Management Recommendations for Washington's Priority Habitats

Oregon White Oak Woodlands

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and John T. Morgan

January 1998

Washington Department of FISH and WILDLIFE

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Washington Department of Fish and Wildlife
600 Capitol Way N
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WASHINGTON DEPARTMENT OF FISH AND WILDLIFE
REGIONAL CONTACTS

For Assistance with PHS Information Specific to Your County, Contact the Following WDFW Representative.

If you live in...	Contact...
Asotin, Columbia, Ferry, Garfield, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	John Andrews 8702 N. Division St. Spokane, WA 99218-1199 Phone: (509) 456-4082
Adams, Chelan, Douglas, Grant, Okanogan	Tracy Lloyd 1550 Alder St. NW Ephrata, WA 98823-9699 Phone: (509) 754-4624
Benton, Franklin, Kittitas, Yakima	Ted Clausing 1701 24th Ave. Yakima, WA 98902-5720 Phone: (509) 575-2740
Island, King, San Juan, Skagit, Snohomish, Whatcom	Ted Muller 16018 Mill Creek Blvd. Mill Creek, WA 98012-1296 Phone: (206) 775-1311
Clark, Cowlitz, Klickitat, Lewis, Skamania, Wahkiakum	Bryan Cowan 2108 Grand Blvd. Vancouver WA 98661 Phone: (360) 696-6211
Clallam, Grays Harbor, Jefferson, Kitsap, Mason, Pacific, Pierce, Thurston	Steve Keller 48 Devonshire Rd. Montesano, WA 98563-9618 Phone: (360) 249-4628

EXECUTIVE SUMMARY

Oregon white oak (*Quercus garryana*) is Washington's only native oak. Although limited and declining, oaks and their associated floras comprise distinct woodland ecosystems. The various plant communities and stand age mixtures within oak forests provide valuable habitat that contributes to wildlife diversity statewide. In conjunction with other forest types, oak woodlands provide a mix of feeding, resting, and breeding habitat for many wildlife species. More than 200 vertebrate and a profusion of invertebrate species use Washington's oak woodlands. Some species occur in especially high densities, whereas others are not typically found in Washington. Oaks provide habitat for species that are state listed as Sensitive, Threatened, Endangered, or candidates for these listings.

Oregon white oaks occur within the Puget Trough, Washington's south-central counties, along the Columbia Gorge, and northward along the east side of the Cascade range. Some small stands and relict groves can be found in the San Juan Islands, along Hood Canal, and in the Willapa Hills. Oregon white oaks are generally restricted to lower elevations, drier areas, and areas with historically limited conifer competition. West of the Cascades, oaks are found within the Western Hemlock Forest Zone and often occupy the narrow sub-zone between prairies and conifer forests. East of the Cascades, oaks are found within the Ponderosa Pine Forest Zone and occupy the transition zone between conifers and shrub-steppe. The Columbia Gorge is a transitional area where a mixture of east and west forest plant constituents can be found. Oregon white oaks tolerate an array of soil types but flourish in the deep loams of southwestern Washington. This tree species reproduces by seed and sprout.

Priority Oregon white oak woodlands are stands of pure oak or oak/conifer associations where canopy coverage of the oak component of the stand is $\geq$25%; or where total canopy coverage of the stand is <25%, but oak accounts for at least 50% of the canopy coverage present. The latter is often referred to as an oak savanna. In non-urbanized areas west of the Cascades, priority oak habitat is stands $\geq$0.4 ha (1 ac) in size. East of the Cascades, priority oak habitat is stands $\geq$2 ha (5 ac) in size. In urban or urbanizing areas, single oaks, or stands of oaks <0.4 ha (1 ac), may also be considered priority habitat when found to be particularly valuable to fish and wildlife (i.e., they contain many cavities, have a large diameter at breast height [dbh], are used by priority species, or have a large canopy).

Oregon white oak woodlands are used by an abundance of mammals, birds, reptiles, and amphibians. Many invertebrates, including various moths, butterflies, gall wasps, and spiders, are found exclusively in association with this oak species. Oak/conifer associations provide contiguous aerial pathways for animals such as the State Threatened western gray squirrel, and they provide important roosting, nesting, and feeding habitat for wild turkeys and other birds and mammals. Dead oaks and dead portions of live oaks harbor insect populations and provide nesting cavities. Acorns, oak leaves, fungi, and insects provide food. Some birds, such as the Nashville warbler, exhibit unusually high breeding densities in oak. Oaks in Washington may play a critical

role in the conservation of neotropical migrant birds that migrate through, or nest in, Oregon white oak woodlands.

The decline of Oregon white oak woodlands has been accelerated by human activities --primarily oak removal. Conifer encroachment is a significant threat to remaining oaks, particularly on the west side of the Cascades and in portions of the Columbia Gorge, and is aggravated by urban development, fire suppression, timber conversion, and cattle grazing. Grazing is a primary use of oak woodlands and reduces species richness of ground cover, increases soil moisture, compacts soils, and disturbs sod, all of which may promote conifer growth and encroachment west of the Cascades. East of the Cascades, these pressures may also affect oak woodlands. In addition, the selective harvest of east-side conifers is detrimental to those wildlife species that depend on mixed oak/conifer associations. Fire suppression has also contributed to the decline of Oregon white oak woodlands. Natural fires and those intentionally set by Native Americans historically played a paramount role in oak forest ecology, especially natural oak regeneration. Frequent low-intensity fires curbed conifer encroachment, controlled stand density, and initiated oak sprouting. Today, managed burning can help restore degraded oak habitat.

Management recommendations are designed to maintain and enhance the integrity of Oregon white oak woodlands, reverse the trend of oak habitat loss, and promote the protection of oak habitat that is presently in good condition. Oaks west of the Cascades and in wetter sites along the Columbia Gorge should be cut only for stand enhancement. Replacing the wholesale removal of mixed oak/conifer stands with selective cutting would reduce fragmentation and conifer encroachment, and it would benefit structural and vegetative species diversity within oak forests. Encroaching conifers within oak groves should be thinned, and conifers adjacent to these stands should be retained for wildlife. An alternative to removing trees is to leave them standing as snags. East of the Cascades, the drier climate generally inhibits conifer growth. Conifers in this region's oak stands typically are limited and should be retained with the oaks because conifers contribute to the declining oak/pine habitat type.

Specific recommendations include the following:

- Do not cut Oregon white oak woodlands except for habitat enhancement.
- Allow only early spring, low-impact cattle grazing.
- Allow low-impact recreation (hunting, fishing, hiking, mushroom and acorn collecting).
- Selectively harvest individual oaks to improve stand age-class and structural diversity.
- Thin encroaching conifers in oak woodlands west of the Cascades and along the Columbia Gorge; do not remove conifers from mixed stands east of the Cascades.
- Retain large, dominant oaks and standing dead and dying trees.
- Create snags when thinning oaks or conifers instead of removing trees.
- Leave fallen trees, limbs, and leaf litter for foraging, nesting, and denning sites.
- Retain contiguous aerial pathways.
- Conduct prescribed burns where appropriate.

Other oak enhancement activities include the following:

- Planting Oregon white oak acorns and seedlings.
- Using alternatives to oak fuelwood.
- Selling or donating oak woodlands to conservation and land trust organizations.
- Purchasing contiguous or notable stands of oaks by local, state, and federal agencies.
- Moving toward the elimination of grazing on state-owned oak woodlands.
- Designating large, contiguous oak and oak/conifer stands as critical areas.
- Encouraging aggressive oak enhancement/regeneration measures by local, state, and federal agencies.

INTRODUCTION

Fish and wildlife are public resources. Although the Washington Department of Fish and Wildlife (WDFW) is charged with protecting and perpetuating fish and wildlife species, the agency has very limited authority over the habitat on which animals depend. Instead, protection of Washington's fish and wildlife resources is currently achieved through voluntary actions of landowners and through the State Environmental Policy Act (SEPA), Growth Management Act (GMA), Forest Practices Act (FPA), Shoreline Management Act (SMA), and similar planning processes that primarily involve city and county governments. Landowners, agencies, governments, and members of the public have a shared responsibility to protect and maintain fish and wildlife resources for present and future generations; the information contained in this document is intended to assist all entities in this endeavor.

The Washington Department of Fish and Wildlife has identified those fish and wildlife resources that are a priority for management and conservation. Priority habitats are those habitat types with unique or significant value to many fish or wildlife species. Priority species are those fish and wildlife species requiring special efforts to ensure their perpetuation because of their low numbers, sensitivity to habitat alteration, tendency to form vulnerable aggregations, or because they are of commercial, recreational, or tribal importance. Descriptions of those habitats and species designated as priority are published in the Priority Habitats and Species (PHS) List (Wash. Dept. Fish and Wildl. 1996).

PHS Management Recommendations

The Department has developed management recommendations for Washington's priority habitats and species to provide planners, elected officials, landowners, and citizens with comprehensive information on important fish, wildlife, and habitat resources. These management recommendations are designed to assist in making land use decisions that incorporate the needs of fish and wildlife. Considering the needs of fish and wildlife can help prevent species from becoming extinct or increasingly threatened and may contribute to the recovery of species already imperiled.

Agency biologists develop management recommendations for Washington's priority habitats and species through a comprehensive review and synthesis of the best scientific information available. Sources include professional journals and publications, symposia, reference books, and personal communications with professionals on specific habitats or species. Management recommendations are reviewed within the Department and by other resource professionals and potential users of the information. The recommendations may be revised if scientists learn more regarding a priority habitat or priority species.

It is expected that these management recommendations will contribute to the scientific component of planning, protection, and restoration efforts for fish and wildlife. These efforts include local

comprehensive plans and critical areas regulations, habitat conservation plans, individual landowner farm and forest plans, and cooperative restoration projects. These recommendations may provide a baseline for WDFW participation in other planning processes that address oak management strategies; however, WDFW will defer to negotiated agreements regarding oak management that may result from our participation in those planning processes.

Because PHS management recommendations address fish and wildlife resources statewide, they are generalized. Management recommendations are not intended as specific prescriptions but as guidelines for planning. Because natural systems are inherently complex and because human activities have added to that complexity, management recommendations may have to be modified for on-the-ground implementation. Modifications to management recommendations should strive to retain or restore characteristics needed by fish and wildlife. Consultation with fish and wildlife professionals is recommended when modifications are being considered.

Habitat management recommendations are directed at maintaining and enhancing habitat needed for a wide array of species. Although the management recommendations attempt to incorporate general requirements of most individual species, particular species with special needs are not covered in detail. Management recommendations for these particular species have been written in separate documents for each species. If differences exist in the documents, then the most protective recommendation should be implemented.

The locations of priority habitats and species are mapped statewide. These maps represent WDFW's best knowledge of Washington State's fish and wildlife resources based on research and field surveys conducted over the past 20 years. Management recommendations should be used whenever priority habitats and species occur in a particular area whether or not the WDFW maps show that occurrence. These maps can be used for initial assessment of fish and wildlife resources in an area, but they should also be supplemented with a field survey or local knowledge to determine the presence of priority habitats or priority species. The PHS data shows WDFW's knowledge of important fish and wildlife resources but cannot show the absence of these resources. In summary, management recommendations for Washington's priority habitats and species...

Are:	Are not:
Guidelines	Regulations
Generalized	Site specific
Updated with new information	Static
Based on fish and wildlife needs	Based on other land use objectives
To be used for all occurrences	To be used only for mapped occurrences

Goals

Management recommendations for Washington's priority habitats and species are guidelines based on the best available scientific information and are designed to meet the following goals:

- Maintain or enhance the structural attributes and ecological functions of habitat needed to support healthy populations of fish and wildlife.
- Maintain or enhance populations of priority species within their present and/or historical range in order to prevent future declines.
- Restore species that have experienced significant declines.

Format

Management recommendations for each priority habitat are written in six sections:

DEFINITION	Explains those parameters that make a habitat type a priority in terms of biota, extent, structure, and function.
RATIONALE	Outlines the basis for designating the habitat as priority.
DISTRIBUTION	Summarizes information on the geographic extent of the habitat in Washington.
HABITAT DESCRIPTION	Delineates and characterizes plant communities and related abiotic factors, habitat structure and function, and topography; describes statewide habitat variation.
FISH AND WILDLIFE USE	Describes fish and wildlife use of the habitat; identifies factors that limit use of the habitat.
IMPACTS OF LAND USE	Identifies past and present land uses or practices that affect fish and wildlife use of the habitat.
MANAGEMENT RECOMMENDATIONS	Provides management guidelines based on a synthesis of the best available scientific information.

Management recommendations for Washington's priority habitats and species are intended to be used in conjunction with mapped and digital data which display important fish, wildlife, and habitat occurrences statewide. Data can be obtained by calling the PHS Data Request Line at (360) 902-2543. Questions and requests for additional PHS information may be directed to:

Priority Habitats and Species
WDFW Habitat Program
600 Capitol Way N
Olympia, WA 98501-1091

DEFINITION

Priority Oregon white oak (*Quercus garryana*) woodlands consist of stands of pure oak or oak/conifer associations where canopy coverage of the oak component of the stand is ≥25%; or where total canopy coverage of the stand is <25%, but oak accounts for at least 50% of the canopy coverage present. The latter is often referred to as an oak savanna. In non-urbanized areas west of the Cascades, priority oak habitat consists of stands ≥0.4 ha (1 ac) in size. East of the Cascades, priority oak habitat consists of stands ≥2 ha (5 ac) in size. In urban or urbanizing areas, single oaks, or stands of oaks <0.4 ha (1 ac), may also be considered a priority when found to be particularly valuable to fish and wildlife (i.e., they contain many cavities, have a large diameter at breast height [dbh], are used by priority species, or have a large canopy).

RATIONALE

Oregon white oak woodlands provide rare and variable habitat and comprise a distinct ecosystem that contributes significantly to the diversity of wildlife found in Washington (Connel et al. 1973, Jackman 1975, Manuwal 1989, Tweit and Johnson 1992).

Approximately 200 species of birds, mammals, reptiles, and amphibians use Washington oak forest habitat to some degree[1] (scientific and common names of plants and animals mentioned in the text are listed in Appendix A). Oak woodlands in Washington provide habitat for species that are state listed as Threatened or Endangered, or are candidates under consideration for state listing as Sensitive, Threatened, or Endangered (Rodrick and Milner 1991; Larsen et al. 1995, 1997). Oak stands along the Klickitat River harbor some wildlife species not normally found in Washington

[1]Sources: Beal, 1910, 1911; Steinecker and Browning 1970; Steinecker 1977; Chappell 1979; Knight 1979; Thomas et al. 1979; Menke and Fry 1980; Voeks 1981; Koenig and Heck 1988; Manuwal 1989; Kessler 1990; Riggle 1991; Macklin and Thompson 1992; Leonard et al. 1993; Andelman and Stock 1994; Storm and Leonard 1995; Wash. Dept. Fish and Wildl. 1997; and K. McAlister, D. Morrison, S. Pozzanghera, G. Schirato, L. Stream, D. Ware, B. Weiler, and M. Whalen, pers. comm.

(e.g., acorn woodpecker; Beal 1911, Tweit and Johnson 1992) and support unusually dense populations of other species (e.g., Nashville warbler; Manuwal 1989).

The decay characteristics of Oregon white oak are ideal for cavity-nesting species (Jackman 1975), and leaves and acorns provide a primary source of nutrition for an array of animal types (Christisen and Korschgen 1955, U.S. For. Serv. 1969, Miller 1985). Invertebrates that use Washington oak forests include moths, wasps, spiders, and butterflies (Appendix B). Some of these species are far more likely to be found within oaks, and invertebrate animals comprise the only known group of oak-obligate species[2] (Pyle 1989; L. Crabo, pers. comm.; R. Crawford, pers. comm.).

Oregon white oak habitat in Washington is declining and occurs in a limited distribution (Taylor and Boss 1975, Kertis 1986). The remaining Washington stands tend to be small, fragmented or isolated, and many have been degraded (Kertis 1986). Oregon white oak woodlands are recognized as an important element of the natural and cultural histories of Washington State; they provide aesthetic, economic, and recreational value to the citizens of Washington, and they are vital to many of the animals that inhabit them (State of Washington, Senate Resolution 1991-8654)

DISTRIBUTION

Oregon white oak occurs from south-central California northward to southwest British Columbia (U.S. For. Serv. 1965, Taylor and Boss 1975, Franklin and Dyrness).

Historically, the distribution of Oregon white oaks in Washington was more extensive than today (Detling 1968, Taylor and Boss 1975). Oaks originally became established in Washington during the madro-tertiary period (Detling 1968). This warm and dry period peaked about 6,000 years ago, and with those favorable conditions oaks and associated flora reached their greatest distribution in the state. The subsequent trend toward cooler and moister climatic conditions has favored conifer establishment and has probably contributed to the diminished extent of Oregon white oak today (Hansen 1947). The current distribution of Oregon white oak woodlands in Washington is limited primarily to the

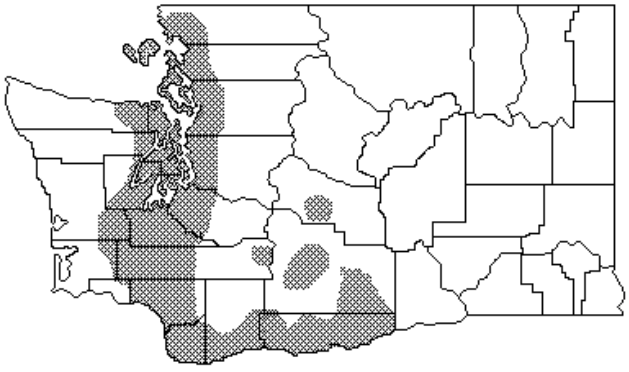

Figure 1. Range of Oregon white oak woodlands in Washington. Map derived from WDFW data files and the literature.

[2]Oak-obligate species are those that are dependent on oak for some portion of their life cycle.

Puget Trough, Washington's south-central counties, along the Columbia Gorge, and northward along the east side of the Cascade Range (Scheffer 1959, Stein 1980, Miller 1985) (Fig. 1). Some small stands and relict groves can be found in the San Juan Islands, the Willapa Hills, along the Hood Canal, and along the fringes of its current boundaries (Taylor and Boss 1975; C. Maxwell, pers. comm.). Within this limited range, oak woodlands are considered uncommon. In Washington, a shrub-like race of Oregon white oak exists on the shores and islands of Puget Sound (U.S. For. Serv. 1965).

HABITAT DESCRIPTION

Oregon white oak, also known as Garry oak, is the only native oak in Washington (Scheffer 1959, Miller 1985, Kertis 1986). It is an element of several different plant community types within its range and often occupies a narrow sub-zone between prairies and conifer forests (Sprague and Hansen 1946). It is found in open savannas, in pure stands, and intermixed with conifers and other deciduous trees, but it is usually confined to drier microsites within conifer zones (Stein 1980). Oregon white oak occupies locations where soil moisture is between that supporting grasses or ponderosa pine (dry or xeric sites) and that supporting Douglas-fir (moist or mesic sites) (U.S. For. Serv. 1965). Oregon white oak can occasionally be found in wetlands; however, this is probably due to water encroachment more recent than the origination of the stand (J. Macklin, pers. comm.).

Climate

In Washington, oak stands occur within the 63-102 cm (25-40 in) rainfall zone. Most important is a 10-25 cm (4-10 in) rainfall parameter during the growing season that occurs between April and September. Stands that receive more than 25 cm (10 in) of rainfall during the growing season typically encounter greater competition from faster growing coniferous tree species (Sprague and Hansen 1946, U.S. For. Serv. 1965, Taylor and Boss 1975, Franklin and Dyrness 1988).

Soil

Oregon white oak is tolerant of a broad array of soil types. It is frequently found in well-drained, gravelly soils (Taylor and Boss 1975, Stein 1990), but in the Pacific Northwest it reaches optimum development in the deep loams of southwestern Washington and the Willamette Valley in Oregon (Silen 1958, Kertis 1986). This species occasionally occurs on heavy clays (U.S. For. Serv. 1965).

Vegetation Communities

Because of their unique distribution in Washington, Oregon white oaks occur in association with a variety of vegetative communities and often represent a distinct ecotone. They are found within dense hardwood stands, as open savannas, and as a component of oak/conifer mixed communities.

In the moist, Douglas-fir dominated Puget Trough, Oregon white oaks are associated with sub-zones between prairie and conifer forest. Along the eastern Cascade slope, these oaks occupy the transition zone between conifers and shrub-steppe that occurs within the drier ponderosa pine region (Voeks 1981). The Columbia Gorge is a transitional area and can have characteristics similar to either side of the Cascades. Here, oaks may occur with Douglas-fir or ponderosa pine depending on the specific site.

Because Oregon white oaks are distributed in the transition zone between wet and dry extremes, a gradient of vegetation communities can be expected. In its western range and on wetter, western slopes, the associated vegetation may mimic that of nearby conifer forests where a well-developed shrub understory and a less-developed herbaceous layer are present. Eastern- or southern-facing slopes, and those areas east of the Cascades or in rain shadows, will typically exhibit less shrub understory and sometimes possess dense, herbaceous, or grassy ground cover.

Tree Constituents

West of the Cascades, Oregon white oaks are found within the Western Hemlock Forest Zone where typical tree associations include Douglas-fir, bigleaf maple, Pacific dogwood, and Oregon ash. In drier areas or areas with poor soils, oaks also may be found with Pacific madrone and ponderosa pine. East of the Cascades, oaks are found in the Ponderosa Pine and Interior Douglas-fir Forest Zones. Common associates in this drier region include Pacific madrone, black cottonwood, quaking aspen, and ponderosa pine (Silen 1958, Thilenius 1968, Kertis 1986, Franklin and Dyrness 1988, Riggle 1991).

Understory Shrubs

In the western portion of the Oregon white oak range in Washington, typical woodland understory shrub associates include ocean spray, oval-leaf viburnum, California hazelnut, serviceberry, common snowberry, wild blackberry, Indian plum, poison oak, tall Oregon grape, and scotch broom (Taylor and Boss 1975; Kertis 1986; Caicco 1989; Kessler 1990; C. Chappell, pers. comm.). Within the eastern portion of the range, poison oak, bitterbrush, and big sagebrush are common shrub constituents (Taylor and Boss 1975, Alverson 1988, Riggle 1991).

Grasses and Forbs

Large numbers of forbs and grasses are associated with oak woodlands, and many of these are dry-site species that are also associated with adjacent grasslands. Forbs found may include western bittercress, American vetch, western wood strawberry, spring beauty, chickweed, balsamroot, and lupine (Kertis 1986, Alverson 1988, Kessler 1990). Some grasses found are velvet grass, bluebunch wheatgrass, long-stoloned sedge, red fescue, Idaho fescue, western ryegrass, orchard grass, and Kentucky bluegrass (Kertis 1986; Riggle 1991; C. Chappell, pers. comm.). Cheatgrass and other non-native weed species are commonly present, especially in disturbed and grazed areas (Taylor and Boss 1975).

Oak Reproduction

Oregon white oaks successfully reproduce by both seed and sprout, although natural regeneration by sprouting appears to more prevalent (Reed and Sugihara 1987, Sugihara and Reed 1987). Sprouts have a competitive advantage over seedlings because they are nourished by existing root systems (Gumtow-Farrior and Gumtow-Farrior 1994). Because acorns are a heavy seed, they do not naturally disperse far from their parent tree. Seed caching and dispersal by animals such as Douglas' squirrel, Lewis' woodpecker, and Steller's jay are probably the major long-distance dissemination mechanisms in Washington (Silen 1958, Barrett 1980, Voeks 1981).

Acorns are used by insect larvae and are often eaten by birds and mammals before germination can occur (Connel et al. 1973, Coblentz 1980, Kertis 1986, Koenig and Heck 1988). Other naturally-occurring factors that cause mortality in sprouting oaks include browsing, trampling, fire, and competition from other plants (Silen 1958, Kertis 1986).

WILDLIFE USE

The diversity of wildlife species found in Washington oak habitat is closely linked to the geographic, floristic, and structural diversity present within Oregon white oak woodlands. Differences in associated plant communities, stand structure, and mixtures of age classes offer habitat variations for feeding, breeding, resting, and shelter.

Oak Features Important to Wildlife

Wildlife use of Oregon white oak woodlands is dependent on structural and spatial conditions. Open-canopy stands of oak generally have more complex plant understories than closed-canopy stands and can, therefore, support more wildlife species. Oak snags and dead portions of live trees harbor insect populations and provide nesting cavities and perches for birds and mammals. Acorns

(mast) as well as leaves, fungi, and insects provide food. Oak/conifer associations provide contiguous aerial pathways for squirrels and other animals.

Oak as a Source of Cavities

Many wildlife species use cavities for nesting, resting, and escape from inclement weather and predators (Barrett 1980, Manuwal 1989, Gumtow-Farrior and Gumtow-Farrior 1994). Cavities can develop in dead trees (snags), dead portions of live trees, and sound live trees. Non-excavated cavities develop in live trees after decay-causing organisms infect a wound, such as a broken bole or branch, and the tree grows around the wound to contain the decay (Gumtow-Farrior and Gumtow-Farrior 1994). Excavated cavities, typically formed in dead trees or weakened portions of live trees, are created by the active removal of wood fiber by birds. Only a few bird species (primary cavity users) are capable of creating cavities, but many species (secondary cavity users) use pre-formed cavities.

A number of natural pressures can weaken portions of an oak or cause them to perish, thus providing better opportunities for primary excavators to produce cavities. Some trees succumb to defoliating insects or insects that attack by creating galls between the tree's bark and wood (U.S. For. Serv. 1965). Recent insect blights have occurred in Klickitat County where already drought-stressed trees have succumbed (B. Weiler, pers. comm.).

Thirty-one species of fungi also affect Oregon white oak. Some inhibit growth, and others kill trees. The major decay fungi are shoestring root rot (*Amillaria mellea*) and trunk rot (*Polyporus dryophilus*) (U.S. For. Serv. 1965). Decomposing fungi, coupled with the rotting characteristics of this oak species, simplify the excavation of cavities for woodpeckers by softening wood (Jackman 1975). The process is often facilitated by the loss of limbs that expose heartwood (Gumtow-Farrior 1991).

Oak as a Food Source

The quantity and quality of food available to an animal influence its activities, health, and ability to reproduce (Christisen and Korschgen 1955). Woodpeckers forage heavily for insects on the trunks, branches, and twigs of oaks (Jackman 1975). Oak mast (acorns) and foliage constitute a significant percentage of the diet of many birds, mammals, and invertebrates (Voeks 1981; Miller 1985; Pyle 1989; L. Crabo, pers. comm.; R. Crawford, pers. comm.), and it is possible that acorns influence more wildlife species than any other single kind of natural food (Christisen and Korschgen 1955, U.S. For. Serv. 1969). Christisen and Korschgen (1955) reported that as many as 186 species of birds and mammals use oak species as a food source. This number exceeds that recorded for any other genus of woody plants, with the possible exception of *Rubus* (various berry species).

Leaves. The leaves of Oregon white oak are browsed by deer and elk. Oak leaves may be a significant food source at times because they possess a protein content nearly equal to that of alfalfa (Miller 1985). Oak woodlands, which provide food sources for deer and other animals, also support predator populations. Mountain lions, for instance, are dependent to some degree on deer for food. Therefore, those oak woodlands that contribute to a healthy deer population also may contribute to a healthy lion population (Barrett 1980). During larval stages, some invertebrates (oak-obligates) rely exclusively on the leaves of Oregon white oak (Pyle 1989; L. Crabo, pers. comm.; R. Crawford, pers. comm.).

Acorns. Acorn production by Oregon white oaks is sporadic. These oaks produce significant crops of acorns every few years, but reasons to explain the periodicity of acorn production are not known (Silen 1958). In production years, acorns develop through the growing season and mature seeds fall in September or October (U.S. For. Serv. 1965).

In California, approximately 45 wildlife species consume acorns, including woodpeckers, band-tailed pigeons, Steller's jays, raccoons, and ground squirrels (Connel et al. 1973). In Virginia and Missouri, acorns proved to be a significant staple for wild turkeys, wood ducks, mallards, raccoons, and skunks (Christisen and Korschgen 1955). Oregon consumers of acorns include western gray squirrel, Douglas' squirrel, black bear, and Lewis' woodpecker (Voeks 1981). All of these acorn consumers are found within or near Washington's oak woodlands.

In a study among Oregon white oak stands near Corvallis, Oregon, Coblentz (1976) found that acorns comprised 9-93% by weight of the stomach contents of 4 black-tailed deer collected. Overall consumption of acorns by small mammals was also high. Sixty-one percent of the acorns in experimental savanna enclosures, and 96% from closed canopy forest enclosures, were consumed by small mammals.

In California, acorns comprise over 50% of the diet of acorn woodpeckers and are critical to overwinter survival and subsequent spring breeding (Koenig and Heck 1988). Acorn woodpeckers are considered rare in Washington and are known to occur only near Lyle, Klickitat County (Beal 1911, Tweit and Johnson 1992). The scrub jay, more common to Klickitat County, also commonly uses acorns and can be considered dependent on acorn production (Beal 1910).

Oak-Associated Wildlife Species and Species Groups

Oak forests in Washington harbor many kinds of animals. Many of these are so highly associated with oak woodlands that they have been used to help shape specific restoration goals of Oregon white oak in south Puget Sound (Hanna and Dunn 1996).

Woodpeckers

Woodpeckers are vital to the diversity of wildlife in oak woodlands because they are primary excavators and provide cavities for nesting species that do not bore their own nest holes. Evidence suggests that the density of cavity-nesting species is linked closely to the number of cavities available. This, in turn, has been shown to be directly related to the number of snags available to cavity excavators (Jackman 1975) and/or the density of live, large-diameter, open-formed oaks (Gumtow-Farrior 1991). Not all snags or live trees are useable by woodpeckers (Jackman 1975), and different species of woodpeckers may require trees of varying diameters (Conner et al. 1975). Therefore, an abundance of quality snags and live trees of varying size and age class are needed to ensure suitable quantities for nesting and feeding.

Oak trees with heart rot not only provide cavities for nests, but suitable habitat for carpenter ants and other insects as well. Insects, especially ants, are primary food items of woodpeckers (Connor et al. 1975). Pileated woodpeckers, for instance, are highly skilled at locating trees that harbor large numbers of insects and so require a constant supply of new snags for food resources (Jackman 1975).

Western Gray Squirrel

A close correlation exists between the distribution of the western gray squirrel, a State Threatened species, and Oregon white oak habitat in Washington (Wash. Dept. Wildl. 1993). This co-occurrence is expected because acorns are a critical winter food item for this rare squirrel throughout most of its range.

Like oaks in Washington, western gray squirrels were probably more widely distributed in prehistoric times, and their decline parallels that of the Oregon white oak. However, it should be noted that the decline of this squirrel species is also attributed to factors not related to the Oregon white oak (Wash. Dept. Wildl. 1993). Declines of western gray squirrel populations in Yakima County and the Columbia Gorge area coincided with the invasion and increase in the number of California ground squirrels. It is suspected that the ground squirrels transferred mange to the western gray squirrels, decimating their populations (Wash. Dept. Wildl. 1993). Also, other squirrels and even woodpeckers are more aggressive than western gray squirrels and out-compete them for food and cavity nests in Oregon white oak woodlands (Cross 1969, Barnum 1975, Foster 1992). In the Puget Trough area, western gray squirrels seem to have been displaced by increasing human populations (Wash. Dept. Wildl. 1993). Eastern gray squirrels, which are more tolerant of humans and can more easily adapt to alternative food sources (Byrne 1979), have invaded urbanizing areas within western gray squirrel range (Wash. Dept. Wildl. 1993).

Neotropical Migrant Birds

Oregon white oak woodlands have been identified as critical habitat for some neotropical migrant birds. Coupled with the decline of this habitat type (particularly in the Puget Trough), the importance of oaks to neotropical migrant birds is magnified. Twenty-six of the 118 species of neotropical migrant birds that frequent Washington are associated with Oregon white oaks to some degree. Of these, band-tailed pigeon, rufous hummingbird, orange-crowned warbler, and chipping sparrow are oak-associated species in Washington with known population declines (Andelman and Stock 1993). In south-central Washington, Nashville warblers have been observed in greater abundance in stands dominated by Oregon white oaks compared to riparian areas with a greater diversity of overstory trees (Manuwal 1989).

Reptiles

Three species of reptiles associated with oak woodlands include: the California Mountain kingsnake, sharptail snake, and southern alligator lizard (St. John 1985, 1987; Storm and Leonard 1995; B. Leonard, pers. comm.). Each of these uses logs, bark, and rocks for cover, common components of oak woodlands.

Invertebrates

Oak forests in Washington support many species of invertebrate wildlife (Appendix B). Many invertebrate species that occur in other habitat types may be more likely to occur in Oregon white oak woodlands. For example, at Bald Hills over 70 species of insects occur, 50 of which are 10 times more likely to occur in oaks (R. Crawford, pers. comm.). Known oak-obligates in Washington include 5 moth, 2 wasp, and 1 butterfly species (Pyle 1989; L. Crabo, pers. comm.; R. Crawford, pers. comm.).

IMPACTS OF LAND USE

Most oak woodlands in the state are privately owned, and private parcels collectively comprise the largest contiguous tracts (Wash. Dept. Wildl. 1993; C. Dugger, pers. comm.; B. Weiler, pers. comm.). Statewide mapping is underway by WDFW to quantify the extent of Washington's oak habitat. Large tracts of oak habitat are located on the Yakama Tribal lands (40,500 ha [100,000 ac]) (E. Hansen, pers. comm.) and Ft. Lewis Military Reservation (1,458 ha [3,600 ac]) (Macklin and Thompson 1992). The Washington Department of Fish and Wildlife and the Department of Natural Resources own and manage approximately 5,265 ha (13,000 ac) of oak habitat statewide. Klickitat County, which harbors most of Washington's oak, contains approximately 79,000 ha (195,000 ac) of oak and oak/pine woodlands >25% canopy coverage. Thurston County contains about 4,000 ha (10,000 ac) of oak and mixed oak stands.

The decline of Oregon white oak in Washington has been accelerated by a number of human activities. Stand thinning and land conversion for conifer production, agriculture, fuelwood cutting, cattle grazing, and urban development are all considered significant contributors to the current decline of Oregon white oak, although their relative importance is largely unknown (D. Anderson, pers. comm.; C. Dugger, pers. comm.; B. Weiler, pers. comm.).

There is no significant use of Oregon white oak by the timber industry, in part because of more economically important and abundant supplies elsewhere. This low economic pressure and the exceptionally slow growth of the species (Hall et al. 1959) has resulted in Oregon white oak either being ignored and left standing, being cut and sold as firewood, or being cut and piled-burned on site (C. Dugger, pers. comm.).

Shitaki mushrooms are propagated on Oregon white oak, and acorn flour is produced from the meat of acorns. Very small Shitaki mushroom and acorn flour production industries exist in at least one location in Klickitat County (B. Weiler, pers. comm.).

Fishing, camping, hunting, climbing, rafting, mountain biking, snowmobiling, and hiking are recreational activities known to occur in or next to Oregon white oak stands (Riggle 1991).

Threats to Oregon White Oak

Land Conversion

Klickitat County and adjoining lands harbor the largest stands of Oregon white oak in Washington. Within this area, conversion to agricultural and range lands, urban development, and losses from fuelwood cutting are the most significant contributors to oak woodland decline (B. Weiler, pers. comm.). In western Washington, land conversion for urban development clearly threatens remnant oak woodlands, particularly in Thurston and Pierce counties (Kessler 1990). Currently, counties with oak do not monitor urban growth rates in such a way that declines in Oregon white oak can be measured. Statewide mapping of oaks would enable land planners and biologists to quantify oak loss trends.

Conifer Encroachment

Conifer encroachment, predominately by Douglas-fir, occurs primarily west of the Cascade crest and in wetter areas on the east side, such as the White Salmon River drainage of the Columbia Gorge. In drier areas east of the Cascades, conifer competition with oaks is generally negligible. Oregon white oak is usually sub-climax and becomes climax only on dry, rocky, southerly exposures (U.S. For. Serv. 1965). In Oregon's Willamette Valley, the general trend of encroachment is further suggested by the presence of relict oaks within dense stands of Douglas-fir (Sprague and Hansen 1946).

On wetter sites, Douglas-fir grows at a rate 3 to 5 times that of Oregon white oak (Sprague and Hansen 1946), and oak seedlings and saplings can be quickly out-competed by faster growing conifers. Shade tolerance is higher in juvenile than mature stages of Oregon white oak. Once oak trees become overtopped by Douglas-fir, they are unable to withstand the subsequent low light intensities (Silen 1958, Miller 1985, Kertis 1986).

From northern California to Washington, an increased presence of Douglas-fir seedlings and saplings and a noticeable lack of oak regeneration beneath oak canopy has been observed (Barnhardt et al. 1987). In western Washington, Douglas-fir encroachment affects the few Oregon white oak communities that exist today (Scheffer 1959, Kertis 1986) and is perpetuated and accelerated by land management practices.

The suppression of wildfires, along with continuing cattle grazing and timber conversion, are thought to contribute to encroachment by Douglas-fir in Oregon white oak-dominated sites. Urban and suburban development contributes to the replacement of oaks by faster growing conifer species across the landscape. Development exceeds the rate of spatial reproduction of oaks and includes development of land suitable but not currently occupied by oaks (Lang 1961, Kertis 1986, Franklin and Dyrness 1988, Manuwal 1989).

In addition to reducing the extent of this unique habitat, encroachment by Douglas-fir can reduce the number of cavities available to cavity-using wildlife. Gumtow-Farrior (1991) found fewer cavities in mixed oak/Douglas-fir stands than in pure, primarily older oak stands. Of 300 oaks and an equal number of Douglas-firs sampled, 98% of the cavities found occurred in oak trees.

Except for wholesale oak removal, Douglas-fir encroachment may be the most significant and widespread threat to the existence of Oregon white oak communities within its western range. Historically, fire has played a significant role in the control of conifers, and in recent times fire suppression has perpetuated the Douglas-fir problem. In the northern oak woodlands of California, Barnhardt et al. (1987:57) hypothesized that "in the absence of periodic wildfires or other destructive forces, Douglas-fir will increase within these oak woodlands to eventually dominate and replace the oaks."

An encroachment problem is identifiable when oak reproduction is limited or absent among oaks overshaded by conifers, or when overshaded oaks are sick or dying. Conifer encroachment by Douglas-fir in oak woodlands can be limited effectively by prescribed burning measures (Reed and Sugihara 1987). Conifer encroachment will continue throughout the extent of Washington's oak woodlands unless management priorities and practices are altered (Reed and Sugihara 1987).

Timber Harvest

East Versus West. Oregon white oak has virtually no economic value as a timber species and if cut it is either for firewood or it is pile-burned on site (C. Dugger, pers. comm.). Conifers can be

produced and harvested at a rate 3 to 5 times that of Oregon white oak (Sprague and Hansen 1946). Therefore, the replacement of oak with faster growing conifers produces more marketable timber in far less time.

Distinct differences exist in timber practices and oak/conifer interactions between areas east and west of the Cascade Range. Typically, clearcutting of oaks occurs regularly in the west and rarely in the drier regions of the east. Conifer encroachment, usually by Douglas-fir, is an acute problem west of the Cascades and in portions of the Columbia Gorge; however, it is virtually nonexistent on drier sites east of the Cascades. Conversely, selective cutting of conifers in the west, which would be beneficial, does not commonly occur. Selective cutting of conifers does occur commonly, however, east of the Cascades and is detrimental to animals like wild turkeys and western gray squirrels that depend on mixed conifer/oak associations to provide useful habitat (B. Weiler, pers. comm.).

Clearcutting. Although economically efficient for conifer production, clearcutting stands of Oregon white oaks contributes to the decline of this slow-growing species and the populations of the animals that inhabit them. Because oak clearcuts usually regenerate to conifer forests west of the Cascades and along the Columbia Gorge, clearcutting perpetuates the conversion of oak woodland to conifer forest (Reed and Sugihara 1987). Even in drier locations where sprouts from cut oaks face little competition from conifers, clearcutting contributes to uniform stand composition with little age-class diversity. Pine/oak forest studies in Virginia revealed that several species of birds that occurred only in more mature areas were negatively affected by pine/oak clearcutting (Conner et al. 1979).

Clearcutting reduces wildlife species abundance by removing habitat and may cause disruption in contiguous aerial pathways that squirrels and other animals need to move through the forest canopy. Clearcutting creates abrupt edges between open and closed canopies. Although it is generally recognized that edge sometimes increases overall species richness, edges can be detrimental to those species that inhabit the interior of contiguously forested areas (Harris 1984). In a Maryland oak forest, the predation rate on open-nesting interior forest birds increased with proximity to edge (Chasko and Gates 1982). Selective cutting, on the other hand, reduces edge and maintains control over age-class within uniform stands by initiating new growth from the stumps of selectively cut oaks (Connel et al. 1973).

Selective Cutting. In the drier climate east of the Cascades, conifers associated with oaks grow more slowly, and conifer encroachment of oaks in most areas is nonexistent (C. Dugger, pers. comm.). It is a misconception that selective cutting of conifers enhances oak woodlands. What commonly occurs is that Douglas-fir and ponderosa pine are harvested, temporarily leaving pure stands of oak. Species including wild turkey and western gray squirrel use conifers within oaks for nesting and roosting and may be adversely affected by the selective harvest of conifers.

Changes in bird species composition coincide with successional changes in vegetation (Johnston and Odum 1956). Selective cutting practices allow for the retention of different age-class and species

composition within stands (Conner et al. 1979), and age diversity within stands contributes to species richness and breeding bird diversity (Connel et al. 1973).
Appropriate timber practices within oak stands vary according to location and tree species composition.

Grazing

Little information exists on the effects of grazing in oak woodlands specifically; however, variables that affect grazing impacts on vegetation include site elevation, plant community condition, and land management objectives (C. Perry, pers. comm.). Domestic livestock grazing is known to have occurred in Washington since at least 1825 (Galbraith and Anderson 1971) and is currently one of the primary uses of Oregon white oak stands.

Cattle will not usually eat oaks until forage vegetation is depleted or in poor condition. Consumption of oaks (primarily sprouts) by cattle generally occurs after intense grazing or in middle to late summer when grasses dry up (C. Perry, pers. comm.). Fall grazing adversely impacts oak sprouts to a greater degree than does spring grazing because oak sprouts in the fall are more exposed within grassy cover (D. Morrison, pers. comm.).

In a northern California study, Saenz and Sawyer (1986) reported that Oregon white oak woodlands grazed a full season contained fewer species of grasses and forbs than those grazed for a partial season. In Washington, high numbers of cattle grazing for short periods impact oaks less than does a longer grazing period using fewer animals (C. Perry, pers. comm.). Hedrick and Keniston (1966) found that soil moisture rose as a result of grazing by sheep and that conifer growth rates were greater on grazed than ungrazed plots.

In western Washington, evidence suggests that grazing enhances Douglas-fir encroachment. Thilenius (1964, cited by Kertis 1986:11) states that the general trend in grazed systems "...is the replacement of herbaceous with woody species. Disturbance of the sod layer allows shrub and seedling establishment to occur, with eventual conifer-hardwood development probable." While this scenario may appear to favor oak establishment, faster growing Douglas-firs can quickly out-compete oaks developing in grazed areas.

In drier oak woodlands, improper grazing replaces native bunchgrasses with cheatgrass or other non-native, invasive species. One of Washington's rarest landscapes, the oak/bunchgrass community, is a dry-site type that can be adversely affected by improper grazing (B. Weiler, pers. comm.).

Historically, land clearing activities for farming and cattle grazing have been extensive in prairies and oak savannas throughout the Pacific Northwest and have served to decrease Oregon white oak woodlands (Thilenius 1968, Kertis 1986). Evidence suggests, however, that oaks can repopulate areas that have been heavily grazed once cattle are removed (Voeks 1981).

The Role of Fire in Oregon White Oak Woodlands

Fire has played a paramount role in the ecology of Oregon white oak woodlands for thousands of years (Agee 1990). Frequent fires are believed to be the major disturbance factor that have maintained Oregon white oak communities in the past (Thilenius 1968, Taylor and Boss 1975, Kertis 1986, Agee 1990).

Historically, fires have served to limit and even decrease the invasion of conifer species into Oregon white oak woodlands. The frequency of fire has controlled stand density and initiated sprouting in oaks injured or killed in previous, higher-intensity fires (Kertis 1986).

Before modern-day fire suppression was invoked, fires occurred more frequently, and the fire regime in Oregon white oak woodlands has historically been considered low in intensity and severity (Sprague and Hansen 1946). Low-intensity fires are those that remain in the understory and do not result in significant mortality to overstory trees (Sugihara and Reed 1987).

The historic climatic qualities of Oregon white oak habitat included nearly continual summer drought. A frequent, low-severity fire regime served to maintain lower accumulations of fuel between widespread fires and, therefore, limited fire intensity to moderate or low levels. Low-severity fire regimes are associated with ecosystem stability, and ecosystem stability is greater in the presence of fire than in its absence (Agee 1990).

Wildfires attributed to lightning and other natural causes were common throughout the Pacific Northwest. Several writers, however, have noted the prominent role Native Americans played in the frequency of fires in the Pacific Northwest before settlement by Europeans (Morris 1934, Habeck 1961, Thilenius 1968, Taylor and Boss 1975). The purposes of frequent burning by Native Americans in oak woodlands were to increase food production and create more effective hunting grounds. To immigrants, wildfires became associated with the destruction of forests and rangelands, and an oversimplified, negative view of wildfires evolved among European settlers. Post-settlement burning was therefore prohibited, and naturally ignited fires were suppressed as well (Shinn 1980).

Ring-growth studies of trees in Oregon's Willamette Valley have demonstrated that fires were frequent between 1647 and 1848 (Sprague and Hansen 1946). The cessation of burning by Native Americans and suppression of naturally ignited fires has changed the vegetation structure and composition within Oregon white oak woodlands (Shinn 1980, Kertis 1986). Post-settlement fire suppression practices brought about increased production of brush and stands of young trees in areas formerly covered by grasslands (Habek 1961).

In Oregon white oak woodlands of northern California, the demise of periodic burns by Native Americans has produced denser stands of oaks and has favored invasion by Douglas-fir, a fire-sensitive species (Holms 1990). Fire suppression practices, along with reduction of fire frequency,

has allowed uncontrolled Douglas-fir establishment. Douglas-fir stands under oak canopies are often dense, which allows the conifer seedlings to survive to a fire-resistant size. After Douglas-fir is thoroughly established in the oak woodlands, fire can no longer control it effectively. Within 3 to 4 decades, the rapidly growing conifers overtop the oak canopy, effectively shading out the oaks (Sugihara and Reed 1987).

Fire is an important element to natural oak regeneration. Holms (1990:4) stated that "Weeds may reduce seedling success in unburned areas, as they compete with oak seedlings for light and moisture. Periodic wildfires could thus reduce herbaceous biomass and favor improved oak reproduction." Kertis (1986) reported that fire stimulates sprouting in Oregon white oaks, whereas Wright and Bailey (1982) noted the general trend for oak seeds is to survive fire with an increased germination rate. Once burned, an area is less likely to burn in subsequent years. Roy (1955) noted that Oregon white oak sprouts grew an average of 2 m (6.6 ft) in height after 2 years, and an average of 2.8 m (9.2 ft) after 3 years. Thus, acorns sprouting in burned areas will have a few years to grow before the next fire comes through.

Fire can offer an array of benefits to wildlife (Wright and Bailey 1982). Initially, fires may temporarily reduce the numbers of small mammals, but low-intensity burns probably have little effect on squirrels, and in some cases their numbers increase. Birds and large mammals are generally favored by fires that increase the successional diversity of the habitat and produce new growth harboring food and shelter resources. Wild turkeys, mourning doves, and woodpeckers are types of birds attracted to burned areas. Because different species of wildlife sometimes require different types of habitat, burns staggered by area, frequency, continuity, and intensity will provide an assortment of habitat associations (Wright and Bailey 1982).

Historically, fires have influenced wildlife habitats, and the importance of fire in the maintenance and health of Oregon white oak woodlands is evident. Frequent, low-intensity fire regimes facilitate the reduction of Douglas-fir and grasses, the initiation of oak sprouting, and the reduction of fuel loads in oak woodlands (Agee 1993). In the absence of fire, open-canopy oak savannas become dense oak woodlands, which in turn will eventually be overtaken by conifers (Agee 1993, Hanna and Dunn 1996). Implementation of carefully planned, controlled burning practices provides habitat diversity, attracts animals, and is a useful option in the management of Oregon white oak woodlands. However, action has to be initiated before Douglas-fir and other conifers, already present as seedlings in many oak stands, overtop the oaks (Agee 1993).

MANAGEMENT RECOMMENDATIONS

The scientific literature provides few specific management recommendations regarding Oregon white oak in Washington. The following recommendations have been derived from a synthesis of the literature and include:

- References to historical cause and effect relationships.
- References to management recommendations that cover a wide variety of oak species, including Oregon white oak.
- References to specific management recommendations for Oregon white oak woodlands in Oregon and California.
- Management recommendations from wildlife and habitat biologists with the Washington Department of Fish and Wildlife and from recognized experts in academic and private sectors.
- Requirements of oak-associated species.

Goals

Management recommendations for Oregon white oak woodlands are designed to meet two goals.

- Maintain or enhance the structural and functional integrity of Oregon white oak woodlands needed to support diverse wildlife populations across the landscape.
- Stop and reverse the trend toward oak habitat loss by retaining areas currently in an unaltered or natural state and by restoring degraded or lost oak habitat. Oak habitat presently in good condition should receive the highest priority for protection.

Land Use

Land Conversion and Oak Removal

Recommendation. Oregon white oak woodlands should not be clearcut, removed, replaced, or patch-cut unless these activities are inherent to the functional maintenance or enhancement of oak habitat. Remaining oak stands $\geq$0.4 ha (1 ac) west of the Cascades and $\geq$2.0 ha (5 ac) east of the Cascades should be maintained or enhanced, regardless of age-class or composition of the stand. Specifically, maintain 25-50% canopy cover of Oregon white oaks in oak woodland stands. In oak

savannas (i.e., stands with <25% total canopy cover), maintain the oak component at ≥50% of the canopy cover present. In urban and urbanizing areas, single trees or small patches of oaks should be maintained if they are deemed important to species highly associated with Oregon white oak.

Rationale. Oregon white oak stands in Washington are currently threatened and declining (Taylor and Boss 1975, Kertis 1986). Clearcutting reduces oak habitat and the numbers of animals within, encourages conifer encroachment, and creates edges. Edges are common in urban and suburban landscapes whereas contiguous habitat types, especially oak, are not. Edges increase the frequency of predation on interior nesting species (Connel et al. 1973, Conner et al. 1979, Chasko and Gates 1982, Reed and Sugihara 1987). Twenty-five to fifty percent canopy cover in oak woodlands provides generally acceptable habitat for a variety of species and provides needed gaps for sunlight (Barrett 1980).

Consequences of Compromise. Wholesale removal of oaks, which reduces oak habitat available to wildlife, will result in a net loss of oak-associated animals. Oak habitat that is clearcut, fragmented, or reduced in size may enhance conifer encroachment on remaining oaks and increase the number of edge-associated species at the expense of interior species.

Grazing

When considering site-specific grazing issues, consult with biologists from the Washington Department of Fish and Wildlife. Also consult with representatives of the Natural Resources Conservation Service and the Washington Department of Natural Resources.

Recommendation. Allow low-impact grazing within oak woodlands. Low-impact grazing is defined by the timing and amount of vegetation removed. Grazing should occur only in early spring to early summer or until seed heads form (Clary and Webster 1989, Kinch 1989). Grazing should cease before 25% of the herbaceous vegetation has been consumed (Marlow 1988; Kinch 1989; C. Perry, pers. comm.) or the herbaceous layer is cropped to within 10-15 cm (4-6 in) of the ground (Clary and Webster 1989), whichever comes first. These conditions usually occur in less than 6 weeks of grazing. Rotate grazing areas to allow recovery of vegetation and to allow oak regeneration to occur (C. Perry, pers. comm.).

Rationale. Overgrazing stimulates alien weed invasion, tramples acorn sprouts, and compacts soils (Silen 1958, U.S. For. Serv. 1965, Saenz and Sawyer 1986, Hanna and Dunn 1996). Limited, short-term, carefully controlled grazing may mimic other thinning measures in young, dense, even-aged oak stands. Grazing is not recommended where oak sprouting and sapling growth are being encouraged, within riparian zones, or where acorn production is desired but scarce (Reed and Sugihara 1987).

Consequences of Compromise. Overgrazing may cause soil compaction, and it may damage the root structures of developing oak seedlings or discourage sprouting of acorns. Over-consumption of herbaceous understory exposes oak seedlings, and cattle are more likely to consume woody vegetation after herbaceous cover is consumed. Wildlife species that use a grassy or herbaceous understory may be negatively affected when cover, forage, or breeding structures are reduced or depleted.

Recreation

Recommendation. Low-impact recreational activities (hunting and fishing, hiking, mushroom cultivation, and limited acorn collection for flour production) are appropriate activities in Oregon white oak woodlands.

Rationale. Low-impact recreational activities foster an appreciation for oaks and oak habitat, and they provide an economic incentive to preserve and enhance oak woodlands.

Oak Restoration and Enhancement

Unlike many other threatened habitat types, Washington oak habitat is transitional and requires active management. To mitigate for land practices that have left oak habitats degraded, land planners should incorporate oak enhancement measures or should consider alternatives to land activities that are not conducive to oak woodland perpetuation. The following recommendations are made with the goal of restoring and enhancing oak habitat.

Prescribed Burning

Fire has demonstrated potential for restoring oak woodlands to a stable equilibrium; however, extreme caution is recommended during initial burning due to potentially high fuel loads. Before conducting any prescribed or pile burns, consult with the Department of Natural Resources for permit requirements, liability information, and logistics assistance by telephoning 1-800-323-BURN.

Recommendation. Low-intensity, prescribed burns conducted on a regular basis (approximately 5-year intervals) are encouraged to exclude Douglas-fir encroachment, stimulate vigorous sprouting, and contribute to multi-aged stands. Maintenance fires should be conducted at more frequent intervals (3-5 years) in areas with serious Douglas-fir encroachment and high fuel loads, and at less frequent intervals (5-10 years) in areas where oak sapling growth success is critical or in areas where fuel loading is not a problem (Reed and Sugihara 1987, Sugihara and Reed 1987, J. Agee, pers. comm.). Scotch broom seeds are stimulated to germinate by fire, so a second fire 1-2 years after the initial burn is required in areas where elimination of this non-native species is a goal (Agee 1993).

Timing of burns is dependent on specific site conditions. In wetter areas, primarily west of the Cascade Range, prescribed burns should be conducted in the fall when grasses and other fine fuels are most combustible. In drier areas east of the Cascades, controlled burns should be conducted in the late-winter or spring to compensate for volatile fuel loads and very dry conditions (D. Morrison, pers. comm.).

Following prescribed burns, seeding with native fescue and grasses will discourage alien weed encroachment (J. Agee, pers. comm.). Also, providing canopy gaps for young sprouts by manually thinning some trees is recommended following burns conducted for sprout regeneration. Because Oregon white oaks are intolerant of shade, sprouts and seedlings require canopy gaps to receive sufficient light to develop into trees (Sugihara and Reed 1987).

An alternative to initial burning in high fuel load situations is manually cutting conifers flush with the ground and removing them. This practice should then be followed by regular mowing until the fuel load is reduced to levels safe enough for prescribed burns (J. Agee, pers. comm.).

Rationale. Fire has been an integral component of oak ecology, and oaks are highly resistant to fire after the sapling stage. Fire targets herbaceous ground cover and Douglas-fir, the latter of which typically encroaches on and impedes oak regeneration and success. Ponderosa pine is a fire-resistant conifer species, and ponderosa pine/oak associations east of the Cascades are not negatively affected by low-intensity fires. Vigorous restoration is suggested in areas with severe Douglas-fir encroachment, and the use of prescribed fires can be an important tool in restoring oak woodlands.

Consequences of Compromise: The effect of eliminating or reducing fire frequency from oak woodlands differs with density of the stand. In open-canopy oak savannas, the lack of fire leads to increased density of shrubs and oaks and to a denser oak woodland. In denser oak woodlands, the lack of fire leads to increases in shrubs and other tree species at the expense of oak in the long run (Agee 1993, Hanna and Dunn 1996).

Selective Harvest and Stand Thinning

Recommendation. Selectively harvest individual oaks where appropriate. Selective harvest should target the removal of trees in dense, even-aged oak stands while encouraging regeneration of oaks by stump sprouting. Carefully selected individual trees should be pruned or removed where overshading threatens younger oaks and oak regeneration. Thinning and cutting activities for oak regeneration should be conducted between December and May for better stump sprouting. The practice of thinning should be employed with the goal of improving age-class and successional diversity within stands. This practice should not result in the spatial decline of oaks. Very old or large oaks should not be removed.

Rationale. Stand thinning encourages sprouting and sprout success, increases age-class diversity, and is a more efficient means of regeneration (U.S. For. Serv. 1965, Kertis 1986, Reed and Sugihara 1987). Thinned stands of oaks support more bird species, greater avian density, and more breeding birds than unthinned stands (DeGraaf et al. 1991), and mixed age-class stands provide greater habitat diversity (Connel et al. 1973).

Consequences of Compromise. Failure to thin even-aged oak stands and failure to open canopy above overshaded oak sprouts and saplings may result in dense, even-aged oak stands of little diversity. Dense, even-aged oak stands support fewer kinds of wildlife.

Recommendation. On the west-side of the Cascades and along the Columbia Gorge, conifers should be removed when they encroach on oaks. Ponderosa pine and Douglas-fir in drier areas and along the east side of the Cascade Range are generally slower growing and do not encroach oaks; these trees should not be removed.

Rationale. Conifer encroachment on wetter sites (usually on the west side of the Cascades) threatens Oregon white oak regeneration. Encroachment by over-topping and shading-out slower growing oaks reduces the likelihood that oaks can reproduce.

Consequences of Compromise. Failure to remove encroaching conifers will result in oak stands dominated by conifers and stands with no oak regeneration or reproduction. Thus, oak stands eventually will be lost.

Retention of Valuable Trees

Recommendation. Large oaks (>50 cm dbh [20 in]), medium oaks (>30 cm dbh [12 in]), older oaks, and oaks with well formed, dominant crowns, should be retained wherever oak enhancement activities occur. Very large oaks are rare and should be retained at the cost of efficient oak regeneration directly under their canopies.

Rationale. Stands of medium to large oaks provide more cavities for nesting than do stands of smaller oaks (Gumtow-Farrior 1991). Trees with well formed, dominant crowns may produce more acorns, and large live trees provide habitat for branch-nesting species. Large well-developed trees produce more mast for regeneration and wildlife consumption (Connel et al. 1973). Very large, old oaks are rare.

Consequences of Compromise. Fewer cavities may limit the number of cavity-nesting animals that can inhabit a particular oak woodlands. Stand domination by trees with smaller crowns and less canopy may limit acorn production. These limitations may affect the numbers of individuals and species that use oak woodlands.

Recommendation. An abundance of snags as well as broken, diseased, and dying trees, and live trees with cavities, heartwood rot, and insect infestations, should be preserved. No standing dead trees should be cut unless absolutely necessary.

Rationale. Snags provide feeding, perching, and resting platforms. Diseased and dying trees provide insects for food and ensure a future source of snags. Large, live trees with cavities are an invaluable resource for cavity nesting species (Connor et al. 1975, Jackman 1975, Hardin and Evans 1976).

Consequences of Compromise. The removal of dead, dying, diseased, and broken trees, as well as those live trees with cavities, heartwood rot, or insect infestations, removes many of the critical structural habitat features essential for wildlife survival. Without an abundance of these important features, the numbers of individual animals and species using Oregon white oak forests may be limited.

Creation of Snags When Thinning or Enhancing Oak Woodlands

Recommendation. Create snags when thinning oaks or conifers instead of removing trees entirely. If the cutting of oaks is necessary to enhance oak woodlands for wildlife, top-cut the trees and leave them standing. Partial pruning or limbing may be needed for trees slated to be removed for reasons of overshading or encroachment. At a minimum, leave the main trunk standing.

Rationale. Snags provide feeding, perching, and resting platforms. Snags are limited features across the landscape and provide structures for nesting and denning. Snags provide habitat for invertebrates, which in turn provide food for vertebrate wildlife. Topping a tree produces a slower decay rate than does girdling.

Consequences of Compromise. Snags are a limited yet very important habitat feature for wildlife. Failure to leave undesirable trees standing may limit the number of trees available for natural snag creation, and it does nothing to mitigate losses of snags due to timber management practices.

Recommendation. Leave fallen dead trees, limbs, and leaf litter for foraging sites and nest/den sites.

Rationale. Downed trees and limbs provide ground denning and nesting habitat for all types of wildlife. Many animals forage among or feed on wood and leaf litter. Leaf litter may help retain soil moisture that aids in oak seedling survival.

Consequences of Compromise. Failure to leave wood and leaf litter removes wildlife nesting, denning, feeding, and cover habitat. Removal of these features may limit the numbers of individuals and species that use oak habitat.

Retention of Contiguous Aerial Pathways

The difference between conifer encroachment and those oak/conifer associations valuable to wildlife is often unclear. Consultation with biologists from the Washington Department of Fish and Wildlife is strongly recommended whenever uncertainty prevails. Almost without exception, conifers associated with oaks in eastern Washington and along drier sites in the Columbia Gorge do not encroach negatively on oaks. Conifer/oak associations in these areas are limited and very valuable as actual or potential habitat, particularly for western gray squirrels and wild turkeys. Conversely, conifer encroachment on oaks in western Washington and along wetter sites in the Columbia Gorge, such as the White Salmon drainage, is prevalent and undesirable.

Recommendation. Mixed oak/conifer associations should be retained where contiguous aerial pathways between oaks and conifers exist. Care should be exercised in determining where good mixed oak/conifer habitat ends and encroachment begins.

Rationale. Mixed oak/conifer associations are particularly important in potential western gray squirrel habitat and for increasing stand diversity for breeding birds (Rodrick and Milner 1991, Wash. Dept. Wildl. 1993).

Consequences of Compromise. Failure to provide conifer associations in oak woodlands may limit the number of species of breeding birds present. In addition, roost sites for wild turkeys and other birds, as well as feeding sites for squirrels, will be absent.

Other Oak Enhancement Activities

- Plant Oregon white oak acorns and oak seedlings.
- Use alternatives to oak fuelwood.
- Sell or donate oak woodlands to conservation and land trust organizations.
- Purchase contiguous or notable stands of oaks by local, state, and federal agencies.
- Move toward the elimination of grazing on state-owned oak woodlands.
- Designate large, contiguous oak and oak/conifer stands as critical areas.
- Encourage aggressive oak enhancement/regeneration measures by local, state, and federal agencies.

REFERENCES CITED

Agee, J. K. 1990. The historical role of fire in Pacific Northwest forests. Pages 25-38 *in* J. D. Walstad, S. R. Radosevich, and D. V. Sandberg, eds. Natural and prescribed fire in Pacific Northwest forests. Oregon State Univ. Press, Corvallis.

)))))). 1993. Fire ecology of Pacific Northwest forests. Island Press, Covelo, Calif. 493pp.

Alverson, E. 1988. Bald Hill Natural Area Reserve natural features report. Unpubl. Rep. Wash. Dept. Nat. Resour., Olympia. 38pp.

Andelman, S. J., and A. Stock. 1994. Management, research and monitoring priorities for the conservation of neotropical migratory landbirds that breed in Washington State. Nat. Heritage Prog., Wash. Dept. Nat. Resour., Olympia. (Irr. Pag.)

Barnhardt, S. J., J. R. McBride, C. Cicero, P. da Silva, and P. Warner. 1987. Vegetation dynamics of the northern oak woodland. Pages 53-58 *in* T. R. Plumb and N. H. Pillsbury, tech. coords. Proc. symposium on multiple-use of California's hardwood resources. U.S. For. Serv. Gen. Tech. Rep. PSW-100.

Barnum, D. A. 1975. Aspects of western gray squirrel ecology. M.S. Thesis, Washington State Univ., Pullman. 58pp.

Barrett, R. H. 1980. Mammals of California oak habitats -- management implications. Pages 275-291 *in* T. R. Plumb, tech. coor. Ecology, management, and utilization of California oaks. U.S. For. Serv. Gen. Tech. Rep. PSW-44.

Beal, F. E. L. 1910. The birds of California in relation to the fruit industry. Part II. U.S.D.A. Biol. Surv. Bull. 34. 24pp.

)))))). 1911. Food of the woodpeckers of the United States. U.S.D.A. Biol. Surv. Bull. 37. 64pp.

Byrne, S. 1979. The distribution and ecology of the non-native tree squirrels *Sciurus carolinensis* and *Sciurus niger* in northern California. Ph.D. Thesis, Univ. California, Berkley. 196pp.

Caicco, S. L. 1989. Oak Patch Natural Area Preserve natural features report. Unpubl. Rep. Wash. Dept. Nat. Resour., Olympia. 9pp.

Chappell, C. B. 1979. The wintering bird community of a selected plot of Oregon white oak woodland in Thurston County, Washington. Unpubl. Rep. Wash. Dept. Wildl., Olympia. 13pp.

Chasko, G. G., and J. E. Gates. 1982. Avian habitat suitability along a transmission-line corridor in an oak-hickory forest region. Wildl. Monogr. 82:1-41.

Christisen, D. M., and L. J. Korschgen. 1955. Acorn yields and wildlife usage in Missouri. Proc. North Am. Wildl. Conf. 20:337-357.

Clary, W. P., and B. F. Webster. 1989. Managing grazing of riparian areas in the intermountain region. U.S. For. Serv. Gen. Tech. Rep. INT-263. 13pp.

Coblentz, B. E. 1980. Production of Oregon white oak acorns in the Willamette Valley, Oregon. Wildl. Soc. Bull. 8:348-350.

Connel, D. L., G. Davis, S. McCormick, and C. Bushey. 1973. The hospitable oak: coordination guidelines for wildlife habitats, No. 3. California Reg., U.S. For. Serv. 11pp.

Conner, R. N., R. G. Hooper, H. S. Crawford, and H. S. Mosby. 1975. Woodpecker nesting habitat in cut and uncut woodlands in Virginia. J. Wildl. Manage. 39:144-150.

)))))), J. W. Via, and I. D. Prather. 1979. Effects of pine-oak clearcutting on winter and breeding birds in southwestern Virginia. Wilson Bull. 92:301-306.

Cross, S. P. 1969. Behavioral aspects of western gray squirrel ecology. Ph.D. Thesis, Univ. Arizona, Tempe. 185pp.

DeGraaf, R. M., W. M. Healy, and R. T. Brooks. 1991. Effects of thinning and deer browsing on breeding birds in New England oak woodlands. For. Ecol. and Manage. 41:179-191.

Detling, L. E. 1968. Historical background of the flora of the Pacific Northwest. Mus. Nat. Hist. Bull. No. 13, Univ. Oregon, Eugene. 57pp.

Foster, S. A. 1992. Studies of ecological factors that affect the population and distribution of the western gray squirrel on northcentral Oregon. Ph.D. Thesis, Portland State Univ., Portland, Oregon. 153pp.

Franklin, J. F., and C. T. Dyrness. 1988. Natural vegetation of Oregon and Washington. Oregon State Univ. Press, Corvallis. 452pp.

Galbraith, W. A., and E. W. Anderson. 1971. Grazing history of the northwest. J. Range Manage. 24:6-12.

Gumtow-Farrior, D. L. 1991. Cavity resources in Oregon white oak and Douglas-fir stands in the mid-Willamette Valley, Oregon. M.S. Thesis, Oregon State Univ., Corvallis. 89pp.

Gumtow-Farrior, D., and C. Gumtow-Farrior. 1994. Wildlife on white oaks woodlands. Woodland Fish and Wildl. Proj. World For. Cent., Portland, Oreg. 12pp.

Habek, J. R. 1961. The original vegetation of the mid-Willamette Valley, Oregon. Northwest Sci. 35:65-77.

Hall, F. C., D. W. Hedrick, and R. F. Keniston. 1959. Grazing and Douglas-fir establishment in the Oregon white oak type. J. For. 57:98-103.

Hanna, I., and P. Dunn. 1996. Restoration goals for Oregon white oak habitats in the south Puget Sound region. The Nat. Conser. of Wash., Seattle. 84pp.

Hansen, H. P. 1947. Climate versus fire and soil as factors in postglacial forest succession in the Puget lowland of Washington. Am. J. Sci. 245:1-28.

Hardin, K. I., and K. E. Evans. 1976. Cavity nesting bird habitat in the oak-hickory forest: a review. U.S. For. Serv. Gen. Tech. Rep. NC-30. 23pp.

Harris, L. D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. Univ. Chicago Press, Chicago, Ill. 211pp.

Hedrick, D. W., and R. F. Keniston. 1966. Grazing and Douglas-fir growth in the Oregon white oak type. J. For. 64:735-738.

Holms, T. H. 1990. Botanical trends in northern California oak woodlands. Rangelands 12:3-7.

Jackman, S. M. 1975. Woodpeckers of the Pacific Northwest: their characteristics and their role in the forests. M.S. Thesis, Oregon State Univ., Corvallis. 159pp.

Johnston, D. W., and E. P. Odum. 1956. Breeding bird populations in relation to plant succession on the Piedmont of Georgia. Ecology 37:50-62.

Kertis, J. 1986. Vegetation dynamics and disturbance history of Oak Patch Preserve, Mason County, Washington. Unpubl. Rep. Wash. Dept. Nat. Resour., Olympia. 112pp.

Kessler, R. 1990. The oak woodlands of Thurston County, Washington: mapping and description of stands. Unpubl. Rep. Wash. Dept. Wildl., Olympia. 25pp.

Kinch, G. 1989. Riparian area management: grazing management in riparian areas. Tech. Reference TR 1737-4. Bur. Land Manage. Denver, Colo. 44pp.

Knight, R. L. 1979. Oregon white oak forest, Census 103. Am. Birds 33:82.

Koenig, W. D., and M. K. Heck. 1988. Ability of two species of oak woodland birds to subsist on acorns. Condor 90:705-708.

Lang, F. A. 1961. A study of vegetation change on the gravelly prairies of Pierce and Thurston counties, western Washington. M.S. Thesis, Univ. Washington, Seattle. 101pp.

Larsen, E. M., E. Rodrick, and R. M. Milner, technical editors. 1995. Management recommendations for Washington's priority species, Vol. 1: Invertebrates. Wash. Dept. Fish and Wildl., Olympia. (Irr. Pag.)

)))))), technical editor. 1997. Management recommendations for Washington's priority species, Vol.3: Amphibians and Reptiles. Wash. Dept. Fish and Wildl., Olympia. (Irr. Pag.).

Leonard, W. P., H. A. Brown, L. L. C. Jones, K. R. McAllister, and R. M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Soc., Seattle, Wash. 168pp.

Macklin, J. D., and D. C. Thompson. 1992. Oregon white oak woodlands of Ft. Lewis, Pierce County, Washington. Unpubl. Rep. Seattle Dist. Corps of Eng., Seattle, Wash. (Irr. Pag.)

Manuwal, D. A. 1989. Birds of the Klickitat National Scenic River Area. Unpubl. Rep. Wash. Dept. Wildl. and U.S. For. Serv., Olympia. 70pp.

Marlow, C. B. 1988. Mitigating livestock impacts to streambanks within northern Rocky Mountain foothills riparian zones. Pages 147-150 *in* J. Emerick, S. Foster, L. Hayden-Wing, J. Hodgson, J. W. Monarch, A. Smith, O. Thorne II, and J. Todd, eds. Issues and technology in the management of impacted wildlife: proceedings III. Thorne Ecol. Inst., Boulder., Colo.

Menke, J. W., and M. E. Fry. 1980. Trends in oak utilization -- fuelwood, mast production, animal use. Pages 297-305 *in* T. R. Plumb, tech. coor. Ecology, management, and utilization of California oaks. U.S. For. Serv. Gen. Tech. Rep. PSW-44.

Miller, H. A. 1985. Oregon white oak. Pages 275-278 *in* H. A. Miller and S. H. Lamb., eds. Oaks of North America. Naturegraph Publ., Happy Camp, Calif.

Morris, W. G. 1934. Forest fires in western Oregon and western Washington. Oreg. Hist. Quart. 35:313-339.

Pyle, R. M. 1989. Washington butterfly conservation status report and plan. Unpubl. Rep., Wash. Dept. Wildl., Olympia. 217pp.

Reed, L. J., and N. G. Sugihara. 1987. Northern oak woodlands -- ecosystem in jeopardy or is it already too late? Pages 59-63 *in* T. R. Plumb and N. H. Pillsbury, tech. coords. Proc. symposium on multiple-use of California's hardwood resources. U.S. For. Serv. Gen. Tech. Rep. PSW-100.

Riggle, J. R. 1991. Oak Creek nongame pilot project. Unpubl. Rep. Wash. Dept. Wildl., Olympia. 48pp.

Rodrick, E., and R. Milner, eds. 1991. Management recommendations for Washington's priority habitats and species. Wash. Dept. Wildl., Olympia. (Irr. Pag.)

Roy, D. F. 1955. Hardwood sprout measurements in northwestern California. For. Res. Note No. 95. Southwest For. and Range Exper. Stn., U.S. For. Serv., Berkeley, Calif. 6pp.

Saenz, L., and J. O. Sawyer. 1986. Grasslands as compared to adjacent *Quercus garryana* woodland understories exposed to different grazing regimes. Madroño 33:40-46.

Scheffer, T. H. 1959. Field studies of the Garry oak in Washington. Univ. Washington Arboretum Bull. 22:88-89.

Shinn, D. A. 1980. Historical perspectives on range burning in the inland Pacific Northwest. J. Range Manage. 33:415-423.

Silen, R. R. 1958. Silvical characteristics of Oregon white oak. Silvical Ser. No. 10. Pac. Northwest For. and Range Exp. Stn., U.S. For. Serv., Portland, Oreg. 13pp.

Sprague, F. L., and H. P. Hansen. 1946. Forest succession in the McDonald Forest, Willamette Valley, Oregon. Northwest Sci. 20:89-98.

Stein, W. I. 1980. Oregon white oak 233. Pages 110-111 *in* F. H. Eyre, ed. Forest cover types of the United States and Canada. Soc. Amer. For., Washington D.C.

)))))). 1990. *Quercus garryana* Dougl. ex Hook. Oregon white oak. Pages 650-660 *in* R. M. Burns and B. H. Honkala, eds. Silvics of North America, Vol. 2, Hardwoods. U.S. For. Serv. Agric. Handb. 654. Washington D.C.

Steinecker, W. E. 1977. Supplemental data on the food habits of the western gray squirrel. Calif. Fish and Game 63:11-21.

)))))), and B. M. Browning. 1970. Food habits of the western gray squirrel. Calif. Fish and Game 56:36-49.

St. John, A. D. 1985. The herpetology of the interior Umpqua River drainage Douglas County, Oregon. Tech. Rep. 85-2-02, Oreg. Dept. Fish and Wildl., Portland. 69pp.

)))))). 1987. The herpetology of the oak habitat of southwestern Klamath County, Oregon. Tech. Rep. 87-3-01, Oreg. Dept. Fish and Wildl., Portland. 49pp.

Storm, R. M., and W. P. Brown, coordinating editors. 1995. Reptiles of Washington and Oregon. Seattle Audubon Soc., Seattle, Wash. 176pp.

Sugihara, N. G., and L. J. Reed. 1987. Prescribed fire for restoration and maintenance of Bald Hills oak woodlands. Pages 446-451 *in* T. R. Plumb and N. H. Pillsbury, tech. coords. Proc. symposium on multiple-use of California's hardwood resources. U.S. For. Serv. Gen. Tech. Rep. PSW-100.

Taylor, R. J., and T. R. Boss. 1975. Biosystematics of *Quercus garryana* in relation to its distribution in the state of Washington. Northwest Sci. 49:48-57.

Thilenius, J. F. 1968. The *Quercus garryana* forests of the Willamette Valley, Oregon. Ecology 49:1124-1133.

Thomas, J. W., R. G. Anderson, C. Maser, and E. L. Bull. 1979. Snags. Pages 60-76 *in* J. W. Thomas, tech. ed. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. Agric. Handb. 553, U.S. For. Serv., Wash. D.C.

Tweit, B., and J. Johnson. 1992. Washington and Oregon spring season regional report. Am. Birds 46:469-472.

U.S. Forest Service. 1965. Silvics of forest trees of the United States. U.S. For. Serv. Agric. Handb. No. 271. Washington D.C. 762pp.

)))))). 1969. Wildlife habitat improvement handbook. U.S. For. Serv. Washington D.C. (Irr. Pag.)

Voeks, R. A. 1981. The biogeography of Oregon white oak. M.S. Thesis, Portland State Univ., Portland, Oreg. 119pp.

Washington Department of Wildlife. 1993. Status of the western gray squirrel *Sciurus griseus* in Washington. Wash. Dept. Wildl., Olympia. 40pp.

Washington Department of Fish and Wildlife. 1996. Priority habitats and species list. Wash. Dept. Fish and Wildl., Olympia. 28pp.

)))))). 1996. State listed species and state candidate species. Inf. Brochure, Wildl. Manage. Prog., Wash. Dept. Fish and Wildl., Olympia. 2pp.

Wright, H. A., and A. W. Bailey. 1982. Fire ecology: United States and southern Canada. Wiley, New York, N.Y. 501pp.

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APPENDICES

Appendix A. Common and scientific names of plants and animals mention in the text.

Plants

American vetch (*Vicia americana*)
Balsamroot (*Balsamarhiza sagittata*)
Bigleaf maple (*Acer macrophyllum*)
Big sagebrush (*Artemesia tridentata*)
Bitterbrush (*Purshia tridentata*)
Blackberry (*Rubus ursinus*)
Black cottonwood (*Populus trichocarpa*)
Bluebunch wheatgrass (*Agropyron spicatum*)
California hazelnut (*Corylus cornuta*)
Cheatgrass (*Bromus tectorum*)
Chickweed (*Cerastium* spp.)
Common snowberry (*Symphoricarpus albus*)
Douglas-fir (*Pseudotsuga menziesii*)
Idaho fescue (*Festuca idahoensis*)
Indian plum (*Oemleria cerasiformes*)
Kentucky bluegrass (*Poa pratensis*)
Long-stoloned sedge (*Carex inops*)
Lupine *(Lupinus* spp.)
Ocean Spray (*Holodiscus discolor*)
Orchard grass (*Dactylis glomerata*)
Oregon ash (*Fraxinus latifolia*)
Oregon white oak (*Quercus garryana*)
Oval-leaf viburnum (*Viburnum ellipticum*)
Ponderosa pine (*Pinus ponderosa*)
Pacific dogwood (*Cornus nuttallii*)
Pacific madrone (*Arbutus menziesii*)
Poison oak (*Rhus diversiloba*)
Quaking aspen (*Populus tremuloides*)
Red fescue (*Festuca rubra*)
Scotch broom (*Cytisus scoparius*)
Serviceberry (*Amelanchier alnifolia*)
Spring beauty (*Claytonia lanceolata*)
Tall Oregon grape (*Berberis aquifolium*)
Velvet grass (*Holcus lanatus*)
Western bittercress (*Cardamine oligosperma*)
Western wood strawberry (*Fragaria vesca*)
Western hemlock (*Tsuga heterophylla*)
Western ryegrass (*Elymus glaucus*)

Reptiles

Southern alligator lizard (*Elgaria multicarinata*)
Sharptail snake (*Contia tenuis*)
California mountain king snake (*Lampropeltis zonata*)

Birds

Wood duck (*Aix sponsa*)
Mallard (*Anas platyrhynchos*)
Wild turkey (*Meleagris gallopavo*)
Band-tailed pigeon (*Columba fasciata*)
Rufus hummingbird (*Selasphorus rufus*)
Lewis' woodpecker (*Melanerpes lewis*)
Acorn woodpecker (*Melanerpes formicivorus*)
Pileated woodpecker (*Dryocopus pileatus*)
Steller's jay (*Cyanocitta stelleri*)
Scrub jay (*Aphelocoma coeruescens*)
Orange-crowned warbler (*Vermivora celata*)
Nashville warbler (*Vermivora ruficapilla*)
Chipping sparrow (*Spizella passerina*)

Mammals

California ground squirrel (*Spermophilus beecheyi*)
Douglas' squirrel (*Tamiasciurus douglasii*)
Eastern gray squirrel (*Sciurus carolinensis*)
Western gray squirrel (*Sciurus griseus*)
Raccoon (*Procyon lotor*)
Black bear (*Ursus americanus*)
Striped skunk (*Mephitis mephitis*)
Mountain lion (*Felis concolor*)
Elk (*Cervus elaphus*)
Black-tailed deer (*Odocoileus hemionus*)

Appendix B. Invertebrates known to occur in Oregon white oak woodlands (Pyle 1989; L. Crabo, pers. comm.; R. Crawford, pers. comm.; J. Miller, pers. comm). (Species in bold are highly associated with the Oregon oak type and occur in Washington. Species marked with an asterisk have not yet been documented in Washington, but have been found near state borders.)

Moths and Butterflies

(Class: Insecta, Order: Lepidoptera)

Association Codes: O = Suspected obligate: larvae are known oak feeders.
A = Associate: larvae are suspected oak feeders, adults are found in oak habitats.
F = Faculative: Larvae are polyphagous and eat oak. Common, widespread moth species.

Species	Assoc. Code	Comments
Moths		
Abagrotis baueri	A	Rare; known only from oak forests at Satus Pass, Klickitat Co.; not limited to oak in Oregon
*Abagrotis pulchrata**	A	Rare west coast species known from southern Vancouver Island and 5 counties in western Oregon; larval food plant unknown
Acronicta marmorata	O	Common east of Cascades; probably in Puget prairies; known to feed on oak
*Annaphila macfarlandi**	A	Known only from Benton County, Oregon
Aseptis binotata curvata	F	Common throughout Washington
*Autographa speciosa**	A	Extremely rare; collected on southern Vancouver Island at the turn of the century, and in southwest Oregon
Bomolocha palparia	F	Western and northern Washington
Catocala aholibah	O	Uncommon; known only in Yakima County; known oak feeder
*Catocala llia**	O	Present in Oregon as far north as Marion and Wasco counties
Catocala verilliana beutenmulleri	O	Uncommon; found in Yakima and Klickitat counties; known oak feeder
Cissusa subtermina	O	Common east of Cascades and in Cowlitz Co.; probably in Puget prairies; known oak feeder
*Cosmia calami**	O	Found in the Willamette Valley and Wasco County, Oregon; known oak feeder
Egira crucialls	F	Abundant in Washington; reported specifically on *Q. garryana*
*Egira februalls**	O	Widespread from the Willamette Valley to the Columbia River; known oak feeder
Egira hiemalis	F	Common in Washington; reported specifically on *Q. garryana*
*Feralia februalis**	O	Widespread in Willamette Valley; known oak feeder
*Lacinipolia quadrilineata**	A	Widespread in western Oregon, north to the Columbia River; feeds on low herbs

Appendix B. Continued.

Species	Assoc. Code	Comments
Lithophane contenta	O	Uncommon; found in Klickitat and Thurston counties; known to feed on oak
Litocala sexsignata	A	Uncommon; found in Yakima and Klickitat counties; suspected oak feeder
Meganola miniscula	O	Common east of Cascades; known to feed on oak and lichens growing on oak branches
*Nycteola columbiana**	A	Found on southern Vancouver Island and the Willamette Valley; food-plant unknown
*Orthosia ferrigera **	O	Widespread from the Willamette Valley to the Columbia River; known oak feeder
Orthosia hibisci quinquefasciata	F	Abundant in Washington
Orthosia pacifica	A	Moderately common; most common in oak forests east of Cascades and in Cowlitz County; also in western Washington forests; also feeds on *Salix* spp.
Perigonica tertia	F	Abundant east of the Cascades; less common in Thurston County; known to feed on oak
*Pseudocopivaleria sonoma**	A	Known from Josephine and Clackamas counties, Oregon; suspected oak feeder
Pseudoglaea (new species)	F	Most common in riparian communities with oak in Yakima and Klickitat counties; also near Ellensburg; range extends to California; may feed on oak and other plants
Pseudoglaea olivata	F	Common throughout Washington
Zale lunata salicis	F	Common in western Washington and wooded portions of eastern Washington
Butterflies		
California sister *Adelpha bredowii californica*	A	Very few Washington records; in Clark and Pierce counties; in California, host plant are *Quercus* spp.; *Q. garryana* not recorded, but probable
Propertius' duskywing *Erynnis propertius*	O	Uses oak thicket openings along creeks; occurs only with *Q. garryana* in Washington, but not fully coincident with the range of this oak
California hairstreak *Satyrium californicum*	A	Uses oak among other plants; found in eastern Cascades and Blue Mountains, and Okanogan and Pend Oreille counties

Gall Wasps
(Class: Insecta, Order: Hymenoptera, Family: Cynipidae)

Species	Comments
*Andricus albicomus** (Weld)	Documented exclusively on *Q. garryana*
Andricus californicus (Ashmead)	Present in California, Oregon, and Washington on several *Quercus* spp.
*Andricus chrysolepidicola garryanae** (Kinsey)	Documented exclusively on *Q. garryana*
Andricus discularis (Weld)	Documented exclusively on *Q. garryana*
Andricus pattersonae (Fullaway)	Present in California and Washington on *Q. garryana*
*Andricus stellaris** (Weld)	Documented exclusively on *Q. garryana*
*Andricus verensis** (Weld)	Documented exclusively on *Q. garryana*
*Besbicus leachii** (Kinsey)	Documented exclusively on *Q. garryana*
Besbicus mirabilis (Kinsey)	Present in Oregon, Washington, B.C, on *Q. garryana*
Disholcaspis eldoradensis (Beutenmüller)	Present fror California to Washington on several *Quercus* spp.
*Disholcaspis mellifica** (Weld)	Documented exclusively on *Q. garryana*
Disholcaspis simulata vancouverensis (Kinsey)	Present in Oregon and Washington
Disholcaspis washingtonensis (Gillette)	Present in California, Oregon, and Washington on *Q. garryana*
Neuroterus washingtonensis (Beutenmüller)	Documented exclusively on *Q. garryana*
Synergus garryana (Gillette)	Guest in galls of *Disholcaspis eldoradensis*
*Xanthoteras teres** (Weld)	Documented exclusively on *Q. garryana*

Spiders
(Class: Arachnida, Order: Araneida)

All spiders listed occur in Washington. Those for which the name appears in bold are suspected oak-obligates.

Species	Comments
Bathyphantes sp. #1	
Callobius deces	
Ceratinopsis oregonicola	
Clubonia mimula	
Cybaeota nana	
Dictyna oregona	
***Linyphantes* sp. #8**	
Misumenops importunus	
Ozyptila conspurcata	
Pardosa distincta	Prairies associated with oak
Phrurotimpus certus	

Appendix B. Continued.

Species	Comments
Phrurotimpus parallelus	Common throughout western Washington
Theridion sp. #1	
Tricholathys rothi	Prairies associated with oak
Trogloneta sp. #1	Highly associated with but not confined to oak
Wubana ornata	
Xysticus gosiutus	
Zanomys aquilonia	
Zora hespera	
Zanomys kaiba	