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Patterns of Old Growth Harvest and Implications For Cascades Wildlife

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Introduction

Although intensive harvest of the old-growth Douglas-fir (*Pseudotsuga menzeisii*) forests on federal lands west of the Cascade Mountains began in the late 1940s and 1950s, the wildlife habitat implications were not widely perceived until the late 1960s and early 1970s. For example, state agency habitat assessments in western Oregon in 1966 and 1967 (Hutchison et al. 1966, Aney 1967) did not identify old-growth harvest as an issue. As of 1977, the Coniferous Forest Biome research program of the U.S. International Biological Program (IBP) had produced 532 publications, bulletins, theses, and internal reports. Fourteen, or 2.6 percent, of these deal with vertebrate ecology; none deal with impacts of Douglas-fir management on wildlife (Edmonds 1977). It is partly because of this late awareness that the old-growth harvesting issue has surfaced so dramatically. Luman and Neitro (1980), Meslow et al. (1981), and Schoen et al. (1981) have called for national attention in the last two sessions of this conference. This paper describes the harvesting pattern and presents basic ecological information that may be of use in assessing impacts. We suggest habitat conservation strategies derived from island biogeography principles. All statistics and area references refer to Oregon and Washington west of the Cascades crest unless otherwise noted. Because of time and personal background limitations we consider only amphibians, reptiles, and mammals.

Harvesting Trends

For the last 30 years, annual loss and removal of Douglas-fir sawtimber from western Washington and western Oregon has averaged 3 times annual growth (USDA 1978: tables 34, 35, 36). During the 1950s private industry made large gains toward balancing the cut with growth. Small gains were made on public lands in the 1960s, but overall the trend has been toward greater deficit cutting (Figure 1, USDA 1978). While there has been a modest 5 percent reduction in total commercial forest acreage, the reduction in net volume of softwood growing stock has been 18 percent, the reduction in net volume of softwood sawtimber has been 21 percent, and the reduction in large-diameter-class softwood has been 34 percent. This trend may continue in the future, as "public old-growth harvest substitutes

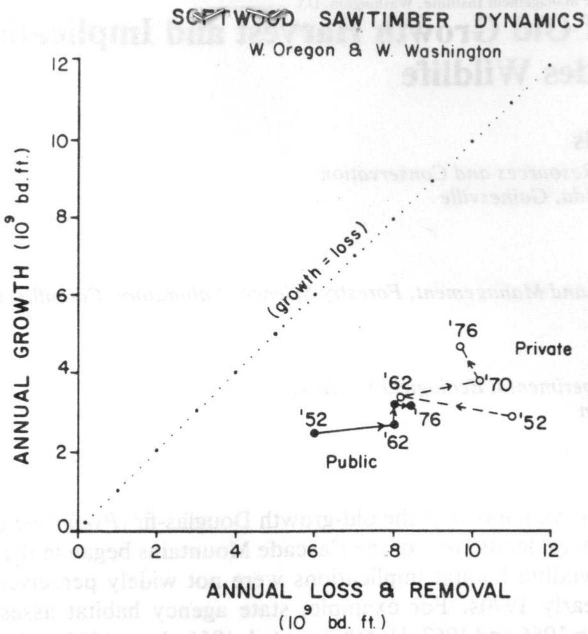

Figure 1. Disparity between annual growth, and annual loss and removal of softwood from private and public lands in western Washington and western Oregon. USDA 1978.

for private young-growth harvest over the next 25 years'' (Adams 1977, Brodie et al. 1978). Yet, a different analysis suggests that ''only in the north coast timbershed in western Oregon and in the three eastern Oregon timbersheds could harvesting continue at the current level for the next 30 years . . . for western Oregon as a whole, this projection indicates a decline of 22 percent by the year 2000.'' (Beuter et al. 1976). Only when the recently planted stands reach high levels of mean annual increment will the current annual cut be matched by annual production.

Cutting statistics for the Willamette National Forest in west central Oregon illustrate the trend for the region. Except during the depression of the mid 1930s, the harvest has increased geometrically since the First World War. Between 1935 and 1965 the annual rate of increase in volume of cut was 4.7 percent. This has resulted in a doubling of the cut every 15 years (Figure 2).

The Spatial Cutting Pattern

In 1900, old-growth Douglas-fir forests were distributed from near sea level to over 4,000 feet (1,220 m) elevation. The larger trees and volumes were restricted to the lower elevations and river valleys (Figure 3, Langille et al. 1903). Cutting statistics for the Willamette N.F. indicate the widespread and dramatic shift in cutting from the low elevations in the 1940s to higher elevations during the 1970s (Figure 4). In addition to the high standing volumes, there are logistic and economic

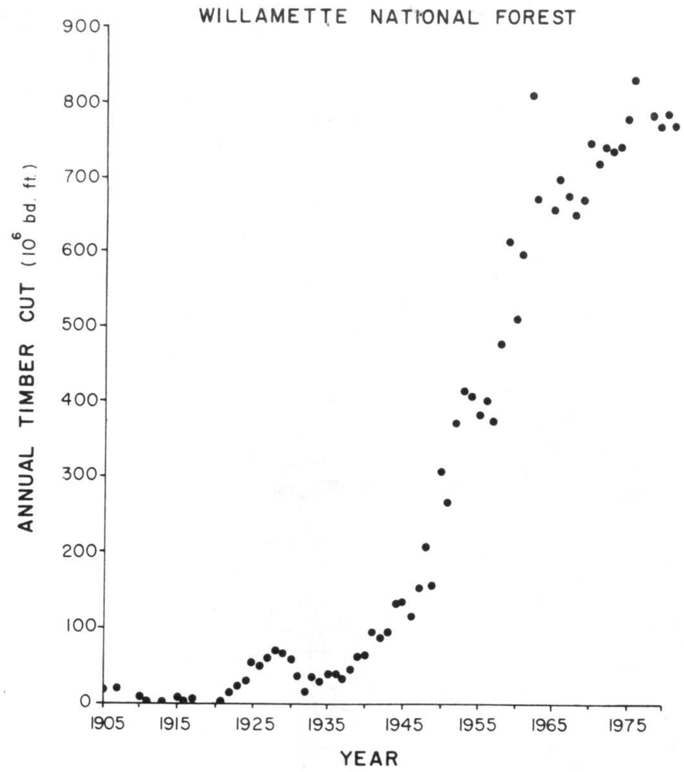

Figure 2. Annual timber cut in million bd. ft. from the Willamette National Forest. Data from historical cutting summary, timber management plan, Willamette N.F. (effective date FY 1977).

advantages to cutting the low elevation and valley bottom sites first. Thus the general pattern has been for clearcutting to begin at low elevations, proceed up the river valleys, and terminate in the steep terrain of the high elevation sites where volumes are low because of extreme environments and frequent fires. Because of lower volumes per acre, and because the average tree is progressively younger and smaller (Tedder 1979), the increase in acreage cut on the Willamette N.F. has been five times greater than the increase in volume cut during the last 40 years (data from Paulson and Leavengood 1977, Acreage cut data from T.R.I. System Forest Supervisor's Office, Eugene, Ore.).

The Situation Today

The temporal and spatial patterns described above have led to conditions as we know them today. A sample of 77 3.9-square-mile (10 km^2) quadrats taken from 1981 Willamette N.F. vegetation type maps suggests that about 25 percent of the Willamette N.F. remains in ''old-growth.'' This is equal to the percentage of National Forest land west of the Cascades summit that is greater than 250 years

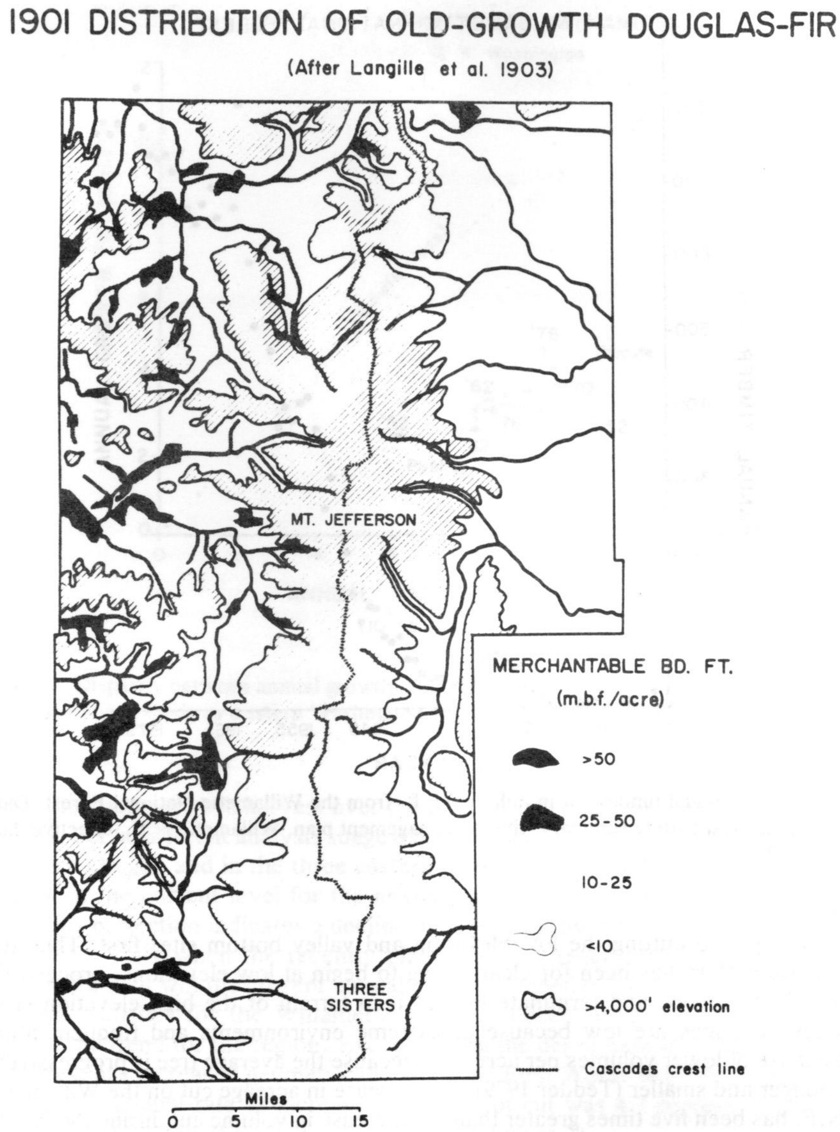

Figure 3. Distribution of Douglas-fir in the Cascade Forest Reserve (now the Willamette N.F.) by volume class and elevation in 1901. (Redrawn from Langille et al. 1903).

old and has had less than 10 percent of the timber removed (Sirmon, in press). Only 3.3 percent of the Siuslaw N.F. remains in old-growth Douglas-fir (TRI System, Forest Supervisor's Office, Corvallis, Ore.). Meslow et al. (1981) note that the situation in southwestern Washington and northwestern Oregon is particularly critical; the Olympic penninsula (including Olympic National Park) is nearly

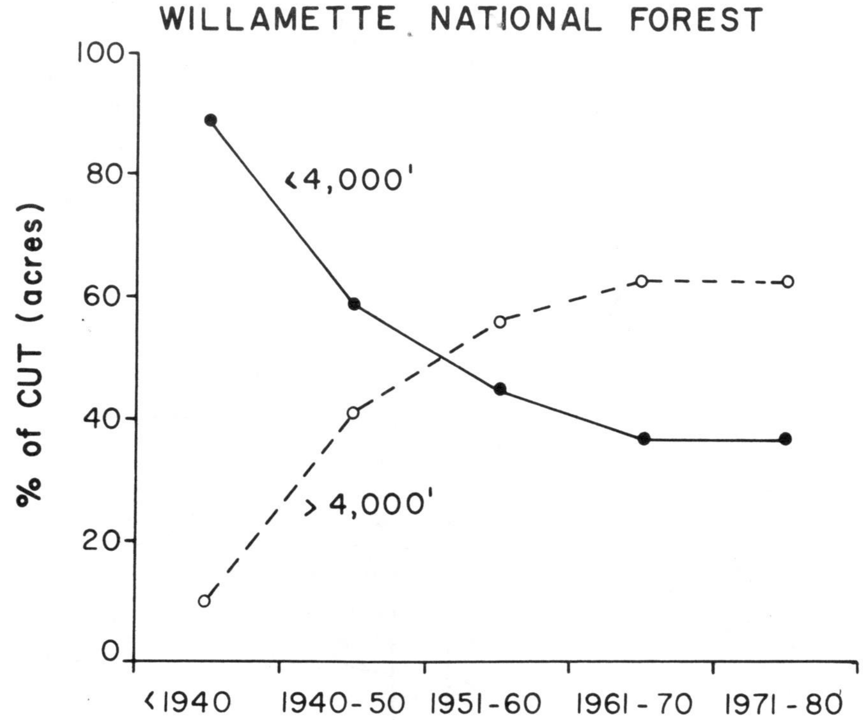

Figure 4. Percentage of total annual cut from two elevation classes in the Willamette N.F. Data extracted from Total Resource Inventory (TRI) system, Forest supervisor's office, Eugene, Ore.

isolated by 60 miles (96 km) of development. Private industry has little old-growth remaining on its lands (Beuter et al. 1976), and it is projected that old-growth will be liquidated from Bureau of Land Management (BLM) Lands within 30 years (Luman and Neitro 1980). Since active regeneration policies have been in effect only 20 years, the distribution of stand age classes on public lands is distinctly bimodal. About 40 percent of BLM acreage is stocked with trees less than 60 years old, about 44 percent has trees over 110 years old, and only 17 percent is between 60 and 110 years of age.

Of equal importance to the reduction in total old-growth acreage and change in age distribution is the reduction in average patch size and the insularization of old-growth habitat islands. In certain areas old-growth remains as the matrix, with clearcuts and young stands appearing as the islands. A gradation of patterns with increasing proportions of clearing leads to the opposite extreme where young growth is clearly the matrix and old-growth occurs only as totally isolated stands (Figure 5). Remaining old-growth stands of the Siuslaw N.F. have a median size of 31 acres (12.6 ha) and a mean of 68.2 acres (27.6 ha). Exact figures for inter-island distances are not yet available but they approach 5 miles (18 km) in three of the four districts of the Siuslaw N.F.

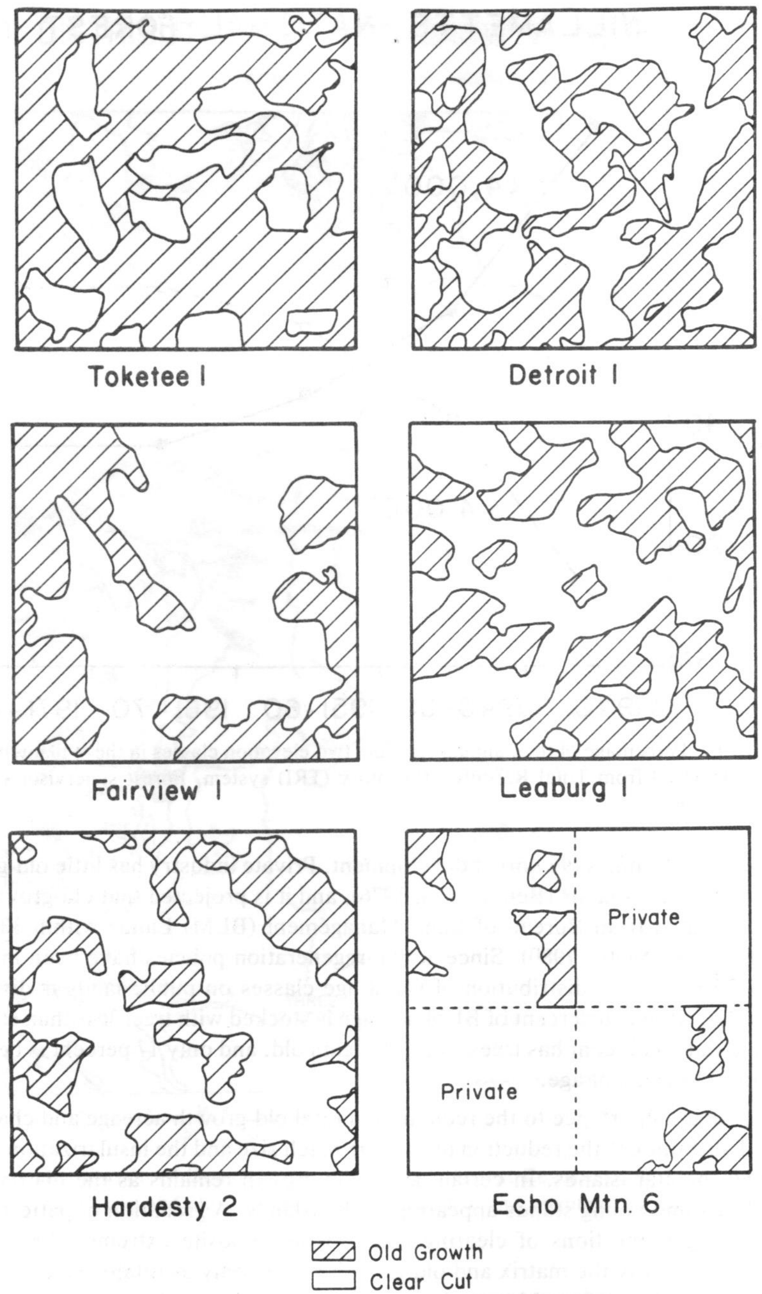

Figure 5. Current distribution of old-growth in 5 representative 3.9-square-mile (10 km^2) quadrat samples taken from 1981 vegetation type maps of the Willamette N.F. Names refer to quadrangle maps programmed into the TRI system. Forest Supervisor's office, Eugene, Ore.

Some Consequences For Wildlife

In an attempt to evaluate the effects of old-growth insularization on wildlife we conducted preliminary faunal surveys in 15 old-growth stands in the Willamette N.F. in the summer of 1981. During the survey we recorded data on 15 site-specific variables such as size of area, elevation, degree of isolation, shape, slope, aspect, and a description of site and stand characteristics such as occurrence of surface water, talus, down logs, snags, and vegetation composition. At each site we proceeded through the list of potential amphibian, reptile, and mammal species and assigned subjective probability values to the presence or absence of each species (Maser et al. 1981).

Despite the small sample size and several confounded variables, it soon became apparent that the variable of greatest importance in governing potential species richness is elevation. We plotted the distributional range of the 108 amphibian, reptile, and mammal species of Western Oregon as a function of elevation (e.g., Figure 6). The 95 species that potentially occur at 1,000 ft (300 m) above sea level is about 40 percent greater than the number of potential species at 4,000 ft (1,200 m) and 2.4 times the number that occur at 6,000 feet (1,800 m) (Table 1). Small mammal trapping data and bird census data from the H. J. Andrews Experimental Ecological Reserve (Unpub. US/IBP data), and small mammal trapping data from Mount Rainier National Park (Schamberger 1970) suggest a slight inverse relation between density of all species combined and elevation.

We recognize that elevation is not a management variable, but the decision to allocate old-growth management areas to low, medium, or high elevation sites is a decision variable of critical importance. To date, old-growth harvesting has been particularly intense at lower elevations. Conversely, wilderness areas, parks, and old-growth set-aside areas occur disproportionately at high elevations (Figure 7). The historical pattern of wildfire (Langille et al. 1903), and thus the probability of future wildfire, is much greater on high elevation sites (Burke 1979). Coupled with the threat of windthrow, landslides, slumps, and other forest protection problems associated with high elevations, these sites make poor choices as old-growth management areas that are expected to persist for centuries. Maintenance of communities intrinsically rich in vertebrate species over long periods of time will require protection of low elevation sites in addition to the present system of high elevation refuges.

A second variable of importance in governing potential species richness is the presence of surface water and wetness of the site. The 96 species that potentially occur on moist sites is about 2.6 times as many as occur on very wet sites and 1.7 times as many as occur on very dry sites. If community richness is the objective, then old-growth management areas should be located on moist sites containing surface water. But, since site potential and standing volume are closely correlated with moisture availability, these sites have been disproportionately logged and replanted. Increased attention needs to be given to moist sites when selecting old-growth habitat islands.

Complexity of habitat corresponds with successional development and may be represented by discrete stand structure types (Figure 8). Ordination of vertebrate species along the successional gradient reveals that the two extremes of age (regeneration stands and old-growth) support notably high vertebrate species rich-

Figure 6. Ordination of western Oregon mammal distributions as a function of elevation.

Table 1. Number of western Oregon amphibian, reptile, and mammal species whose ranges transcend noted elevation points.

Elevation in feet (m)	No. Species
500 (150)	95
1000 (300)	95
2000 (600)	90
3000 (900)	84
4000 (1200)	68
5000 (1500)	60
6000 (1800)	40
7000 (2100)	32
8000 (2400)	17

ness (e.g., Figure 9). This is especially obvious if a distinction is drawn between primary habitat and secondary habitat on the basis of suitability for all natural history functions (e.g., feeding, overwintering, reproducing, escaping). Very early or very late successional stages provide primary habitat for twice as many species as the middle-aged stands (Figure 10). Short rotation forests that do not include the last two successional stages (large sawtimber and old-growth) will not provide primary habitat for 36 species of amphibians, reptiles, and mammals. Although some of these species may use the short rotation forests as secondary habitat, they require that older-aged stands or specific patches of primary habitat be maintained within the short rotation forest. Unfortunately, the two mid-successional stages of least value to wildlife dominate about 60 percent of the standard rotation time (80 years).

Two habitat elements that explain much of the increase in species richness in older stands are standing snags and fallen logs (Thomas et al. 1979, Maser et al. 1979, Franklin et al. 1981). First-generation plantations where residual snags and logs have been retained will provide habitat for species that will not occur in later generation plantations not containing these elements. The tally of species that will occur in short rotation stands without snags is reduced 10 percent below the number occurring in stands with snags (Figure 11). The number of species occurring in short rotation stands that contain neither snags nor fallen logs is reduced about 29 percent below the number occurring in unmanaged old-growth stands. Based on these observations and projections we strongly endorse current recommendations for the inclusion of broken-top trees, snags, and fallen logs in short rotation stands (Thomas 1979).

A final point concerning the changing forest structure centers on the expected shift in age class frequencies in time. At present, about 20 percent of western Oregon and western Washington public forest acreage has trees in the middle classes between age 30 and 80 (only 15 percent of BLM acreage). Over half of the acreage is stocked with trees either less than 30 or greater than 200 years of age (51 percent of BLM acreage). In other words, while only 20 percent occurs in the age classes that have a notably low number of species, over 50 percent occurs in

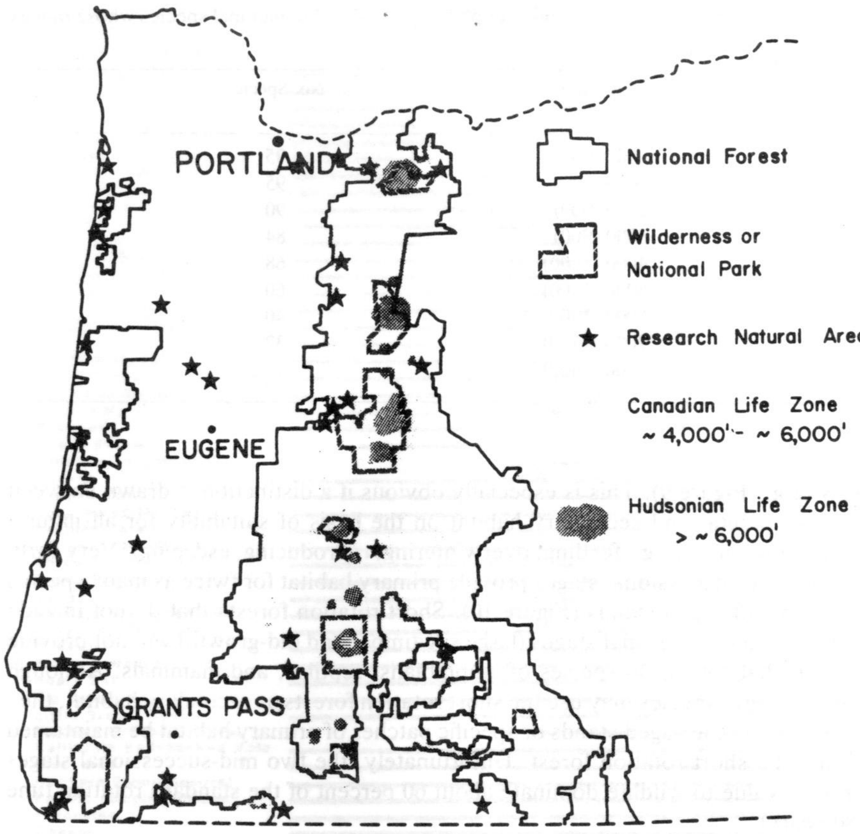

Figure 7. Location of western Oregon national forests, parks, wilderness areas, and research natural areas against the backdrop of the high elevation Canadian and Hudsonian life zones (Bailey 1936). Most protected old growth occurs at elevations above the range of 25 mammal species. Data and location map contributed by Sarah Green and Bob Frenkel.

the age classes supporting the highest number of species. Fifty years from now as much as 65 percent of public land acreage and a higher percentage of total acreage will fall between the ages of 30 and 90. Unless remedial steps are taken, wildlife population declines, similar to the declines in midwestern and eastern areas earlier this century will probably occur.

Habitat Island Design Principles

Island biogeographers recognize two distinct kinds of islands (Darlington 1957). Oceanic islands such as Krakatoa were never associated with a continental land mass and thus the animal community developed from initial colonist species to progressively richer and more complex levels. Islands such as those of the Aleutian chain were formerly points on a continuous land mass. Their origin involves isolation due to rising sea levels. The animal communities of these islands have

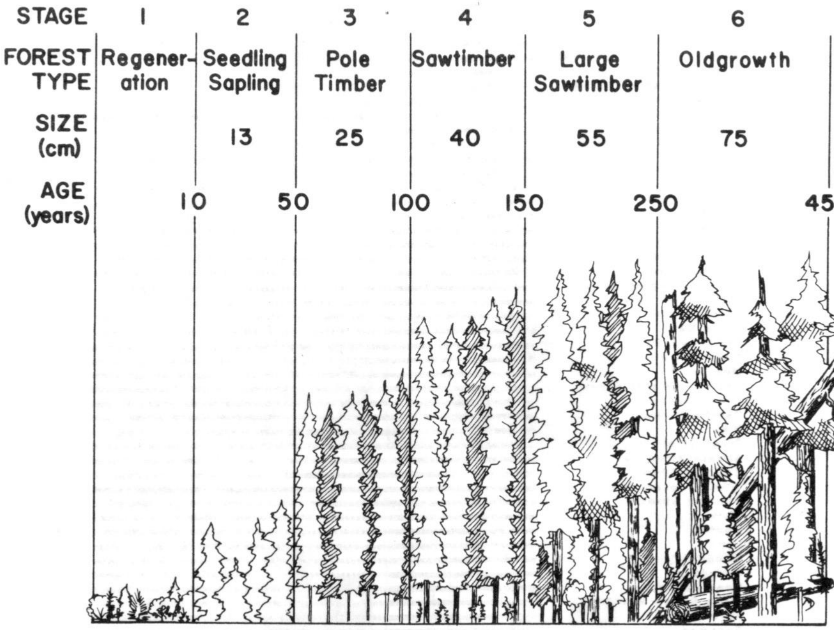

Figure 8. Six discrete stand types representing the development of structural complexity in Douglas-fir-western hemlock (*Tsuga heterophylla*) stands.

regressed from higher levels of species richness characteristic of larger continents to a reduced number of species characteristic of islands. An important principle of island biogeography is that, when standardized for size and degree of isolation, true oceanic islands never develop the same level of species richness as the land bridge islands. Type of origin has considerable influence on species richness.

If the true island analogy applies to old-growth habitat islands and we wish to maintain high levels of species richness, we should identify patches of old-growth that are, or were recently, part of the contiguous natural forest. This proposition begs the question of which patches. It also implies that selection of areas, with some principles in mind, will be, on average, superior to what will result if we make no choice at all (Harris and Kangas 1979, Harris 1980, Harris and Marion 1981). We have assembled data regarding habitat island biogeography and the species depletion process for the Cascades and believe many principles of biogeography derived from true islands apply to old-growth habitats. For example, consider the 375-square-mile (968 km^2) Mt. Rainier National Park an island in the surrounding sea of development. The park presently supports populations of 37 species of mammals. This is 43 percent of the 86 species that occur in western Washington and 54 percent of the species that potentially occur in the park. The 37 present species represent only 74 percent of the species recorded in the park in 1920 by Taylor and Shaw (Weisbrod 1976). The loss of 13 species might be explained on an individual basis, but the fact remains that 26 percent of the mammal species found in 1920 do not presently occur in the park.

Figure 9. Ordination of western Oregon mammal species as a function of the successional stages of Douglas-fir noted in Figure 8.

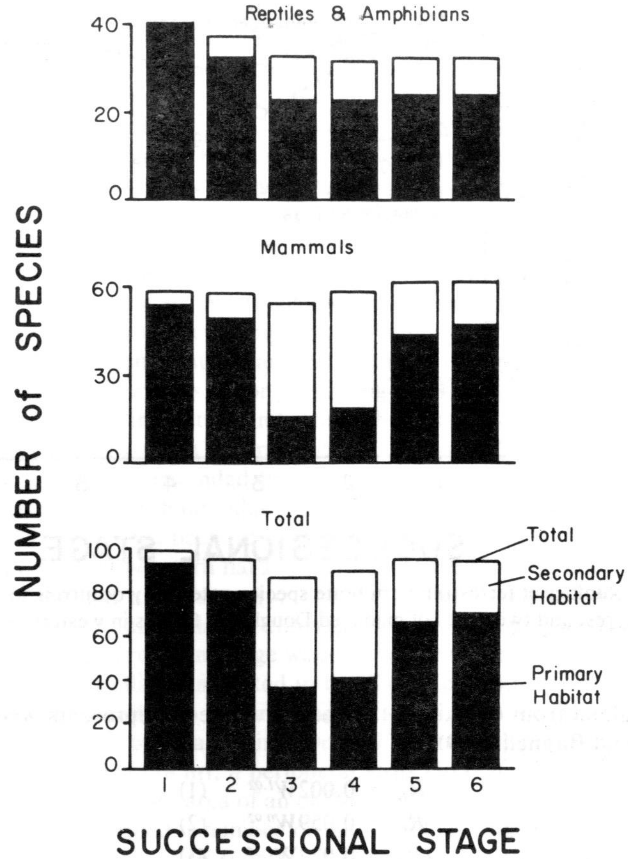

Figure 10. Number of amphibian and reptile, mammal, and total cursorial vertebrate species meeting their primary and/or secondary habitat requirements in the different successional stages illustrated in Figure 8.

The same depletion process is occurring throughout western Oregon. The grizzly (*Ursus arctos*), gray wolf (*Canis lupus*) and fisher (*Martes pennanti*) have been extirpated. Wolverines (*Gulo gulo*) and lynx (*Lynx canadensis*) are very rare. Notably, these are all top carnivores. Olterman and Verts (1972) reviewed the status of 41 Oregon mammal species of questionable status. Of those ever occurring in the western Cascades, the difference between trophic status and numerical status is revealing. Seven of the eight species (88 percent) judged to be "extirpated," "rare," or "endangered" are carnivores. Conversely, five of eight species (62 percent) in the "not rare or endangered" category are herbivores. It seems not only intuitive but true that carnivores deserve special consideration in our efforts to conserve animal community diversity.

Estimates of home range size (in ha) for herbivores, omnivores, and carnivores

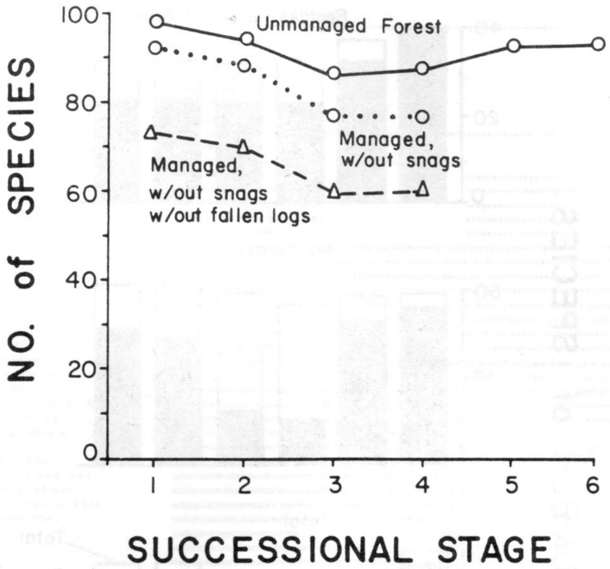

Figure 11. Number of terrestrial vertebrate species potentially occurring in an unmanaged Douglas-fir forest and two types of managed Douglas-fir forests in western Oregon.

can be obtained from equations 1, 2, and 3 where *W* represents weight in grams (Harestad and Bunnell 1979):

$$R_H = 0.002W^{1.02} \quad (1)$$
$$R_O = 0.059W^{0.92} \quad (2)$$
[1]$$R_C = 0.022W^{1.30} \quad (3)$$

Based on these equations, the projected range size for a 145 pound (66 kg) cougar (*Felis concolor*) is over 100,000 acres (440,000 ha), a 40 pound bobcat (*Lynx rufus*) is 19,000 acres (7,700 ha), a 35 pound (16 kg) wolverine is 16,000 acres (6,500 ha), a 25 pound (11 kg) otter (*Lutra canadensis*) is 10,000 acres (4,000 ha), a 15 pound (6.8 kg) fisher is 5,000 acres (2,000 ha), and a 125 pound (57 kg) blackbear (*Ursus americanus*) is 3,500 acres (1,400 ha). Compare these home range estimates with the size of the 10 largest old growth Douglas-fir stands in the Siuslaw N.F.: 971 (390), 734 (300), 655 (265), 640 (260), 572 (230), 536 (220), 509 (205), 478 (195), 457 (185), 304 (125) acres (ha). It becomes immediately obvious that none of the species listed could be contained by or expected to exist totally within even the largest existing old growth stand. Paying no regard to minimum population size, the six widest-ranging mammal species presently occurring in the Suislaw N.F. could not be contained by even the largest existing old growth islands.

We realize that these species are not restricted to old-growth, and that their survival is not totally dependent on the preservation of islands of old-growth. We

[1]Revised equation based on data published in Harestad and Bunnell 1979.

cite the statistics to demonstrate that old-growth set asides, in and of themselves, will not suffice as a conservation strategy for many of the wider-ranging species. Conversely, if the largest existing old-growth islands (at least in the Siuslaw N.F.) are not sufficiently large to support the full complement of native species, it is relevant to one of the often heard debates, "either a smaller number of large areas or a larger number of smaller areas." This does not argue against the choice of large old-growth islands for habitat management but, for any given acreage commitment, the extremes of strategy are few large areas versus many small areas. Because of the above and other considerations mentioned previously, it seems that some of the emphasis should now be changed from the old-growth system to the system of old-growth. We recommend development of an interdependent system of strategically located habitat islands interconnected by habitat corridors. Specific design recommendations are forthcoming. The adequacy of a tract of old-growth for any given species or for preserving a full complement of species is not only dependent upon the nature and size of the tract, but the degree of insularity and the setting within which the tract occurs. A 50-acre (20 ha) tract demarcated by flagging tape and surrounded by hundreds of acres of similar habitat would have a much different habitat value than a 50-acre tract surrounded by clearcut.

Bond (1957) noted that because of climatic changes induced by clearing, small, isolated stands of midwestern hardwood forest tended toward drier "preclimax" conditions. He went on to state (p. 374) that, "Recognition of the relationship between woods size and relative climaxness helps explain why there are more species in this study preferring large woods than those preferring smaller woods." Wind penetration studies conducted in the Cascades tend to support the rule of thumb that a peripheral strip of remaining forest "three-tree-heights" wide will be climatically impacted by clearcutting (Dr. L. Fritschen, pers. comm.). Based on a tree height of 250 feet (78 m), a peripheral strip 750 feet (232 m) wide would be required to buffer the core area of an old-growth stand from climatic impact.

Curtis (1956) described a number of plant ecology changes believed to result from the insularization of Wisconsin woodlots. Kendeigh (1944) observed that when forest stands were less than about 50 acres (20 ha) the proportion of "edge species" of birds became so great as to invalidate use of the plot for censusing "forest interior" species. Several authors have addressed the minimum size concept (e.g., Anderson and Robbins 1981, Lovejoy and Oren 1981) and most conclude that something will be lost no matter what minimum size is chosen.

We suggest that minimum size is not a constant that can be discovered, but rather a variable depending on the specific objective, the surroundings, and the circumstances. In order to maintain its old-growth character we believe that an area totally surrounded by clearcut or regeneration stands would need to be 10 times as large as an old-growth area surrounded by mature timber. The size of stands should be inversely proportional to the insularity caused by surrounding young growth. Based on our surveys and related research we believe that a 62 acre (25 ha) patch will maintain its integrity as an old-growth stand if surrounded by mature timber. As progressively more of the periphery is cut away, the stand size would need to be increased accordingly (Figure 12).

Considering old-growth island size a variable rather than a constant should offer increased flexibility to forest managers and provide incentive for the management of long rotation islands. An interdependent system of long rotation islands con-

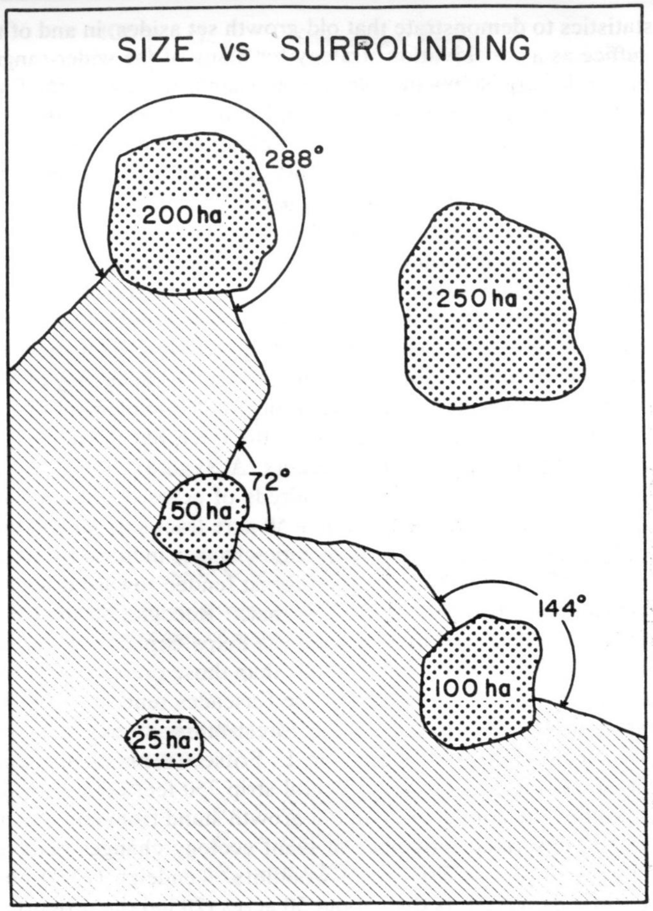

Figure 12. Inverse relation between recommended size of old-growth stands and the degree of insularity determined by surroundings.

taining old-growth stands that are interconnected by travel corridors should address the habitat requirements of old-growth wildlife species as well as the wide ranging species dependent upon several habitat types. Further research into old-growth as a habitat type as well as the characteristics of an ideal system of old-growth stands is badly needed.

Summary

Perceptions of the significance of old-growth harvesting in western Oregon and western Washington have been quite recent. While there has been a modest 5 percent reduction in commercial forest acreage, the reduction in softwood net volume, softwood sawtimber, and large diameter sawtimber has been 18 percent, 21 percent, and 34 percent, respectively. Cutting predominated on low elevation sites during early decades but has since shifted to predominantly high elevation

sites. Approximately 25 percent of the Willamette N.F. remains in old-growth. The largest old-growth Douglas-fir stand remaining in the Siuslaw N.F. is less than 1,000 acres (400 ha); the median size is 31 acres (12.5 ha), and the mean is 68 acres (27.6 ha).

Vertebrate species diversity declines inversely with elevation and yet most old-growth set-aside areas occur at high elevations. Vertebrate species diversity is high in very early and very late stages of the Douglas-fir successional sequence. This suggests that an inter-dependent system of clearcuts and old-growth stands should be interspersed throughout the managed forest. We believe habitat island size should be treated as a variable rather than a constant. Recommended size is inverse to the degree the stand is exposed to clearcuts and young stands. Long rotation management islands that buffer the old-growth stands will minimize the old-growth acreage required as set-asides.

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