OREGON OAK COMMUNITIES WORKING GROUP: CONTENT PREPARED FOR THE OOCWG WEBSITE

By David Vesely, Pacific Wildlife Research Inc.

ISSUES AND CONCERNS

Oregon White Oak: Past Distribution in the Pacific Northwest

The distribution of Oregon white oak has shifted across the Pacific Northwest for thousands of years as climatic conditions have evolved. As glaciers retreated from the region (18,000 to 10,000 years ago), spruce, fir, and tundra plants became established as soon as the ice melted. During the next 5000 years, the climate became warmer and drier, and fires became more frequent across the landscape. These conditions favored xeric (adapted to warm, dry conditions) plant communities. Pollen analysis indicates that prairies, oak savanna, and dry forests dominated by Douglas-fir and pine replaced cold-climate plant communities. Oregon white oak savannas probably reached their maximum extent at this time. Fires ignited by lighting maintained wide expanses of savanna across the Willamette Valley and southern Puget Lowlands. Pollen records suggest that oak habitats and other xeric vegetation eventually began to decline as the region became cooler and wetter. Forests of western hemlock, western redcedar, and other mesic (adapted to moderate conditions) plants became widespread. By about 6,000 years ago, the present climate and natural patterns of vegetation were established in the Pacific Northwest.

In spite of climatic conditions that have favored the expansion of conifer forests, early European explorers and settlers found vast areas of prairie and oak savanna across the Puget Lowlands and Willamette Valley. Traveling through the Willamette Valley in 1841, explorer Charles Wilkes described the landscape as being "destitute of trees, except oaks". The means by which forests were prevented from encroaching upon the prairies and savannas was fire. Although the present climate has made lightening-ignited fire a rare event in the lowlands west of the Cascades, American Indians used fire as a tool for managing natural resources. Oregon white oaks are able to endure on fire-prone landscapes where other trees are unable to become established.

The Cowlitz and Upper Chehalis Indians of the Puget Lowlands and the Kalapuya tribes of the Willamette Valley set fire to thousands of acres every year to regenerate the prairie plants on which they depended for food and medicine. Some of the most important plants were camas (*Cammassia quamash*), tarweed (*Madia* spp.), and wapato (*Sagittaria* spp.). Fire also cleared the brush from underneath oaks and made collecting acorns easier. A mush made from acorns was very important in the diet of these Indians. Some woodlands were deliberately left unburned to provide areas where deer, elk, grouse, and other game would concentrate, so that these animals could be hunted more successfully.

Pioneers arriving in western Washington and Oregon during the mid-1800's were able to suppress the practice of annual burning by the American Indians. Since then, the wide expanses of savannas and prairie have largely been converted to agricultural fields, pastureland, suburbs, and cities. The few patches of oak savanna and open woodlands that have remained undeveloped, are now being

encroached upon by Douglas-fir, grand fir, bigleaf maple, and other trees that can out-compete Oregon white oak in the absence of fire. The loss of oak-dominated habitats is recognized as a serious threat to native biodiversity of the Pacific Northwest.

Threats to Oak Habitats

Oregon white oak savannas and woodlands are among the most endangered ecological communities in the Pacific Northwest. Oak habitats face several serious threats:

- More than 99% of pre-settlement prairies and savannas in western Washington and Oregon have been converted to farms, urban areas, and other human developments.
- Valley woodlands once dominated by widely-spaced oaks are slowly transforming into forests crowded with conifers and shade-tolerant trees. Oregon white oaks are unable to survive for more than a few decades in such conditions.
- On rural landscapes, legacy oaks that persisted on pastures and woodlots for centuries are being cut down as agricultural practices intensify.
- Foresters viewed Oregon white oak as an undesirable species because no strong market has developed for the wood. Therefore, there has been no economic motivation to maintain oak woodlands.
- Invasive, non-native plants such as Scot's broom, Himalayan blackberry, and false-brome reduce the survival and growth rate of oak seedlings. Invasive plants also compete against wildflowers and grasses that are associated with oak habitats, thus reducing native biodiversity of the site.
- Park managers and homeowners do not often plant Oregon white oak for landscaping because of its reputation for slow growth.

Conservationists and public land managers in the Pacific Northwest recognize the critical role oak savannas and woodlands play as wildlife habitat and maintaining ecosystem functions. However, most federal and state lands are concentrated in the Cascades, Coast Range, and Olympic Peninsula, regions with few suitable sites for growing oaks. Therefore, the future of oak savannas and woodlands depends upon the active participation of private landowners.

CONSERVATION AND RESTORATION

Landowners can tackle much of the fieldwork necessary for restoring oak habitats on farms and small woodlands. However, some tasks such as tree felling and broadcast burning can be extremely dangerous and are better left to professionals. Private landowners are encouraged to seek out educational materials and training opportunities for oak management from university extension services, state resource management agencies, and small woodland associations. The following sections provide an introduction to some major restoration activities, as well as some examples of completed projects on public and private lands.

Oak Restoration and Management Activities

Tree Thinning

Thinning is a practice in which some trees are removed to increase growth of the trees that are retained. This effect is achieved by reducing competition among trees for limited amounts of water, nutrients, and sunlight. The remaining trees utilize these additional resources by increasing their

rate of photosynthesis and producing new wood and other tissues. A "release" thinning refers to a treatment designed to favor one tree species by removing less desirable species dominating the site, such as removing conifers to ensure the survival and growth of oaks. Thinning permits you to manage the process of tree competition and dominance. Some advantages of thinning include:

- Can be used to release oaks from conifers and shade-tolerant hardwoods that will otherwise dominate the site without active management.
- Provides an opportunity for landowners to harvest and sell trees, while improving stand conditions for oaks.
- Promotes faster growth of selected trees than is possible under natural processes of tree competition and mortality.
- Allows landowners to select for certain tree species and shape woodland structure to best meet their management plans.

Prescribed Fire

Prior to European settlement, oaks were only able to persist in the valleys and foothills of the Pacific Northwest because of American Indian burning practices and natural wildfire. Prescribed fire, which is used for a specific management objective under a narrowly defined set of environmental conditions to minimize wildfire risk, remains a useful technique for restoring and managing oak savannas and woodlands. Some of the purposes of prescribed fire include:

- Establish or maintain certain prairie plants that require fire to regenerate.
- Remove brush and undesirable tree seedlings.
- Reducing the volume of logging slash after a tree thinning.

The consequences of an out-of-control fire can be so severe that private landowners should not consider the use of fire without contact your local fire department and arranging for professional supervision of the operation.

Herbicide Treatments

Chemical herbicides are very effective for controlling brush and weeds and should be considered as one component of a flexible, integrated vegetation management plan. One important advantage of herbicides is that they can be applied without stimulating germination of new weeds from the seedbed. A successful control program not only depends on selecting the correct herbicide formula for target species on your property, but also on the timing and method of application. Many forestry herbicides are designed to be most effective at specific phases in a plant's growth cycle.

Always follow the application methods, and rates specified on the label of the herbicide. We recommend that landowners review educational materials on herbicide treatments available from local extension service staff, or a consult with a restoration specialist before implementing a large-scale herbicide treatment program.

Planting Oaks, Managing Sprouts

Direct seeding of Oregon white oak acorns should be done in the fall soon after the start of the rainy season when the upper layer of soil has been moistened. Plant acorns 1/2 to 2 inches deep if irrigation will be available for the first two summers. Plant deeper (2 to 4 in) if acorn predation by wildlife is expected to be a problem or irrigation will not be used. Wildlife can also be prevented from digging up acorns by placing a square of hardware cloth over the planting site and securing it the ground with landscape staples. These can be replaced by wire cages once the germinant appears

above ground. Oak seedlings and saplings grow very slowly in the shade of an existing tree canopy. To ensure good survival and growth, seedlings should be planted in an opening large enough to permit sunlight to reach the ground.

Because of the increasing popularity of Oregon white oaks, containerized seedlings are becoming more widely available from local nurseries. There are three primary advantages of seedlings: (1) There is no uncertainty whether an acorn will germinate; (2) Seedlings may have attained up to a year of growth under optimal nursery conditions, and will have a good head start when planted at the site; and (3) Wildlife predation and insect damage are less likely with seedlings compared to acorns.

Oregon white oaks sprout vigorously from cut stumps, roots, and dying trees. Sprouts provide a great opportunity to expand your existing stand or to manage as replacements for your mature trees when they die. Sprouts can utilize the existing root system developed by the previous tree and allocate more growth to the above-ground portions of the tree. Therefore, oaks that develop from sprouts usually achieve greater height during the first several years of development compared to trees started from acorns or seedlings. Sprouts that originate low to the ground (less than 8 inches) develop into better stems than sprouts higher on the stump. Eventually, some sprouts will clearly begin to outgrow others. Remove the slowest growing sprouts and retain the largest ones. This will ensure that all of the nutrients and water required for growth are allocated to the best candidate for the new tree stem.

Managing Wildlife Habitat

Wildlife thrived in pre-settlement savannas and oak woodlands of the Pacific Northwest. Columbia white-tailed deer and Roosevelt elk once roamed widely across the lowlands. Wolves and grizzly bears hunted large these herbivores among the oaks, and California condors scavenged the carcasses of their victims. Although the large carnivores are long gone from western Oregon and Washington, much of the wildlife diversity associated with oak woodlands and savannas remains today. Considering the impact that cities, agriculture, and roads have made on the landscape, its remarkable that only six of the approximately 200 vertebrate species that use oak habitats in the region are listed as endangered, threatened, or are candidates for such listing by the US Fish and Wildlife Service. Nevertheless, there is evidence that habitat loss or fragmentation poses an increasingly serious threat to perhaps two dozen more species in the Puget lowlands and valleys of western Oregon. Among the most imperiled species are the western rattlesnake, western meadowlark, vesper sparrow, streaked horned lark, and Botta's pocket gopher. So what steps can landowners do to enhance conditions for wildlife on their property? Here are some points to remember:

- Protect existing oaks from encroachment by other tree species. Dense, mixed species stands are relatively common—pure oak woodlands are a rare habitat type.
- On large properties, manage for a variety of patch sizes and types. Some wildlife species prefer large closed-canopy stands of oaks, other species prefer stands with canopy gaps, and still others tend to use edges between woodlands and open areas.
- Ensure adequate spacing among oaks to maintain tree growth and health. Thin oaks before tree canopies begin to overlap.
- Maintain or create large diameter snags and logs for wildlife.

Monitoring

Documenting management actions and monitoring their effects on trees, other vegetation, and wildlife is crucial to achieving your long-term goals. Landowners must recognize that native plant communities are complex and dynamic ecosystems that do not always develop according to our predictions. Monitoring activities should be designed to measure progress toward your restoration goals. If a goal is important enough for you to invest your time, land, and money, then it seems prudent to take steps to assess whether your management actions are leading toward the desired future condition for your property.

Photographs taken every five years are perhaps one of the easiest ways to record vegetation changes over time. Each photo in the series should be taken from exactly the same point (establish a permanent marker!) and precisely framed to encompass the same area of the stand. Including a vertical, brightly-painted pole of a known length within the frame allows viewers to estimate heights of ground vegetation layers. Make sure that you take each photo at the same time each year so that the series shows long-term vegetation trends, not seasonal changes in foliage. Keep good notes about your photo sessions.

Past and Ongoing Projects

USFWS Baskett Butte Refuge, Polk County, Oregon *[confirmed]*

Adam Novick Property, Lane County, Oregon *[confirmed]*

Columbia Gorge National Scenic Area, Hood River County, Oregon *[confirmed]*

Columbia Land Trust, Klickitat County, WA *[confirmed]*

Integrated Resource Management Projects *[Connie is preparing a project summary]*

ECOLOGY AND CURRENT DISTRIBUTION OF COMMON OAKS IN THE PACIFIC NORTHWEST

Oregon white oak has, by far, the most extensive distribution of any *Quercus* species across the Pacific Northwest. However two other oaks, Canyon live oak and black oak are common in southwest Oregon and the Klamath region of California. The following information on these three species has been collected from Burns and Honkala[1], where further details about the life histories of these trees can be found.

Canyon Live Oak (*Quercus crysolepsis*)

[1] Burns, R.M. and B.H. Honkala. 1990. Silvics of North America, Vol. 2, Hardwoods. Washington DC: U.S.D.A. Forest Service Agriculture Handbook 654.

*** Geographic Range:** In southern Oregon, canyon live oak grows on the interior side of the Coast Ranges and on the lower slopes of the Cascade Range. Its range extends southward through the Klamath Mountains and the Sierra Nevada to Baja, Mexico. Isolated populations occur in Nevada and Arizona.
* **Soils and Topography:** In southwest Oregon, Canyon live oak usually grows on steep, shallow, rocky, infertile soils having little soil development. Where soils are deeper, the species usually occurs as a sub-dominant component of the forest canopy or as a shrub. Canyon live oak grows at elevations of 1,600 to 5,000 ft in southwestern Oregon. As it's name implies, Canyon live oak is often the dominant tree in steep, rocky canyons.
*** Plant Communities:** In southwestern Oregon, canyon live oak is primarily associated with Douglas-fir, tanoak, giant chinkapin (*Castanopsis chrysophylla*), and Pacific madrone (*Arbutus menziesii*) in the mixed evergreen forests. Canyon live oak is less tolerant of shade than its associates in the mixed evergreen forests of the Siskiyou region, but is more tolerant than Pacific madrone. Canyon live oak occurs as an early successional shrub or tree, but is soon outgrown by its associates and eliminated from a stand. On drier, more open sites, it persists in the climax forest as a subordinate tree and shrub. Only on very rocky, canyon walls does it occur as a dominant in the climax forest.
*** Reproduction and Growth:** Canyon live oak trees do not usually begin producing flowers until they are 15-20 years old. Flowering usually occurs in May or June. Acorn production is somewhat irregular; good crops tend to occur at 2-3 year intervals. Acorns mature in one season and fall to the ground in October. Canyon live oak also regenerates from sprouts that appear from dormant buds when the tree is injured or burned. Sprout growth can be rapid-growth of more than 3 ft in one year has been measured. Saplings and mature trees grow slowly.
*** Other Notes:** Canyon live oak was used historically for farm implements, shipbuilding, furniture, and fuel. One of it's common names, maul oak, came from its use as handles for splitting mauls.

Oregon White Oak (*Quercus garryanna*)

*** Geographic Range:** At it's northernmost extent, Oregon white oak occurs on Vancouver Island, isolated populations in the Frasier Valley, British Columbia and on islands in Puget Sound. The species is common along the Columbia River Gorge and in interior valleys of western Oregon. In California, Oregon white oak occurs in the Klamath region, interior Coast Range, and localized populations in the southern Sierras.
*** Soils and Topography:** Oregon white oak grows on a wide range of soil series, but is outgrown by faster growing trees on good sites. The species can survive on seasonally-flooded clay soils, as well as xeric sites-conditions to which its competitors are poorly adapted. Oregon white oak typically occurs on flood plains, terraces, and gentle slopes.
*** Plant Communities:** Oregon white oak occurs as scattered trees in savanna communities and in pure or mixed-species closed canopy woodlands. The Oregon Natural Heritage Information Center has identified nine native plant associations in the state that are dominated by Oregon white oak. Pacific madrone (Arbutus menziesii), western serviceberry (Amelanchier alnifolia), ponderosa pine (Pinus ponderosa), Douglas-fir (*Pseudotsuga menziesii*), and grand fir (*Abies grandis*) are among the most common tree species that co-occur with Oregon white oak. Poison-oak (*Rhus diuersiloba*) and common snowberry (*Symphoricarpos albus*) are perhaps the most characteristic shrubs of Oregon white oak habitats. Oregon white oak is typically a seral species that only maintains dominance over competing trees through the action of natural disturbance, usually fire. Several characteristics of white oaks (low amount of resin, thick bark, capability to withstand

injuries) allow the species to survive on fire-prone landscapes where other species are unable to become established. The vast expanses of oak savanna that were perpetuated by annual burning conducted by American Indian tribes largely have transitioned into dense, closed canopy woodlands or converted to agricultural uses since European settlement. In the absence of fire, Oregon white oak woodlands will eventually become dominated by tree species that are faster growing or more shade tolerant such as Douglas-fir, grand fir, and bigleaf maple. Oregon white oak can occur as a climax species on droughty sites or where natural fire is frequent.
*** Reproduction and Growth:** Oregon white oak flowers between March-June, depending upon latitude and elevation. Acorns mature in one season and drop between late August and November. Annual acorn production is irregular. In the Willamette Valley, one heavy acorn crop was estimated to be 1,550-lbs/per ac. Acorns germinate soon after coming into contact with the ground. Oregon white oak also regenerate from sprouts that arise from dormant buds at the base of the tree or on exposed roots. The species usually grows slowly in both height and diameter. Measurements taken from cut stumps across widely separated locations indicate that 16 to 20 rings per inch are typical, although much faster growth has been measured at some sites.
*** Other Notes:** Like other western oaks, Oregon white oak is not widely utilized for commercial purposes because of the uncertain supply of oak logs for mills and the species' slow growth. It has been used in limited production flooring and cabinet stock. Oregon white oak has proven to have exceptional properties for the manufacture of wine barrels.

California Black Oak (*Quercus kelloggii*)

*** Geographic Range:** California black oak is most common in the northern Coast Range of California and along the west side of the southern Cascades and Sierra Mountains. The species is locally common in southwestern Oregon. Northernmost populations occur near Eugene, Oregon.
*** Soils and Topography:** The species requires well-drained sites for good growth. Coarse- and medium-textured soils provide the most suitable conditions; the species is rarely found on clay soils. California black oak occurs across a wide range of topographic positions: from flat, valley floors having gravel soils to high, montane ridges. The species can withstand high moisture stress and thrive on sites too dry for most other tree species.
*** Plant Communities:** California black oak usually occurs as a component of hardwood stands or mixed hardwood-conifer forests. More than 20 different tree species and 30 shrubs are known to co-occur on sites with California black oak. Some of the most commonly associated species are ponderosa pine (*Pinus ponderosa*), knobcone pine (*Pinus attenuata*),California white fir (*Abies concolor var. lowiana*), bigcone Douglas-fir (*Pseudotsuga macrocarpa*), tanoak (*Lithocarpus densiflorus*), Pacific madrone, and Oregon white oak. California black oak typically occurs as a dominant or co-dominant tree in even-age forests that result from a stand replacement fire. The species rarely occurs in forest understories.
*** Reproduction and Growth:** California black oak flowers from mid-March to mid-May depending on local conditions. Acorns mature in the second year. Trees typically don't produce any acorns until they are at least 30 years old and don't yield abundantly until they are more than 80 years old. The magnitude of the acorn crop varies greatly from year-to-year. Depending on the location of the stand, abundant crops may occur every 2-3 years, or as infrequently as one out of every eight years. Most regeneration occurs from vegetative sprouts that originate from the stump of a tree that was cut or burned. Sprouts can grow more than 7 ft in height in four years following cutting. Saplings can grow faster than most other tree species that co-occur on the same sites,

including conifers, and dominate a stand for many years. One study found that 100-year old California black oaks average 72 ft in height.
*** Other Notes:** During the late-1800's, shipbuilders along the northern California Coast manufactured ship keels and ribs from California black oaks having forked stems of certain dimensions. Today, California black oaks are utilized for pallets, industrial lumber, and fuelwood.

RESEARCH

Although the oaks of the Pacific Northwest have not been studied as intensively as commercial tree species in the region, hundreds of scientific papers and government reports have been written on different aspects of oak ecology and management. The following bibliography includes a selection of literature that may be of broad interest to ecologists, land managers, and restoration practitioners. Two recent bibliographies are excellent sources of further research information:

Fuchs, Marilyn A. 2001. Towards a Recovery Strategy for Garry Oak and Associated Ecosystems in Canada: Ecological Assessment and Literature Review. Technical Report GBEI/EC-00-030. Environment Canada, Canadian Wildlife Service, Pacific and Yukon Region. URL: http://www.goert.ca/

Harrington, C.A. and M. Kallas. 2002. A bibliography for *Quercus garryana* and other geographically associated and botanically related oaks. Gen. Tech. Rep. PNW-GTR-554. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 115 p. http://www.fs.fed.us/pnw/publications/index.shtml

The bibliography has been arranged according to the following six topics:

- Autecology [species-specific studies]
- Plant Community Studies
- Ecological Restoration
- Oak Management
- Wildlife & Invertebrate Studies
- Human Culture and Oaks

Autecology

Coblentz, B.E. 1980. Production of Oregon white oak acorns in the Willamette Valley, Oregon. Wildlife Society Bulletin 8:348-350.

Fuchs, M.A., P.G. Krannitz, and A.S. Harestad. 2000. Factors affecting emergence and first-year survival of seedlings of Garry oaks (*Quercus garryana*) in British Columbia, Canada. For. Ecol. Manage. 137:209-219.\

Fuchs, M.A.; Krannitz, P.G.; Harestad, A.S.; Bunnell, F.L. 1997. Seeds that fly on feathered wings: acorn dispersal by Steller's jays. In: Pillsbury, N.H.; Verner, J.; Tietje, W.D., eds. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues. Gen. Tech. Rep.

PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 648–
650. URL: http://www.psw.fs.fed.us/Tech_Pub/gtrs.html

Glendenning, R. 1944. The Garry oak in British Columbia - an interesting example of discontinuous distribution. Can. Field-Nat. 58:61-65.

Hibbs, D.E. and B.J. Yoder. 1993. Development of Oregon white oak seedlings. Northw. Sci. 67:30-36.

Papanikolas, S. 1997. The effects of shade and planting date on Oregon white oak (*Quercus garryana*) Seedlings. M.Sc. Thesis, Univ. of Washington, Seattle, WA.

Stein, W.I. 1990. *Quercus garryana* Dougl. ex Hook. Pp. 650-660 in R.M. Burns and B.H. Honkala, tech. coords. Silvics of North America. Volume 2. Agricultural Handbook 654. US Department of Agriculture Forest Service, Timber Management Research, Washington, DC.

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

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

Voeks, R.A. 1981. The Biogeography of Oregon White Oak (*Quercus garryana*) in Central Oregon. M.Sc. Thesis, Portland State Univ., Portland, OR.

Plant Community Studies

Agee, J.K. 1990. The historical role of fire in Pacific Northwest forests. In: Walstad, J.D.; Radosevich, S.R.; Sandberg, D.V., eds. Natural and prescribed fire in Pacific Northwest forests. Corvallis, OR: Oregon State University Press: 25–38.

Allen, G.B.; Brown, K.J.; Hebda, R.J. 1999. Surface pollen spectra from southern Vancouver Island, British Columbia, Canada. Canadian Journal of Botany. 77(6):786–799.

Barnhart, S.J.; McBride, J.R.; Warner, P. 1996. Invasion of northern oak woodlands by *Pseudotsuga menziesii* (Mirb.) Franco in the Sonoma Mountains of California. Madroño. 43(1): 28–45.

Barnosky, C.W. 1981. A record of late-Quaternary vegetation from Davis Lake, southern Puget Lowland, Washington. Quaternary Research. 16: 221–239.

Erickson, W.R. 1996. Classification and interpretation of Garry oak (*Quercus garryana*) plant communities and ecosystems in southwestern British Columbia. Victoria, BC: University of Victoria. 530 p. M.S. thesis.

Franklin, J.F.; Dyrness, C.T. 1988. Natural vegetation of Oregon and Washington. Corvallis, OR: Oregon State University Press. 452 p. (110–129)

Habeck, J.R. 1961. The original vegetation of the mid-Willamette Valley, Oregon. Northwest Science. 35(2): 65–77.

Hansen, H.P. 1938. Postglacial forest succession and climate in the Puget Sound region. Ecology. 19(4): 528–542.

Johannessen, C.L., W.A. Davenport, A. Millet, and S. McWilliams. 1971. The vegetation of the Willamette Valley. Assoc. Am. Geogr. Annals 61:286-302.

Lang, F.A. 1961. A study of vegetation change on the gravelly prairies of Pierce and Thurston Counties, western Washington. Seattle, WA: University of Washington. 109 p. M.S. thesis.

Merrifield, K. 2000. Bryophytes on isolated *Quercus garryana* trunks in urban and agricultural settings in the Willamette Valley, Oregon. The Bryologist. 103(4):720–724.

Pike, L.H. 1973. Lichens and bryophytes of a Willamette Valley oak forest. Northwest Science. 47(3): 149–158.

Regan, A.C. 2001. The effects of fire on woodland structure and regeneration of *Quercus garryana* at Fort Lewis, Washington. Seattle, WA: University of Washington. 69 p. M.S. thesis.

Riegel, G.M., B.G. Smith and J.F. Franklin. 1992. Foothill oak woodlands of the interior valleys of southwestern Oregon. Northw. Sci. 66:66-76.

Ryan, M.W. 1991. Distribution of Bryophytes and Lichens on Garry Oak. M.Sc. Thesis, Univ. of Victoria, Victoria, BC.

Salstrom, D. 1989. Plant Community Dynamics Associated with *Quercus garryana* on Pt. Disney, Waldron Island, Washington. M.Sc. Thesis, Western Washington Univ., Bellingham, WA.

Smith, W.P. 1985. Plant associations within the interior valleys of the Umpqua River basin, Oregon. Journal of Range Management. 38(6): 526–530.

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

Stone, D.F. 1989. Epiphyte succession on *Quercus garryana* branches in the Willamette Valley of western Oregon. The Bryologist. 92(1): 81–94.

Whitlock, C. 1992. Vegetational and climatic history of the Pacific Northwest during the last 20,000 years: implications for understanding present-day biodiversity. Northwest Environmental Journal. 8: 5–28.

Ecological Restoration

Agee, J.K. 1989. Fire in restoration of Oregon white oak woodlands. Pp. 72-73 in C.C. Hardy and S.F. Arno, eds. The Use of Fire in Forest Restoration. Gen. Tech. Rep. GTR-341. US Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Antieau, C.J.; Gaynor, P.E. 1990. Native grassland restoration and creation in western Washington. Restoration and Management Notes. 8(1): 34–35.

Bell, R. and S. Papanikolas. 1997. Restoration planting of Oregon white oak seedlings in western Washington. Pp. 247-257 in P.V. Dunn and K. Ewing, eds. Ecology and Conservation of the South Puget Sound Prairie Landscape. The Nature Conservancy of Washington, Seattle, WA.

Brooks, C.N.; Merenlender, A.M. 2001. Determining the pattern of oak woodland regeneration for a cleared watershed in northwest California: a necessary first step for restoration. Restoration Ecology. 9(1): 1–12.

Reed, L.J. and N.G. Sugihara. 1987. Northern oak woodlands: ecosystem in jeopardy or is it already too late? Pp. 59-63 in T.R. Plumb and N.H. Pillsbury, tech. coords. Proceedings of the Symposium on Multiple-Use Management of California's Hardwood Resources, 12-14 Nov. 1986, San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. US Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Sugihara, N.G. and L.J. Reed. 1987a. Prescribed fire for restoration and maintenance of Bald Hills oak woodlands. Pp. 446-451 in T.R. Plumb and N.H. Pillsbury, tech. coords. Proceedings of the Symposium on Multiple-Use Management of California's Hardwood Resources, 12-14 Nov. 1986, San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. US Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Tveten, R.K. and R.W. Fonda. 1999. Fire effects on prairies and oak woodlands on Fort Lewis, Washington. Northw. Sci. 73:145-158.

Oak Management

Barry, S.J.; Knight, R.S.; McCreary, D.D. 1997. Pruning oak resprouts to enhance growth. In: Pillsbury, N.H.; Verner, J.; Tietje, W.D., eds. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 667–670. URL: http://www.psw.fs.fed.us/Tech_Pub/Documents/gtr-160/gtr-160-cover.pdf

Espenas, L.D.; Kozlik, C.J. 1975. Drying Oregon white oak lumber. Res. Pap. 27. Corvallis, OR: Oregon State University, Forest Research Laboratory. 8 p.

Hall, F.C.; Hedrick, D.W.; Keniston, R.F. 1959. Grazing and Douglas-fir establishment in the Oregon white oak type. Journal of Forestry. 57(2): 98–103.

Hedrick, D.W.; Keniston, R.F. 1966. Grazing and Douglas-fir growth in the Oregon white-oak type. Journal of Forestry. 64(1): 735–738.

Jackson, R.D.; Fulgham, K.O.; Allen-Diaz, B. 1998. *Quercus garryana* Hook. (Fagaceae) stand structure in areas with different grazing histories. Madroño 45(4): 275–282.

Larsen, D.R.; Johnson, P.S. 1998. Linking the ecology of natural oak regeneration to silviculture. Forest Ecology and Management. 106(1): 1–7.

Larsen, E.M. 1997. Management Recommendations for Washington's Priority Habitats: Oregon White Oak Woodlands. Washington Department of Fish and Wildlife, Olympia, WA.

Rose, R.; Chachulski, C.E.C.; Haase, D.L. 1998. Propagation of Pacific Northwest native plants. Corvallis, OR: Oregon State University Press. 248 p.

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

Sauerwein, W.J. 1983. Oregon white oak. Woodland Series 14 [Tech. Note]. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service. 5 p.

Standiford, R.B., tech. coord. 1991. Proceedings of the Symposium on Oak Woodlands and Hardwood Rangeland Management, 31 Oct.-2 Nov. 1990, Davis, CA. Gen. Tech. Rep. PSW-126. US Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Ussery, J.G. and P.G. Krannitz. 1998. Control of Scot's broom (*Cytisus scoparius* (L.) Link.): the relative conservation merits of pulling versus cutting. Northw. Sci. 72:268-273.

Wildlife and Invertebrate Studies

Anderson, S.H. 1970. The avifaunal composition of Oregon white oak stands. Condor 72:417-423.

Barrett, R.H. 1980. Mammals of California oak habitats: management implications. Pp. 275-291 in T.R. Plumb, tech. coord. Proceedings of the Symposium on the Ecology, Management, and Utilization of California Oaks, 26-28 June 1979, Claremont, CA. Gen. Tech. Rep. FS-44. US Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Bayrakci, R.; Carey, A.B.; Wilson, T.M. 2001. Current status of the western gray squirrel population in the Puget Trough, Washington. Northwest Science. 75(4):333–341.

Block, W.M. and M.L. Morrison. 1998. Habitat relationships of amphibians and reptiles in California oak woodlands. J. Herpetol. 32:51-60.

Block, W.M., M.L. Morrison, and J. Verner. 1990. Wildlife and oak-woodland interdependency. Fremontia 18:72-76.

Brown, L.R. 1980. Insects feeding on California oak trees. In: Plumb, T.R., ed.Proceedings of the symposium on the ecology, management, and utilization of California oaks. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department ofAgriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 184–194.

Clark, B.K and D.W. Kaufman. 1990. Short-term responses of small mammals to experimental fire in tallgrass prairie. Can. J. Zool. 68:2450-2454.

Cornell, H.V. 1985. Local and regional richness of cynipine gall wasps on California oaks. Ecology. 66(4): 1247–1260.

Fox, J.F. 1982. Adaptation of gray squirrel behavior to autumn germination by white oak acorns. Evolution 36:800-809.

Gumtow-Farrior, D.L. 1991. Cavity resources in Oregon white oak and Douglas-fir stands in the mid-Willamette Valley, Oregon. Corvallis, OR: Oregon State University. 89 p. M.S. thesis.

Hagar, J.C.; Stern, M.A. 2001. Avifauna in oak woodlands of the Willamette Valley, Oregon. Northwestern Naturalist. 82: 12–25.

McShea, W.J. 2000. The influence of acorn crops on annual variation in rodent and bird populations. Ecology. 81(1): 228–238.

Miller, J.C. 1990. Field assessment of the effects of a microbial pest control agent on nontarget Lepidoptera. Am. Entomol. 36:135-139.

Miller, J.C., P.E. Hanson and D.N. Kimberling. 1991. Development of the gypsy moth (Lepidoptera: Lymantriidae) on Garry oak and red alder in western North America. Environ. Entomol. 20:1097-1101.

Roberts, R.C. 1987. Preserving oak woodland bird species richness: suggested guidelines from geographical ecology. Pp. 190-197 in T.R. Plumb and N.H. Pillsbury, tech. coords. Proceedings of the Symposium on Multiple-Use Management of California's Hardwood Resources, 12-14 Nov. 1986, San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. US Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Rodrick, E.A. 1986. Survey of historic habitats of the western gray squirrel (*Sciurus griseus*) in the southern Puget Trough and Klickitat County, Washington. Seattle, WA: University of Washington. 41 p. M.S. thesis.

Rohlfs, D.A. 1999. A Study of Acorn Feeding Insects Filbert Weevil (*Curculio occidentis* (Casey)) and Filbertworm (*Cydia latiferreana* (Walsingham)) on Garry Oak (*Quercus garryana*) (Dougl.)) in the Southeastern Vancouver Island Area. M.Sc. Thesis, Univ. of British Columbia, Vancouver, BC.

Ryan, L.A. and A.B. Carey. 1995. Biology and Management of the Western Gray Squirrel and Oregon White Oak Woodlands: With Emphasis on the Puget Trough. Gen. Tech. Rep. PNW-348. US Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Siemann, E., J. Haarstad, and D. Tilman. 1997. Short-term and long-term effects of burning on oak savanna arthropods. Am. Midl. Nat. 137:349-601.

Smith, J.L. 1995. Life History, Survivorship, and Parasitoid Complex of the Jumping Gall Wasp, *Neuroterus saltatorius* (Edwards), on Garry Oak, *Quercus garryana* Douglas. M.Sc. Thesis, Univ. of Victoria, Victoria, BC.

Van Dersal, W.R. 1940. Utilization of oaks by birds and mammals. Journal of Wildlife Management. 4(4): 404–428.

Wilson, S.M.; Carey, A.B. 2001. Small mammals in oak woodlands in the Puget Trough, Washington. Northwest Science. 75(4): 342–349.

Human Culture and Oaks

Bainbridge, D.A. 1987. The use of acorns for food in California: past, present, future. In: Plumb, T.R.; Pillsbury, N.H., eds. Proceedings of the symposium on multiple-use management of California's hardwood resources. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 453–458.

Boag, P.G. 1992. Environment and experience settlement culture in nineteenth-century Oregon. Berkeley, CA: University of California Press. 209 p.

Boyd, R. 1986. Strategies of Indian burning in the Willamette Valley. 1986. Can. J. Anthro. 5:65-86.

Hall, F.C. 1956. Use of oak woodlands (*Quercus garryana*) for farm forestry and grazing in the Willamette Valley. Corvallis, OR: Oregon State University. 80 p. M.S. thesis.

Johnson, H.M. 1933. Oregon white oak: properties and uses. The Timberman:14–16.

Lalande, J.; Pullen, R. 1999. Burning for a "fine and beautiful open country": Native uses of fire in southwestern Oregon. In: Boyd, R., ed. Indians, fire and the land in the Pacific Northwest. Corvallis, OR: Oregon State University Press: 255–276.

Norton, H.H. 1979. The association between anthropogenic prairies and important food plants in western Washington. Anthropological Res. Notes 13:175-200.

Norton, H.H.; Boyd, R.; Hunn, E. 1999. The Klikitat Trail of south-central Washington, a reconstruction of seasonally used resource sites. In: Boyd, R., ed. Indians, fire and the land in the Pacific Northwest. Corvallis, OR: Oregon State University Press: 65–93.

Towle, J.C. 1982. Changing geography of Willamette Valley woodlands. Oregon Historical Quarterly. 83: 66–87.

Turner, N.C. and M.A.M. Bell. 1971. The ethnobotany of the Coast Salish Indians of Vancouver Island. Economic Botany 25:63-99.

Towle, J.C. 1979. Settlement and subsistence in the Willamette Valley: some additional considerations. Northw. Anthro. Res. Notes 13:12-21.

Turner, N.J. 1999. "Time to burn:" traditional use of fire to enhance resource production by Aboriginal Peoples in British Columbia. Pp. 185-218 in R. Boyd, ed. Indians, Fire and the Land in the Pacific Northwest. Oregon State Univ. Press, Corvallis, OR.

LINKS TO OTHER RESOURCES

The following table is provided as a guide to useful on-line resources provided by government agencies, universities, and conservation organizations.

Category	Name	Contact Information	Notes
Native Plant Suppliers	PlantNative.com	http://www.plantnative.com/index.htm	National directory of native plant sources and information
	D.L. Phipps State Forest Nursery (Oregon Dept. of Forestry)	http://www.odf.state.or.us/AREAS/southern/nursery/	Source of Oregon native tree seedlings
	Pacific Northwest Native Plant Sources	http://www.tardigrade.org/natives/nurseries.html	
	Washington Native Plant Society	http://www.wnps.org/nurserylist.html	List of suppliers in Washington
	Native Seed Network	http://www.nativeseednetwork.org/home/index.php	List of native plant suppliers
Wildland Fire Safety	Firewise.com	http://www.firewise.org/	
	Washington Dept. of Natural Resources	http://www.dnr.wa.gov/htdocs/rp/prevent.htm	

Category	Name	Contact Information	Notes
	Oregon Dept. of Forestry	http://www.odf.state.or.us/DIVISIONS/protection/fire_protection/	
	British Columbia Ministry of Forests	http://www.for.gov.bc.ca/protect/	
Forestry Equipment & Supplies	Forestry Suppliers Inc.	http://www.forestry-suppliers.com/	
	Ben Meadows Inc.	http://www.benmeadows.com/	
Farm & Woodland Technical Assistance	BLM Landowner's Guide to Restoring & Managing Oregon White Oak Habitats	http://www.or.blm.gov/salem/html/whatwedo/oak_publication/oak_pub_page.htm	Free publication on Oregon white oak management and ecology
	Natural Resource Conservation Service & Farm Service Agency	See http://www.nrcs.usda.gov for local offices	Technical assistance for habitat management
	National Association of Conservation Districts	See http://www.nacdnet.org/resources/cdsonweb.html for local district offices	
	PrivateForest.org	http://www.privateforest.org/	Website containing links to many information sources
	Oregon State University Forestry Extension Program	http://www.cof.orst.edu/cof/extended/extserv/pubs.php	
	Oregon Small Woodlands Association	http://www.oswa.org/index.html	
	Oregon Dept. of Forestry stewardship foresters	http://www.odf.state.or.us/DIVISIONS/management/forestry_assistance/assist/	Provide technical assistance for developing woodland stewardship programs
	Washington Farm Forestry Association	http://www.wafarmforestry.com/	
	Washington Forest Stewardship Program	http://www.dnr.wa.gov/htdocs/rp/steward.htm	List of technical assistance and funding programs
	Washington State University Dept. Natural Resources Forestry Extension	http://ext.nrs.wsu.edu/forestryext/index.htm	
Habitat Conservation & Restoration Grant & Cost-share Opportunities	Natural Resource Conservation Service & Farm Service Agency	See http://www.nrcs.usda.gov for local offices	Several loan, cost-share and easement programs for agricultural lands: CRP, WHIP, EQUIP
	Oregon Watershed Enhancement Funding Directory	http://www.oweb.state.or.us/directory/fundingintro.html	
	Oregon Dept. of Forestry list of funding sources	http://www.odf.state.or.us/divisions/management/forestry_assistance/	State and federal programs listed
	Oregon Forest Resource Trust Program	http://www.odf.state.or.us/divisions/management/forestry_assistance/trust/	
	Washington Forest Stewardship Program	http://www.dnr.wa.gov/htdocs/rp/steward.htm	List of technical assistance and funding programs
	Washington Dept. of Fish & Wildlife	http://wdfw.wa.gov/lands/lip/	Landowner incentive program

Category	Name	Contact Information	Notes
Plant Community Restoration	Washington Native Plant Society	http://www.wnps.org/	
	Native Plant Society of Oregon	http://www.npsoregon.org/	
Oregon White Oak Biology and Ecology	Forest Service, Oregon white oak bibliography	http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=4822	A comprehensive bibliography of oak research and management papers
	Oregon Oak Communities Working Group	http://www.oregonoaks.org	
	British Columbia Garry Oak Ecosystem Recovery Team	http://www.goert.ca/	