM has several shortcomings. First, it is out-dated because it is based on information available prior to 1985, and the relationships between snag density and population sizes have not been validated. New information indicates that amounts and sizes of snags selected by wildlife are far greater than those suggested by existing models (Bull, 1987; Milne and Hejl, 1989; Nelson, 1988; Schreiber and deCalesta, 1992; Raphael and Jones, 1997). A second disadvantage of the BPM is that it does not consider use of snags by species other than primary cavity-nesting birds. The assumption that snags retained to meet the needs of woodpeckers during the breeding season will also meet the requirements of most other snag-dependent species has not been empirically demonstrated. It may not be valid because of the wide range of habitats used to meet various life requisites by species associated with dead wood (Bunnell et al., 2002a). Whereas primary cavity excavators perform an important function by creating cavities, many species use decay features that are not created by woodpeckers, such as hollows and logs. In addition, target snag densities are based only on nesting habitat used by these species. Several studies have demonstrated that habitat used for foraging may not only be different than that used for nesting, but that it may be more limiting than cavity sites (Walankiewicz, 1991; Welsh and Capen, 1992; Weikel and Hayes, 1999). These findings highlight the importance of considering all life-history requirements (i.e., breeding, feeding, roosting, dispersal) when the goal is to provide adequate habitat for any species (Bunnell et al., 2002a). Finally, the BPM is only applicable to projects at the spatial scale of individual timber sales, and therefore offers no guidance on planning at a landscape scale.

Few tools have been developed to provide guidance on the question of how dead wood should be spatially distributed. The BPM (Nietro et al., 1985) used by federal forest managers does not include specific recommendations on how to distribute retained snags. A major consideration in deciding where to retain snags is the current location of existing snags. It is also important to note that our knowledge about the effects of snag distribution patterns on cavity-using wildlife is scant and inconclusive (Chambers et al., 1997). Abundance of primary excavators may be greater when retained structures are aggregated (Saab and Dudley, 1998), but dispersed retention of trees and snags at the stand level generally favors secondary cavity nesters (Bunnell et al., 2002b). Bull et al. (1997) recommended managing snags at the scale of 5- to 25-acre patches, and retaining mixed clusters of live and dead trees within each patch. This approach is intended to maximize the density of cavity nesters by distributing snag clusters at a scale corresponding to territory size. In addition to providing wildlife habitat, other issues, such as safety and risk of windfall, have influenced decisions about how to distribute those trees and snags that are retained. In general, clustering of snags has been recommended in order to reduce worker exposure to safety hazards. Also, the retention of live trees next to snags, rather than clusters of snags only, reduces the probability that snags will fall and provides canopy cover for wildlife using the snags (Bull et al., 1997).

Even less information is available to inform decisions regarding distribution patterns of downed wood to provide suitable habitat for species that use decaying wood on the ground. Bunnell et al. (2002b) suggest that a dispersed distribution of downed wood would promote forest productivity by facilitating dispersal of mycorrhizae by small mammals within a stand. However, empirical data and models to provide specific guidelines, even at the spatial scale of stands, are lacking. The issue of how to distribute dead wood at the scale of landscapes has barely been broached.

Assessing and Managing Dead-Wood Habitat using DecAID

An effective approach to dead-wood management should consider requirements of all associated species, incorporate variability in dead wood according to management goals and habitat types, and be applicable at various spatial scales. The Decayed Wood Advisor (DecAID; Mellen et al., 2006) offers such an approach. Current information on the ecology and distribution of decaying wood in Oregon and Washington, along with comprehensive data on habitat relationships of wildlife with dead wood in the Pacific Northwest, has been compiled in DecAID. As the state-of-the-science source of information on decaying wood in western forests, DecAID represents the best tool currently available to forest managers for managing dead-wood habitat. DecAID is not a model, but rather an advisory tool that can help managers evaluate effects of forest conditions and existing or proposed management activities on organisms that use snags and down wood. This tool provides managers with information about the sizes and abundance of snags and down wood needed to help meet objectives for wildlife management. In addition to providing comprehensive information on dead wood as wildlife habitat, the supporting literature available on the DecAID website also provides an overview of the current knowledge regarding the ecological functions of dead wood (Marcot, 2003).

Two major bodies of literature and data have been compiled in DecAID to address management questions related to amounts and distribution of dead wood: 1) data about habitat relationships of wildlife with dead wood in the Pacific Northwest; and 2) summaries of inventory plots characterizing the current distribution and range of variability of decaying wood in Oregon and Washington. These two primary components of DecAID facilitate both fine- and coarse-filter approaches to management of decaying wood. A fine-filter approach focuses on the providing for the needs of individual species or guilds; the goal of a coarse-filter approach is to manage for an appropriate mix of ecological communities on a landscape scale (Baydack et al., 1999). Together the two approaches comprise a strategy to maintain native ecosystems and their components, while assuring that the needs of special-status species (e.g., threatened and endangered species) are met. Empirical data on wildlife relationships with dead wood from multiple studies are synthesized in a meta-analysis to provide a summary of information about the sizes and amounts of dead wood used by individual species or guilds. This data set can be used as a fine filter to help meet habitat objectives in locations where managing for particular species is a priority. For example, the BLM may implement specific management actions to provide habitat for focal species associated with dead wood. Sensitive species for which BLM lands represent a significant portion of the distribution in western Oregon may be good candidates for fine-filter management. Appendix B shows examples of maps of species distributions relative to BLM ownership developed from the Oregon Natural Heritage Program database that can help guide selection of focal species. Once species are selected, DecAID can provide any available information about habitat associations.

The cumulative species curves that summarize wildlife relationships with dead wood for each forest type and structure class (Fig. 1) have two basic interpretations. First, they can be used to determine which species, and what fraction of all reported species, would be provided suitable habitat for nesting, foraging, and roosting by managing for a specified snag density. A second use of the information displayed in cumulative species curves is to determine amounts and sizes of dead wood needed to provide suitable habitat for a given species or species group, such as management indicator species. More detailed information on dead-wood characteristics associated with particular species, such as decay stage or snag height, can be accessed in underlying data summaries from individual studies.

Variability in the underlying data is portrayed as tolerance levels (Marcot et al., 2002). Tolerance levels are estimates of the percent of all individuals in a population that used some specified range of values representing characteristics of dead wood (from data combined across one or more studies). For example, an 80% tolerance level for the diameter at breast height of snags indicates that 80% of the individuals in the population used snags less than or equal to the value that corresponds to 80% tolerance; 20% of the individuals used larger snags. Tolerance levels are intended to be interpreted as levels of assurance that species needs are met. Choice of tolerance level to use as a guideline depends on management goals. For example, where providing habitat for a particular species is a high priority, managers could use 80% tolerance levels to set objectives for dead wood sizes and amounts. In areas where other uses, such as timber production, have higher priority, lower tolerance levels may be more appropriately used to determine guidelines for management of dead wood. Managers can make use of local knowledge and agency goals to determine priorities for management units within a district. DecAID can be used to facilitate evaluation of trade-offs associated with managing for different levels of dead wood.

Figure WLCH_S.sp-7. Cumulative species curves for density (#/ha) of snags ≥ approximately 50 cm dbh: species use of areas for nesting, roosting, and occurrence with documented snag densities for 30%, 50%, and 80% tolerance levels in the Westside Lowland Conifer-Hardwood Forest Wildlife Habitat Type and Small/medium trees Structural Condition Class.

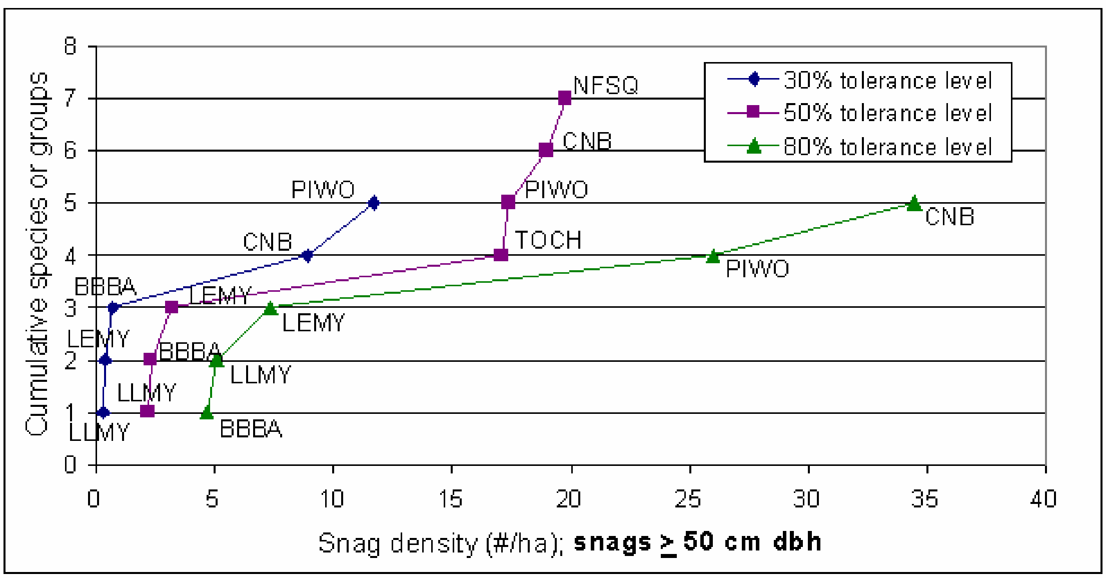


Figure 1. Example of DecAID graph showing results of meta-analysis of the relationship between snag-associated species and snag density at three levels of statistical confidence (Mellen et al., 2006). Codes for species are: BBBA = big brown bat, CNB = cavity-nesting birds, LEMY = long-eared myotis, LLMY = long-legged myotis, NFSQ = northern flying squirrel, PIWO = pileated woodpecker, TOCH = Townsend's chipmunk.

Few studies to date have addressed relationships of wildlife to dead wood at landscape scales. Because of this lack of empirical data, and the difficulty in acquiring it, DecAID relies on a compilation of forest inventory data (Ohmann and Waddell, 2002) to provide a coarse-filter approach for assessing amounts and distributions of dead wood at broad spatial scales. Forest inventory data have been used to generate amounts and distributions of dead wood by habitat and harvest history, allowing users to evaluate current levels of dead wood in relation to those expected in a natural reference condition. In DecAID, inventory data are separated by vegetation and structural condition to represent amounts and distribution of dead wood in various developmental stages of forests, from post-disturbance to late-seral. Data from unharvested plots can assist managers in setting objectives aimed at mimicking natural amounts and distribution patterns (spatial and temporal) of dead wood. However, because management has in many cases reduced dead wood amounts relative to unharvested forests (Cline et al., 1980, Ohmann et al., 1994), managers should not expect to immediately make up the deficits in dead wood to meet goals for wildlife habitat. The amounts of dead wood suggested as goals by DecAID should be considered as long-term objectives for desired future conditions; a reasonable short-term objective might be to show incremental progress towards these goals.

The Umpqua National Forest also has suggested an approach to developing guidelines for snag and down-wood prescriptions based on mimicking natural patterns (White, unpubl.). This approach sets targets for amounts and sizes of snags and down wood based on groups of plant associations. Plant-association groups are assumed to reflect ecological processes that have an influence on dead-wood dynamics, such as productivity, disturbance regime, and environmental conditions. DecAID could incorporate this concept to develop prescriptive guidelines for the distribution of dead wood at the landscape scale; however, corresponding information about wildlife use of dead wood by plant-association group is not available.

Conclusions

Whether the management goal is to maintain biodiversity or to prevent species listing and associated legal challenges, DecAID is the most comprehensive tool currently available to inform dead-wood management. The following bullets highlight the advantages of using DecAID to evaluate and manage dead-wood resources:

- DecAID provides a scientifically defensible approach to dead-wood management because it is based on empirical data from published scientific literature. DecAID incorporates all currently available data about relationships of wildlife habitat with deadwood. The meta-analysis approach employed by DecAID, combining data from multiple regionally relevant studies, provides a more defensible basis for management decisions than relying on the results of single studies.

- DecAID provides both fine-filter (individual wildlife species) and course-filter (range of natural variability) approaches to dead-wood management. The synthesis of detailed empirical data describing wildlife use of dead wood allows managers to account for individual species of concern when planning and implementing forest practices. A landscape-level approach to maintaining amounts and distributions of wood within the range of variation with which wildlife evolved can help ensure that the needs of all species are met.

- Because DecAID is web-based, it can be, and is, continually updated as new information becomes available. The most recent version of DecAID incorporates information from literature and data available through December 2005. This feature of DecAID makes it particularly valuable for adaptive management.

- DecAID was developed for use during revisions of forest plans and is appropriate for planning management of dead wood at the spatial scale of a BLM district. DecAID can be employed both for evaluating alternatives in resource management plans with respect to dead-wood habitat, and for developing management plans once an alternative is selected.

Limitations of DecAID

Although DecAID provides a valuable tool for dead-wood management, users should be aware of its limitations. The authors include a thorough discussion of caveats and cautions associated with the use of DecAID, which are labeled as "must read" for all users (see Mellen et al., 2006). In general, one of the biggest barriers of using DecAID – the large volume of data upon which it is based – also is its biggest asset. Users are encouraged to explore all relevant data available in DecAID before applying interpretations to management actions. Whereas DecAID is extremely rich in data that can provide a defensible basis for management decisions, it does not provide project-level prescriptions. Managers are encouraged to apply local knowledge to develop goals and objectives, and to focus on desired future conditions in the context of a broad spatial scale (e.g., BLM District). Therefore, thoughtful incorporation of local knowledge of plant and animal communities is essential to effective applications of DecAID. A considerable investment of time and energy is required to learn how to use the information synthesized in DecAID.

The amount of data synthesized in DecAID may seem overwhelming in volume, but basic natural history information for most wildlife species in most habitat types is far less than adequate for making informed management decisions. Information on wildlife associated with dead wood and their habitat requirements is particularly scarce for southwestern Oregon. Similarly, research on snag dynamics is relatively recent, and there is still much to be learned about factors affecting decay rates and patterns, especially for tree species other than Douglas-fir. Hardwoods make important contributions to habitat for cavity-using species, both when alive and after death (Chambers et al., 1997; Bunnell et al., 1999). The role of hardwoods in providing habitat has not been well-studied in Oregon and Washington, and thus they are under-represented in the literature and in DecAID.

Long-term Planning for Dead Wood

DecAID provides assistance in establishing long-term goals for dead-wood habitat, but additional tools are needed to plan for sustained amounts of dead wood through time. Managers need to be able to estimate the number of green trees to retain in order to replace snags that will move into softer decay classes and eventually become downed wood. Tools for tracking the dynamics of coarse woody debris have been evolving in sophistication over the last decade. The Snag Recruitment Simulator (SRS) was one of the first models developed to track snag density by size and decay class for the purpose of managing habitat for wildlife (Marcot, 1992). SRS was based on a chronosequence of snag ages and represented a limited range of site conditions. The Snag Dynamics Projection Model (SDPM) improved upon SRS by using remeasurement data from a large sample to predict the probability that an individual snag will fall in a 10-year period (McComb and Ohmann, 1996). More recently, Mellen and Ager (2002) developed the Coarse-Wood Dynamics Model (CWDM), which analyzes the dynamics of down logs as well as snags. CWDM combines rates of snag fall and height loss from Forest Inventory and Analysis (USDA Forest Service, Pacific Northwest Region) remeasurement data, with estimates of decay rates from published studies to predict when snags will transition from one decay class to the next, and when snags transition to downed wood. Of these models, only CWDM distinguishes between snags and logs, and tracks decay of logs by size and decay class over time. Since CWDM's release, updated fall and decay rates from more recent plot re-measurement and expert opinion have been incorporated into the Fire and Fuels Extension (FFE) of the Forest Vegetation Simulator (FVS, http://www.fs.fed.us/fmsc/fvs/), making it the best tool currently available for planning with regard to dead wood in Oregon and Washington. Underlying data on decay and fall rates have not been published but could be obtained from K Mellen-McLean (USFS, Portland, Oreg.). FVS-FFE can be used to determine the number and sizes of snags created by suppression mortality and to track their subsequent decomposition. FVS also can be used to predict when trees will attain sufficient diameter to be recruited as coarse woody debris. Approaches that simulate forest growth and coarse-woody-debris dynamics can be very useful for evaluating the effects of alternative management scenarios on dead-wood habitat over broad spatial scales and long time-frames (Wilhere 2003; Kennedy et al., 2004).

Possible Approaches or Changes

To address goals related to the management of dead wood as wildlife habitat, the BLM needs data about the current status of dead-wood resources and about amounts and characteristics of dead wood needed to support species of management concern. Maps that will provide information about current spatial distributions of dead wood are being developed by IMAP (Interagency Mapping and Assessment Process) using the Gradient Nearest Neighbor (GNN; Ohmann and Gregory, 2002). Mapping for areas of Oregon and Washington covered by the Northwest Forest Plan are expected to be completed by October 2008 (Janet Ohmann, USFS-PNW Research Station). Although GNN-derived maps do not provide sufficiently accurate estimates of dead wood for use at local, project-level scales, they are expected to provide information useful for regional and mid-scale evaluations of management scenarios through time.

In order to obtain additional reliable information about the current status of dead wood, an assessment specific to the BLM lands could be conducted. The summaries of regional inventory plots contained in the current version of DecAID are compiled by wildlife habitat type, but do not distinguish among land ownerships; however, sample-based estimates of dead wood conditions with associated errors could be developed from the current vegetation survey plots on BLM lands. Substantially more data from inventory plots are currently available than were available at the time the DecAID summaries were compiled because the number of plots on BLM lands have since quadrupled.

Validation and testing are necessary for refining any model or tool. A scarcity of wildlife data for many sub-regions in western Oregon dictated pooling of data at regional scales to create summaries in DecAID. Therefore, data collected at local scales will be necessary for validation and refinement of these wildlife relationships to dead-wood characteristics. Local data can then be incorporated into DecAID to improve the quality of data available for guiding management. Monitoring of individual species' responses to different approaches to dead-wood management will also provide valuable input for refining DecAID.

Although DecAID provides the most current and best-available science to inform management of dead wood, some questions remain unanswered. Research and monitoring is especially needed on the following topics:

1. More empirical data are needed to determine how spatial distribution of residual structures affects their use by wildlife at various spatial scales.

2. Information characteristics of dead-wood habitats that influence fitness and productivity of wildlife species would help managers plan for the maintenance of viable populations.

3. What are the roles of live trees, including both conifer and hardwood species that have elements of decay, in providing habitat for species that use dead wood? Which species use them and to what extent? Answering these questions would help managers decide how these elements of decay could count toward meeting goals for providing dead-wood habitat.

DecAID can be used to evaluate the effects of alternative management scenarios on habitat for species associated with dead wood, for evaluating and for developing management plans under the selected alternative. The U.S. Forest Service (USFS) is already using DecAID to set new goals and objectives for dead wood management on several national forests. The BLM can take advantage of the available experience by working with USFS experts to implement DecAID at the district level.

References Cited

Aubry, K.B., and Raley, C.M., 2002, The pileated woodpecker as a keystone habitat modifier in the Pacific Northwest, *in*: Laudenslayer Jr., W. F., Shea, P. J., Valentine, B., Weatherspoon, C. P., and Lisle, T. E., eds., Proceedings of the symposium on the ecology and management of dead wood in western forests: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report, PSW-GTR-181, p. 257-274.

Baydack, R.K., Campa, H. III, and Haufler, J.B., 1999, Practical approaches to the conservation of biological diversity: Washington, D.C., Island Press.

Bull, E.L., 1987, Ecology of the pileated woodpecker in northeastern Oregon: Journal of Wildlife Management, v. 51, p. 472-481.

Bull, E.L., Parks, C.G., Torgersen, T.R., 1997, Trees and logs important to wildlife in the interior Columbia River basin: U.S. Department of Agriculture Forest Service, Pacific Northwest Research Station, General Technical Report, PNW-GTR-391, p. 55.

Bunnell, F.L., Kremsater, L.L., and Wind, E., 1999, Managing to sustain vertebrate richness in forests of the Pacific Northwest: relationships within stands: Environmental Reviews, v.7, p. 97-146.

Bunnell, F.L., Houde, I., Johnston, B., and Wind, E., 2002, How dead trees sustain live organisms in western forests, *in*: Laudenslayer Jr., W.F., Shea, P.J., Valentine, B., Weatherspoon, C.P., and Lisle, T.E., eds., Proceedings of the symposium on the ecology and management of dead wood in western forests: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-181, p. 291-318.

Bunnell, F.L., Boyland, M., and Wind, E., 2002, How should we spatially distribute dying and dead wood?, *in*: Laudenslayer Jr., W.F. Shea, P.J., Valentine, B., Weatherspoon, C.P., and Lisle, T.E., eds., Proceedings of the symposium on the ecology and management of dead wood in western forests: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-181, p. 739-752.

Chambers, C.L., Carrigan, T., Sabin, T.E., Tappeiner, J., and McComb, W.C., 1997, Use of artificially created Douglas-fir snags by cavity-nesting birds: Western Journal of Applied Forestry, v. 12, p. 93-97.

Cline, S.P., Berg, A.B., and Wight, H.M, 1980, Snag characteristics and dynamics in Douglas-fir forests, western Oregon: Journal of Wildlife Management, v. 44, p. 773-786.

Csuti, B., Kimerling, A.J., O'Neil, T., Shaughnessy, M.M., Gaines, E.P., and Huso, M.M.P., 1997, Atlas of Oregon wildlife: Corvallis, Oreg., Oregon State University Press.

Farris, K.L., Huss, M.J., Zack, S., 2004, The role of foraging woodpeckers in the decomposition of ponderosa pine snags: Condor, v. 106, p. 50-59.

Hansen, A.J., Spies, T.A., Swanson, F.J., Ohmann, J.L., 1991, Conserving biodiversity in managed forests: BioScience, v. 41, p. 382-391.

Jackson, J.A., 1979, Tree surfaces as foraging substrates for insectivorous birds, *in*: Dickson, J.G., Conner, R.N., Fleet, R.R., Kroll, J.C., and Jackson, J.A., eds., The role of insectivorous birds in forest ecosystem: proceedings of the symposium: New York, N.Y., Academic Press, p. 69-93.

Kennedy, R.S.H., Olsen, K.A., Pabst, R.J., and Spies, T.A., 2004, A simulation of dead wood dynamics in the Elliot State Forest, Oregon: Salem, Oreg., Report to Oregon Department of Forestry.

Kroll, J.C., and Fleet, R.R., 1979, *in* :Dickson, J.G., Conner, R.N., Fleet, R.R., Kroll, J.C., and Jackson, J.A., eds., The role of insectivorous birds in forest ecosystem: proceedings of the symposium: New York, N.Y., Academic Press, p. 269-281.

Laudenslayer, W.F. Jr., Shea, P.J., Valentine, B.E., Weatherspoon, C.P., and Lisle, T.E., technical coordinators, 2002, Proceedings of the symposium on the ecology and management of dead wood in western forests: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-181, p. 949

Marcot, B.G., 1992, Snag Recruitment Simulator, Rel. 3.1 [computer program]. USDA Forest Service, Pacific Northwest Region, Portland, OR.

Marcot, B.G., 2002, An ecological functional basis for managing decaying wood for wildlife, *in*: Laudenslayer Jr., W.F., Shea, P.J., Valentine, B., Weatherspoon, C.P., and Lisle, T.E., technical coordinators, Proceedings of the symposium on the ecology and management of dead wood in western forests: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-181, p. 895-910

Marcot, B.G., 2003, Ecosystem processes related to wood decay. In: Mellen, K., Marcot, B.G., Ohmann, J.L., Waddell, K., Livingston, S.A., Willhite, E.A., Hostetler, B.B., Ogden, C., and Dreisbach, T., 2006, DecAID, the decayed wood advisor for managing snags, partially dead trees, and down wood for biodiversity in forests of Washington and Oregon. Version 2.0. USDA Forest Service, Pacific Northwest Region and Pacific Northwest Research Station; USDI Fish and Wildlife Service, Oregon State Office; Portland, Oregon. *http://wwwnotes.fs.fed.us:81/pnw/DecAID/DecAID.nsf*

Marcot, B.G., and Vander Heyden, M., 2001, Key ecological functions of wildlife species, *in*: Johnson, D.H., O'Neil, T.A., Managing directors, Wildlife-habitat relationships in Oregon and Washington: Oregon State University Press, Corvallis, Oreg., p. 168-186

Marcot, B.G., Ohmann, J.L., and Mellen, K., 2002, The statistical basis for the DecAID decayed wood management advisor. In: Mellen, K., Marcot, B.G., Ohmann, J.L., Waddell, K., Livingston, S.A., Willhite, E.A., Hostetler, B.B., Ogden, C., and Dreisbach, T., 2006, DecAID, the decayed wood advisor for managing snags, partially dead trees, and down wood for biodiversity in forests of Washington and Oregon. Version 2.0. USDA Forest Service, Pacific

Northwest Region and Pacific Northwest Research Station; USDI Fish and Wildlife Service, Oregon State Office; Portland, Oregon. *http://wwwnotes.fs.fed.us:81/pnw/DecAID/DecAID.nsf*

Marshall, D.B., Chilcote, M., Weeks, H., 1996, Species at risk. Sensitive, threatened, and endangered vertebrates of Oregon: Portland, Oreg., Oregon Department of Fish and Wildlife.

Martin, K., and Eadie, J.M., 1999, Nest webs: A community-wide approach to the management and conservation of cavity-nesting forest birds: Forest Ecology and Management v. 115, p. 243-257.

McComb, W.C., and Ohmann, J.L., 1996, Snag Dynamics Projection Model (SDPM), [computer program], U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Corvallis, Oreg.

Mellen, T.K., and Ager, A., 2002, A coarse wood dynamics model for the western Cascades, *in*: Laudenslayer, W.F. Jr., Shea, P.J., Valentine, B.E., Weatherspoon, C.P., and Lisle, T.E., technical coordinators, Proceedings of the symposium on the ecology and management of dead wood in western forests: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-181, p. 503-516.

Mellen, K., Marcot, B.G., Ohmann, J.L., Waddell, K., Livingston, S.A., Willhite, E.A., Hostetler, B.B., Ogden, C., and Dreisbach, T., 2006, DecAID, the decayed wood advisor for managing snags, partially dead trees, and down wood for biodiversity in forests of Washington and Oregon. Version 2.0. USDA Forest Service, Pacific Northwest Region and Pacific Northwest Research Station; USDI Fish and Wildlife Service, Oregon State Office; Portland, Oregon. *http://wwwnotes.fs.fed.us:81/pnw/DecAID/DecAID.nsf*

Milne, K.A., and Hejl, S.J., 1989, Nest-site characteristics of white-headed woodpeckers: Journal of Wildlife Management, v. 53, p. 50-55.

Newton, I., 1994, The role of nest sites in limiting the numbers of hole-nesting birds: Biological Conservation, v. 70. p. 265-276.

Neitro, W.A., Binkley, V.W., Cline, S.P., Mannan, R.W., Marcot, B.G., Taylor, D., and Wagner, F.F., 1985, Snags, *in*: Brown, E.R., ed., Management of wildlife and fish habitats in forests of western Oregon and Washington: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Part 1 – Chapter narratives, Publication Number R6-F&WL-192-1985, p. 129-169.

Nelson, S. K., 1988, Habitat use and densities of cavity nesting birds in the Oregon Coast Ranges: Corvallis, Oreg., Oregon State University, p. 157.

Ohmann, J.L., McComb, W.C., and Zumrawi, A.A., 1994, Snag abundance for cavity-nesting birds on nonfederal lands in Oregon and Washington: Wildlife Society Bulletin, v. 22 p. 607-620.

Ohmann, J.L., and Gregory, M.J., 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 Forest Research, v. 32, p. 725-741.

Ohmann, J.L., and Waddell, K.L., 2002, Regional patterns of dead wood in forested habitats of Oregon and Washington, *in*: Laudenslayer, W.F. Jr., Shea, P.J., Valentine, B.E., Weatherspoon, C.P., and Lisle, T.E., technical coordinators, Proceedings of the symposium on the ecology and management of dead wood in western forests: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-181, p. 535-560.

O'Neil, T.A., Johnson, D.H., Barrett, C., Trevithick, M., Bettinger, K.A., Kiilsgaard, C., Vander Heyden, M., Greda, E.L., Stinson, D., Marcot, B.G., Doran, P.J., Tank, C., Wunder, L., 2001, Matrixes for Wildlife-Habitat Relationship in Oregon and Washington, *in*: Johnson, D.H., O'Neil, T.A., (Manag. Dirs.), Wildlife-Habitat Relationships in Oregon and Washington: Corvallis, Oreg., Oregon State University Press.

Oregon Department of Fish and Wildlife, 2005, Wildlife Diversity Program: Sensitive Species List, Salem, OR. Available at *http://www.dfw.state.or.us/wildlife/diversity/index.asp. Accessed October 2006*.

Raphael, M.G., 1983, Cavity-nesting bird response to declining snags on a burned forest: a simulation model, *in*: Davis, J.W., Goodwin, G.A., and Ockenfels, R.A., eds., Snag habitat management: proceedings of the symposium: U.S. Department of Agriculture, Forest Service, General Technical Report RM-99, p. 211-215.

Raphael, M. G., and Jones, L.L.C., 1997, Characteristics of resting and denning sites of American martens in central Oregon and western Washington, *in*: G. Proulx, H.N., and Woodward, P.M., eds., Martes: taxonomy, ecology, techniques, and management: Edmonton, Alberta, Canada, Provincial Museum of Alberta, p.146-165

Rose, C.L., Marcot, B.G., Mellen, T.K., Ohmann, J.L., Wadell, K.L., Lindley, D.L., and Schreiber, B., 2001, Decaying wood in Pacific Northwest forests: concepts and tools for habitat management, *in*: Johnson, D.H., and O'Neil, T.A., Managing directors, Wildlife-habitat relationships in Oregon and Washington: Corvallis, Oreg., Oregon State University Press, p. 580-623.

Saab, V.A., and Dudley, J., 1998, Responses of cavity-nesting birds to stand-replacement fire and salvage logging in ponderosa pine/Douglas-fir forests of southwestern Idaho, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Research Paper RMRS-RP-11.

Schreiber, B., and deCalesta D.S., 1992, The relationship between cavity-nesting birds and snags on clearcuts in western Oregon: Forest Ecology and Management v. 50, p. 299-316.

Thomas, J.W., Anderson, R.G., Maser, C., and Bull, E.L., 1979, Snags, *in*: Thomas, J. W., ed., Wildlife habitats in managed forests the Blue Mountains of Oregon and Washington. U.S. Department of Agriculture, Forest Service, Agriculture Handbook No. 553, p. 60-77

U.S. Department of Agriculture, Forest Service and U.S. Department of the Interior, Bureau of Land Management, 1994, Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the range of the Northern Spotted Owl, U.S. Department of Agriculture Forest Service and U.S. Department of the Interior Bureau of Land Management.

Walankiewicz, W., 1991, Do secondary cavity-nesting birds suffer more from competition for cavities or from predation in a primeval deciduous forest?: Natural Areas Journal, v. 11, p. 203 - 212.

Weikel, J.M., and Hayes, J.P., 1999, The foraging ecology of cavity-nesting birds in young forests of the northern Coast Range of Oregon: Condor, v. 101, p. 58-66.

Welsh, H.H. Jr., and Capen, D.E., 1992, Availability of nest sites as a limit to woodpecker populations: Forest Ecology and Management, v. 48, p. 31-41.

Wilhere, G. F., 2003, Simulations of snag dynamics in an industrial Douglas-fir forest: Forest Ecology and Management, v. 174, p. 521-539.

White, D. unpublished. Guidelines for snag and down wood prescriptions in southwestern Oregon. Umpqua National Forest, Roseburg, Oreg.

Appendix A. Occurrence and status of native forest-dwelling wildlife species associated with dead wood (O'Neil et al., 2001) by western Oregon BLM District.

Compiled from Csuti et al., and data from Oregon Natural Heritage Program -ONHP). O = occurs or likely occurs (Csuti et al.1997); D = Documented; S = Suspected (from ONHP data); Blank cells = no evidence of occurrence.

Species		Oregon Status[1]	Salem	Eugene	Coos Bay	Roseburg	Medford	K-Falls
Amphibians								
Northwestern Salamander	*Ambystoma gracile*	none	O	O	O	O	O	
Long-toed Salamander	*Ambystoma macrodactylum*	none	O	O	O	O	O	O
Pacific Giant Salamander	*Dicamptodon tenebrosus*	none	O	O	O	O	O	
Larch Mountain Salamander	*Plethodon larselli*	V	S					
Dunn's Salamander	*Plethodon dunni*	none	O	O	O	O		
W. Red-backed Salamander	*Plethodon vehiculum*	none	O	O	O	O		
Del Norte Salamander	*Plethodon elongatus*	V			D	D	D	
Siskiyou Mtns. Salamander	*Plethodon stormi*	V					D	
Ensatina	*Ensatina eschscholtzii*	none	O	O	O	O	O	
Clouded Salamander	*Aneides ferreus*	U	D	D	D	D	D	
Black Salamander	*Aneides flavipunctatus*	P					D	
Or. Slender Salamander	*Batrachoseps wrighti*	U	D	D				
Cal. Slender Salamander	*Batrachoseps attenuatus*	P			D			
Reptiles								
Western Fence Lizard	*Sceloporus occidentalis*	none	O	O		O	O	O
Western Skink	*Eumeces skiltonianus*	none	O	O	O	O	O	O
Rubber Boa	*Charina bottae*	none	O	O	O	O	O	O
Sharptail Snake	*Contia tenuis*	V	S	D	D	D	D	D

Species		Oregon Status[1]	Salem	Eugene	Coos Bay	Roseburg	Medford	K-Falls
Ringneck Snake	*Diadophis punctatus*	none	O	O	O	O	O	O
Birds								
Great Blue Heron	*Ardea Herodias*	none	O	O	O	O	O	O
Turkey Vulture	*Cathartes aura*	none	O	O	O	O	O	O
Wood Duck	*Aix sponsa*	none	O	O	O	O	O	O
Harlequin Duck	*Histrionicus histrionicus*	U	D	D		D		
Common Goldeneye	*Bucephala clangula*	none						
Barrow's Goldeneye	*Bucephala islandica*	U	O	O		O		
Bufflehead	*Bucephala albeola*	U						D
Hooded Merganser	*Lophodytes cucullatus*	none	O	O	O	O	O	O
Common Merganser	*Mergus merganser*	none	O	O	O	O	O	O
Osprey	*Pandion haliaetus*	none	O	O	O	O	O	O
Bald Eagle	*Haliaeetus leucocephalus*	ST	D	D	D	D	D	D
Northern Goshawk	*Accipiter gentilis*	CR	D	D	D	D	D	D
Red-tailed Hawk	*Buteo jamaicensis*	none	O	O	O	O	O	O
Golden Eagle	*Aquila chrysaetos*	none				O	O	O
American Kestrel	*Falco sparverius*	none	O	O	O	O	O	O
Merlin	*Falco columbarius*							S
Peregrine Falcon	*Falco peregrinus*		D	D	D	D	D	D
Ruffed Grouse	*Bonasa umbellus*	none	O	O	O	O	O	O
Blue Grouse	*Dendragapus obscurus*	none	O	O	O	O	O	O
Wild Turkey	*Meleagris gallopavo*	none	O	O	O	O	O	O
Flammulated Owl	*Otus flammeolus*	CR		D		O	D	O
Western Screech-owl	*Otus kennicottii*	none	O	O	O	O	O	O
Great Horned Owl	*Bubo virginianus*	none	O	O	O	O	O	O
Northern Pygmy-owl	*Glaucidium gnoma*	CR[2]	D	O	O	O	D	O
N. Spotted Owl	*Strix occidentalis*	ST	D	D	D	D	D	D
Great Gray Owl	*Strix nebulosa*	V	S	D	S	D	D	D

Species		Oregon Status[1]	Salem	Eugene	Coos Bay	Roseburg	Medford	K-Falls
Boreal Owl	*Aegolius funereus*	U		O				
Northern Saw-whet Owl	*Aegolius acadicus*	none	O	O	O	O	O	O
Vaux's Swift	*Chaetura vauxi*	none	O	O	O	O	O	O
Lewis' Woodpecker	*Melanerpes lewis*	CR[2]	S	S	D	D	D	D
Acorn Woodpecker	*Melanerpes formicivorus*	none	S	D	D	D	D	
Red-breasted Sapsucker	*Sphyrapicus ruber*	none	O	O	O	O	O	O
Williamson's Sapsucker	*Sphyrapicus thyroideus*	U					D	D
Downy Woodpecker	*Picoides pubescens*	none	O	O	O	O	O	O
Hairy Woodpecker	*Picoides villosus*	none	O	O	O	O	O	O
White-headed Woodpecker	*Picoides albolarvatus*	CR				O	D	D
Three-toed Woodpecker	*Picoides tridactylus*	CR	D				D	S
Black-backed Woodpecker	*Picoides arcticus*	CR	D		O	O	D	D
Northern Flicker	*Colaptes auratus*	none	O	O	O	O	O	O
Pileated Woodpecker	*Dryocopus pileatus*	V	D	D	D	D	D	D
Olive-sided Flycatcher	*Contopus cooperi*	V	D	D	D	D	D	D
Pacific-slope Flycatcher	*Empidonax difficilis*	none	O	O	O	O	O	
Cordilleran Flycatcher	*Empidonax occidentalis*	none	O	O	O	O	O	O
Ash-throated Flycatcher	*Myiarchus cinerascens*	none				O	O	O
Purple Martin	*Progne subis*	CR	D	D	D	D	S	O
Tree Swallow	*Tachycineta bicolor*	none	O	O	O	O	O	O
Violet-green Swallow	*Tachycineta thalassina*	none	O	O	O	O	O	O
Black-capped Chickadee	*Poecile atricapillus*	none	O	O	O	O	O	O
Mountain Chickadee	*Poecile gambeli*	none	O	O	O	O	O	O
Chestnut-backed Chickadee	*Poecile rufescens*	none	O	O	O	O	O	O
Oak Titmouse	*Baeolophus inornatus*	none				O	O	
Juniper Titmouse	*Baeolophus ridgwayi*	none						O
Red-breasted Nuthatch	*Sitta canadensis*	none	O	O	O	O	O	O
White-	*Sitta carolinensis*	none	O	O	O	O	O	O

Species		Oregon Status[1]	Salem	Eugene	Coos Bay	Roseburg	Medford	K-Falls
breasted Nuthatch								
Pygmy Nuthatch	*Sitta pygmaea*	V[2]					D	D
Brown Creeper	*Certhia americana*	none	O	O	O	O	O	O
Bewick's Wren	*Thryomanes bewickii*	none	O	O	O	O	O	O
House Wren	*Troglodytes aedon*	none	O	O	O	O	O	O
Winter Wren	*Troglodytes troglodytes*	none	O	O	O	O	O	O
Western Bluebird	*Sialia Mexicana*	V	D	D	D	D	D	D
Mountain Bluebird	*Sialia currucoides*	none	O	O		O	O	O
Townsend's Solitaire	*Myadestes townsendii*	none	O	O	O	O	O	O
Dark-eyed Junco	*Junco hyemalis*	none	O	O	O	O	O	O
Mammals								
Montane Shrew	*Sorex monticolus*	none	O					
Baird's Shrew	*Sorex bairdi*	none	O	O	O			
Fog Shrew	*Sorex sonomae*	none	O	O	O	O	O	O
Pacific Shrew	*Sorex pacificus*	none	O	O	O	O	O	O
Water Shrew	*Sorex palustris*	none	O	O		O	O	O
Pacific Water Shrew	*Sorex bendirii*	none	O	O	O	O	O	O
Trowbridge's Shrew	*Sorex trowbridgii*	none	O	O	O	O	O	O
Shrew-mole	*Neurotrichus gibbsii*	none	O	O	O	O	O	O
Coast Mole	*Scapanus orarius*	none	O	O	O	O	O	
Mountain Beaver	*Aplodontia rufa*	none	O	O	O	O	O	O
Least Chipmunk	*Tamias minimus*	none						O
Yellow-pine Chipmunk	*Tamias amoenus*	none	?	?	O	O	O	O
Townsend's Chipmunk	*Tamias townsendii*	none	O	O	O	O	O	
Siskiyou Chipmunk	*Tamias siskiyou*	none			O		O	O
Yellow-bellied Marmot	*Marmota flaviventris*	none					O	O
Golden-mantled Ground Squirrel	*Spermophilus lateralis*	none	O	O	O	O	O	O
Douglas'	*Tamiasciurus*	none	O	O	O	O	O	O

Species		Oregon Status[1]	Salem	Eugene	Coos Bay	Roseburg	Medford	K-Falls
Squirrel	*douglasii*							
Northern Flying Squirrel	*Glaucomys sabrinus*	none	O	O	O	O	O	O
Northern Pocket Gopher	*Thomomys talpoides*	none						O
Western Harvest Mouse	*Reithrodontomys megalotis*	none					O	O
Deer Mouse	*Peromyscus maniculatus*	none	O	O	O	O	O	O
Dusky-footed Woodrat	*Neotoma fuscipes*	none	O	O	O	O	O	O
Bushy-tailed Woodrat	*Neotoma cinerea*	none	O	O	O	O	O	O
Western Red-backed Vole	*Clethrionomys californicus*	none	O	O	O	O	O	O
Creeping Vole	*Microtus oregoni*	none	O	O	O	O	O	O
Water Vole	*Microtus richardsoni*	none	O	O		O	O	O
Western Jumping Mouse	*Zapus princeps*	none				O	O	O
Pacific Jumping Mouse	*Zapus trinotatus*	none	O	O	O	O	O	O
Common Porcupine	*Erethizon dorsatum*	none	O	O	O	O	O	O
Gray Fox	*Urocyon cinereoargenteus*	none	O	O	O	O	O	O
Black Bear	*Ursus americanus*	none	O	O	O	O	O	O
Ringtail	*Bassariscus astutus*	U		S	D	D	D	S
Raccoon	*Procyon lotor*	none	O	O	O	O	O	O
American Marten	*Martes americana*	V	S	S	D	S	D	D
Fisher	*Martes pennanti pacifica*	CR		D	D		D	S
Long-tailed Weasel	*Mustela frenata*	none	O	O	O	O	O	O
Western Spotted Skunk	*Spilogale gracilis*	none	O	O	O	O	O	O
Striped Skunk	*Mephitis mephitis*	none	O	O	O	O	O	O
Northern River Otter	*Lutra Canadensis*	none	O	O	O	O	O	O
Mountain Lion	*Felis concolor*	none	O	O	O	O	O	O
Long-eared Myotis	*Myotis evotis*	U	S	D	D	D	D	D
California Myotis	*Myotis californicus*	none	S		D	D	D	D

Species		Oregon Status[1]	Salem	Eugene	Coos Bay	Roseburg	Medford	K-Falls
W. Small-footed Myotis	*Myotis ciliolabrum*	U					S	D
Yuma Myotis	*Myotis yumanensis*	none	S	D	D	D	D	D
Little Brown Myotis	*Myotis lucifugus*	none	O	O	O	O	O	O
Long-legged Myotis	*Myotis volans*	U	D	D	D	D	D	D
Fringed Myotis	*Myotis thysanodes*	V	S	S	D	D	D	D
Silver-haired Bat	*Lasionycteris noctivagans*	U	S		D	D	D	D
Big Brown Bat	*Eptesicus fuscus*	none	O	O	O	O	O	O
Hoary Bat	*Lasiurus cinereus*	none	S		D	D	D	D
Pallid Bat	*Antrozous pallidus*	V	S	S	S	D	D	D
Townsend's Big-eared Bat	*Plecotus townsendii*	CR	D	D	D	D	D	D
Pac. Western Big-eared Bat	*P. townsendii townsendii*	none		?	?			

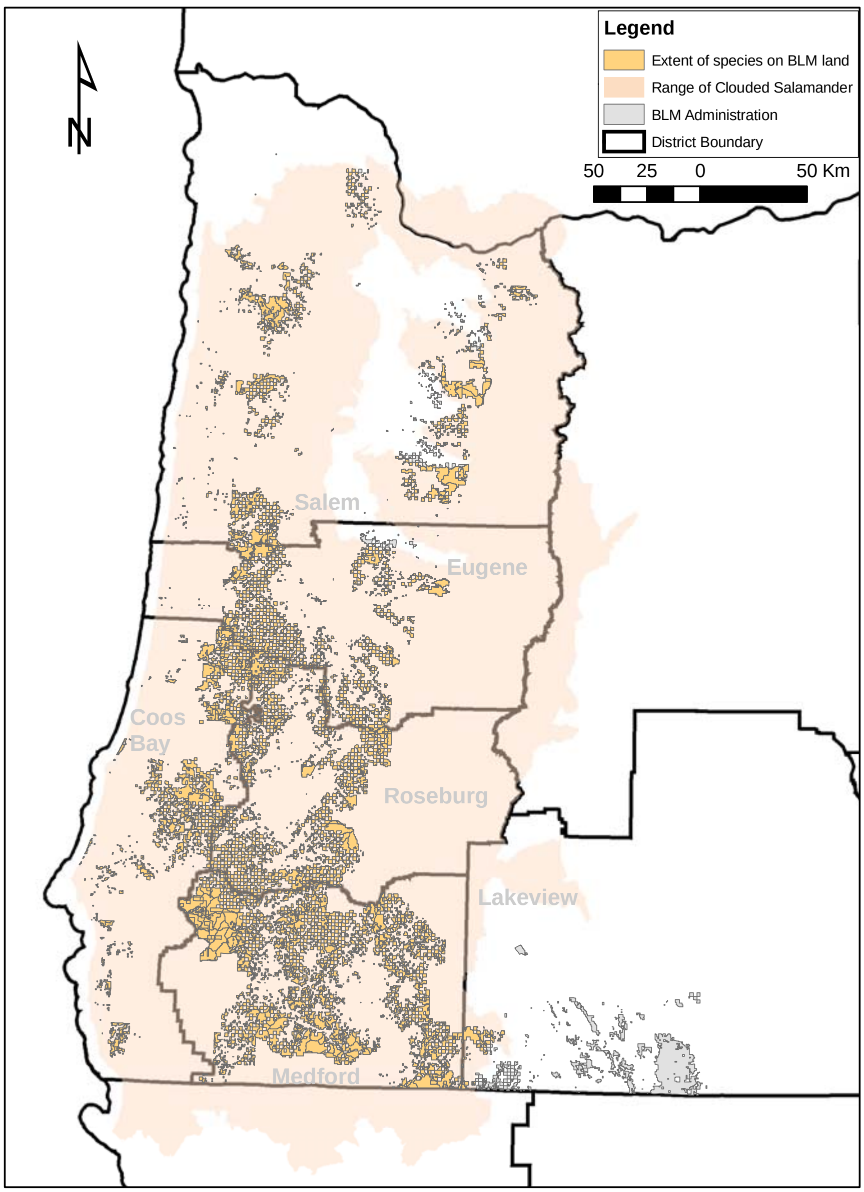
[1] SE = State Endangered; ST = State Threatened; CR = Critical; V = Vulnerable; P = Peripheral/Naturally Rare; U = Undetermined Status (Oregon Department of Fish and Wildlife 2005).

[2] Status pertains to sub-population within Oregon.

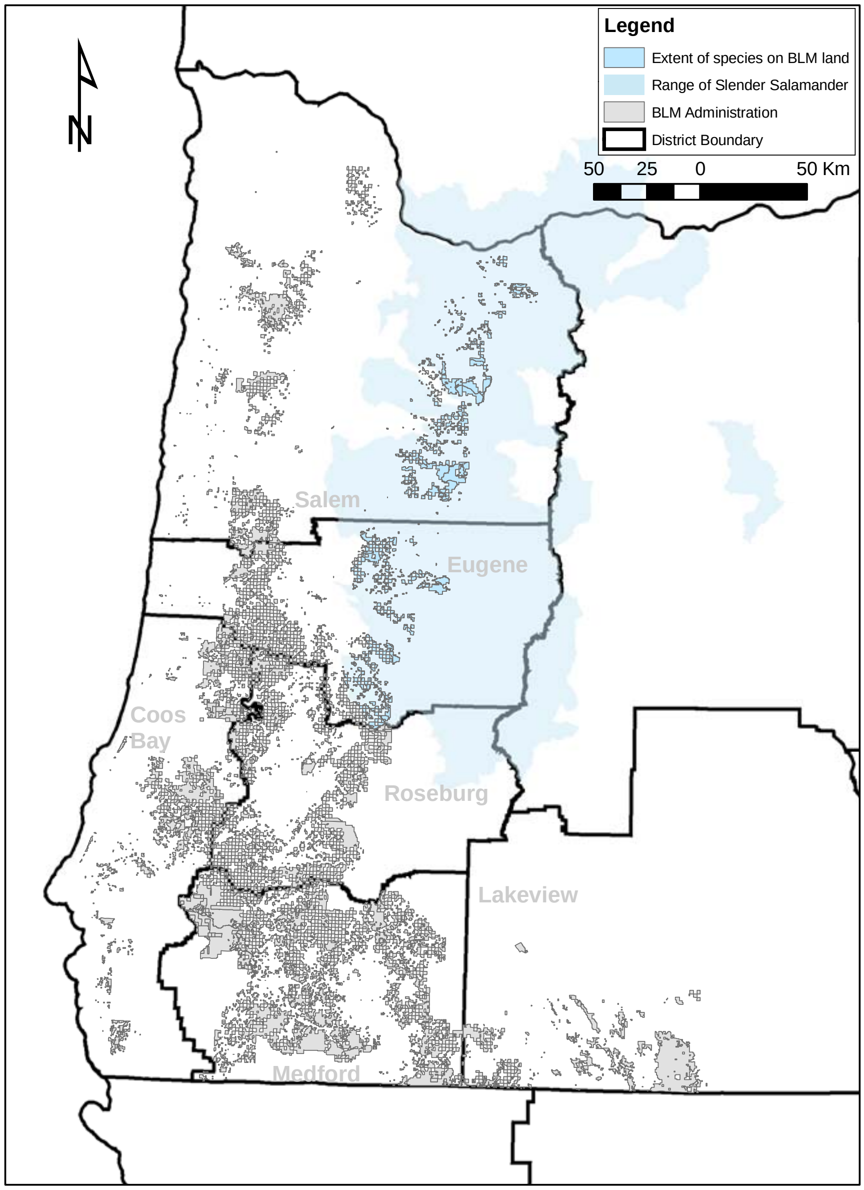
Appendix B. Geographic ranges of selected sensitive species relative to BLM ownership in western Oregon.

From Oregon Natural Heritage Program data

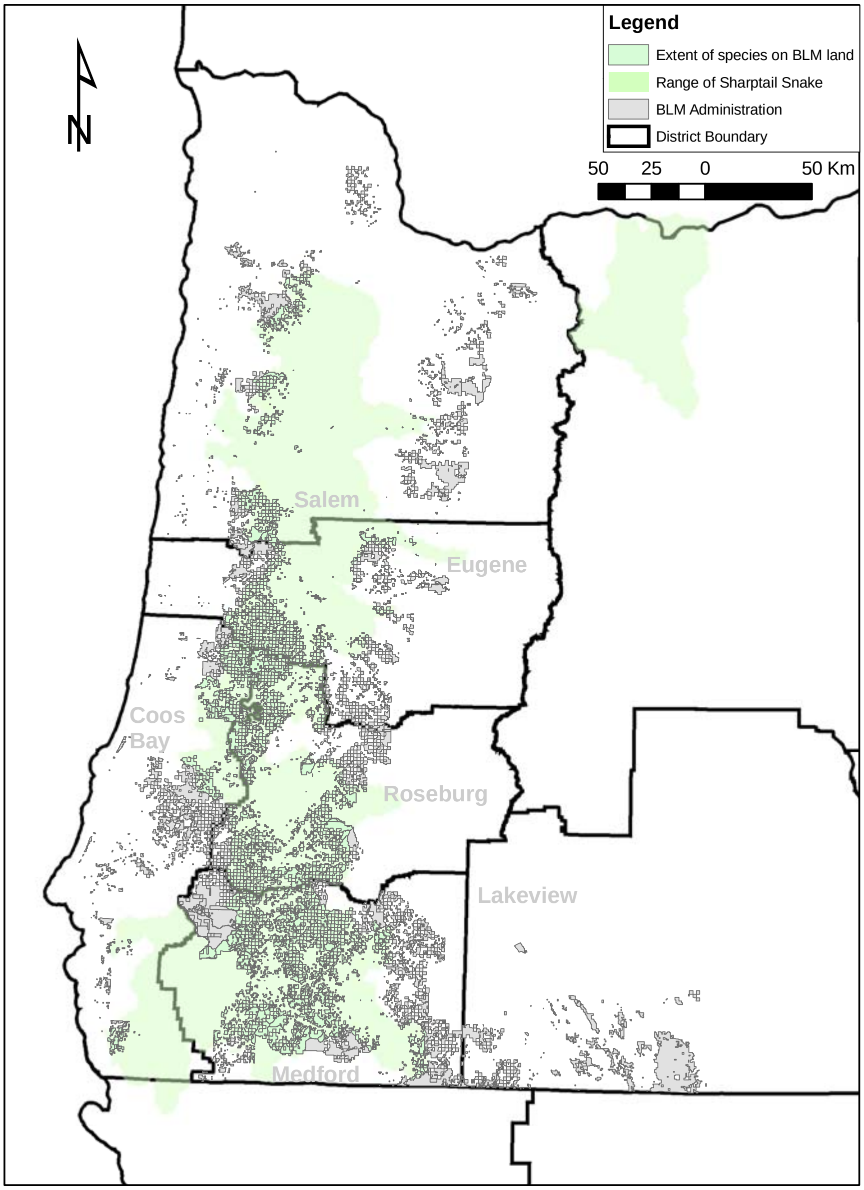
Clouded Salamander



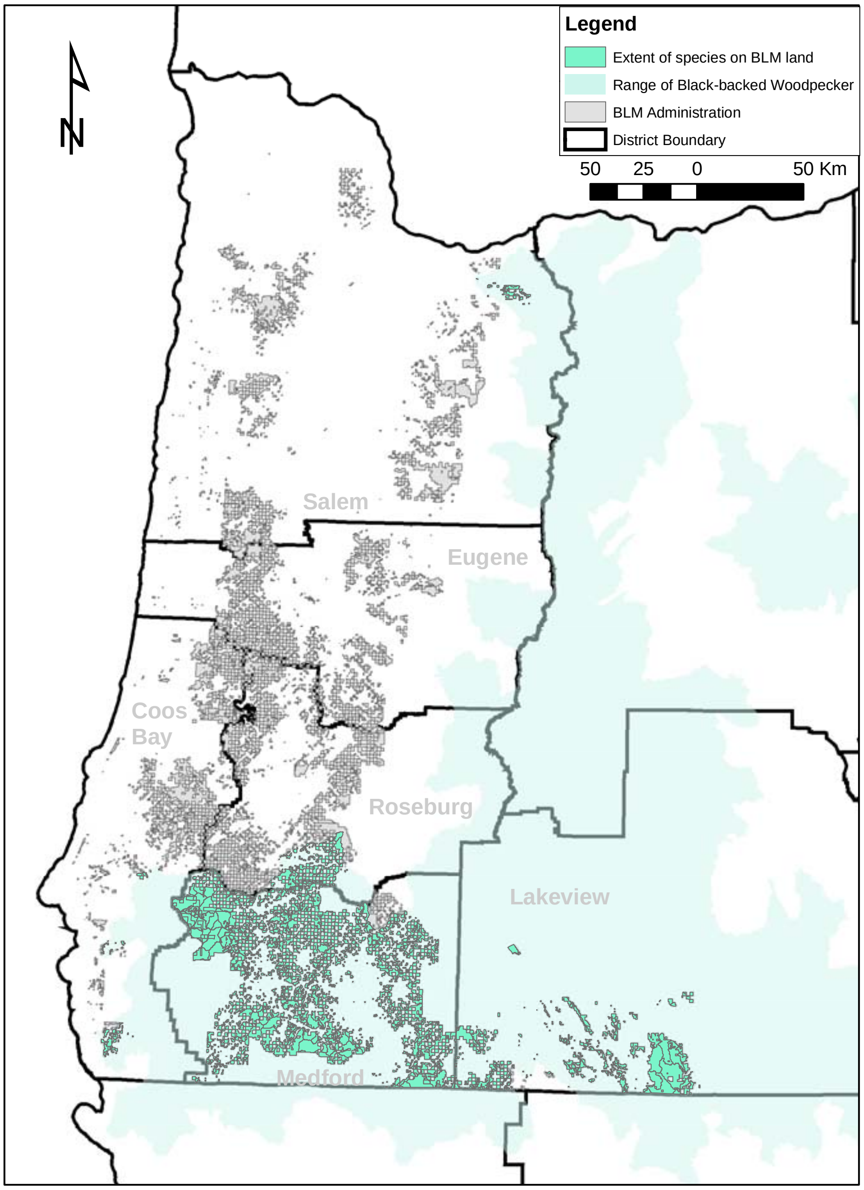
Oregon Slender Salamander



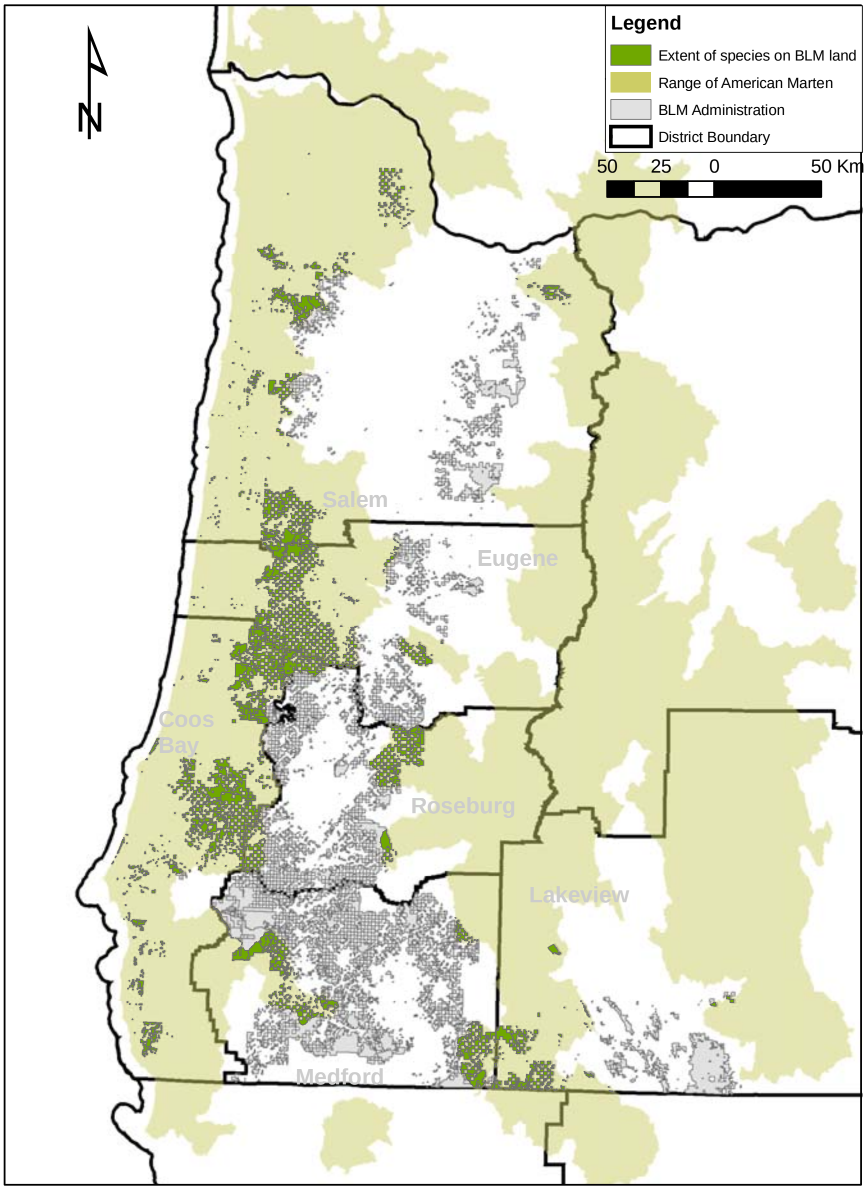
Sharptail Snake



Black-backed Woodpecker



American Marten



Fringed Myotis