

Acker, S. A., J. F. Franklin, et al. (2006). "Two decades of stability and change in old-growth forest at Mount Rainier National Park." Northwest Science **80**(1): 65-72.

We examined how composition and structure of old-growth and mature forests at Mount Rainier National Park changed between the mid-1970s and mid-1990s. We assessed whether the patterns of forest dynamics observed in lower elevation old-growth forests in the Pacific Northwest held true for the higher-elevation forests of the Park. We used measurements of tree recruitment, growth, and mortality on 18 permanent plots that spanned the range of forested environments in the Park. Similar to previous studies, there was little change in stand structure and composition, while a relatively large number of individual stems died or were recruited into the tree population. Most recruitment was of shade-tolerant tree species. Unlike some previous studies, in many stands recruitment of shade-tolerant individuals occurred without substantial mortality of shade-tolerant trees in the upper canopy. Habitat characteristics associated with old-growth forest changed little in most stands. One exception was a mature noble fir stand in which a brief episode of tree mortality, apparently due to drought and pathogens, increased similarity to old-growth structure. Plots in old-growth forest on the coldest and wettest sites in the Park had low similarity to the published definition of upper-slope old-growth forest at both the beginning and end of the study, suggesting that the existing definition may not apply at these environmental extremes.

Box, J. B., J. Howard, et al. (2006). "Freshwater mussels (Bivalvia : Unionoida) of the Umatilla and Middle Fork John Day rivers in eastern Oregon." Northwest Science **80**(2): 95-107.

Freshwater mussels are valuable components of intact salmonid ecosystems and are culturally important to Native Americans. An inventory of the freshwater mussels in the Umatilla and Middle Fork John Day rivers in Oregon was conducted in the summer of 2003. Freshwater mussels were found at all sites surveyed in the Middle Fork John Day River, but at less than 10% of the sites sampled in the Umatilla River system. All three genera of freshwater mussels known to occur in the western United States were found in the Middle Fork John Day River, and co-occurred at almost 50% of the sites sampled. In the Umatilla River, two genera were found. Anodonta and Gonidea, but only in the lower main stem and one tributary. Live Margaritifera were not found in the Umatilla River, although historically they occurred in the system. Shell material collected in the current survey suggests Margaritifera occurred in the Umatilla River main stem until very recently. Habitat degradation, including active channel change and the decline of salmonid and other native fish populations may have contributed to the extirpation of freshwater mussels from historical locations. The data collected in this survey will be used to provide essential information for designing a recovery plan for freshwater mussels in the Umatilla River system, as part of ongoing efforts to rebuild ecosystem function and diversity.

Caplan, J. S. and J. A. Yeakley (2006). "Rubus armeniacus (Himalayan blackberry) occurrence and growth in relation to soil and light conditions in western Oregon." Northwest Science **80**(1): 9-17.

Rubus armeniacus (Himalayan blackberry) is an invasive plant in disturbed habitats in the Pacific Northwest. At 41 sites dominated by R. armeniacus, we measured stand height, mean florican length, canopy cover, slope, aspect, and soil properties (color, NO<sub>3</sub> +

NO<sub>2</sub>-N, organic matter, particle size distribution, and pH). For several soil properties we compared our data to National Resource Conservation Service soil survey data for the soils near our sites. *R. armeniacus* occurred in soils that contained more sand (by 25.6%,  $P < 0.001$ ), less silt (by 9.4%,  $P = 0.03$ ) and less clay (by 13.4%,  $P < 0.001$ ) than this non-biased, random sample of western Oregon soils. Ln(stand height) was significantly related to canopy cover ( $R^2 = 0.44$ ,  $P < 0.001$ ) and florican length was significantly related to gravel ( $R^2 = 0.11$ ,  $P = 0.03$ ). Our results suggest that shade was a primary environmental determinant of *R. armeniacus* occurrence and growth. Our results further suggest that *R. armeniacus* is tolerant of a wide range of soil conditions, notably coarse texture. An ability to withstand soils with low water content or low nutrient availability with only a small reduction in growth may explain *R. armeniacus* occurrence on more coarse-textured substrates than are typical for western Oregon soils. In combination with its adaptation to high light availability conditions, this factor may help explain the frequent occurrence of *R. armeniacus* in anthropogenically disturbed habitats.

Donoghue, E. M. and N. L. Sutton (2006). "Socioeconomic change in planning provinces of the Northwest Forest Plan Region." *Northwest Science* **80**(2): 73-85.

The Northwest Forest Plan's 1994 Record of Decision (ROD) established a framework for a new ecosystem approach to federal land management across 24 million acres of the Pacific Northwest. One strategy outlined in the ROD combined ecosystem management and civic involvement in the creation of planning provinces, consisting of 12 contiguous multi-ownership areas spanning the Plan region. The ROD also directed agencies to monitor the effectiveness of the Plan, including the implementation of a socioeconomic monitoring program. We defined communities within provinces in order to better understand socioeconomic change. We developed a composite measure of community socioeconomic well-being (SEWB) to compare communities within the 12 planning provinces based on their proximity to Forest Service (FS) and Bureau of Land Management (BLM) lands. Some provinces improved in SEWB over the decade and some declined, but this was not related to how much FS and BLM lands were in the province, nor how many communities in the province were close to FS and BLM lands. Communities within 5 miles of FS and BLM lands had significantly lower SEWB scores compared to communities farther away in both 1990 and 2000. Income inequality increased significantly between 1990 and 2000 for communities within 5 miles of FS and BLM lands but showed no significant change for communities farther away. As existing jurisdictions that span multiple land ownerships with mechanisms for dialogue and learning among stakeholders and decisionmakers, planning provinces provide opportunities for increased understanding of the ways that forest management affects to community socioeconomic well-being. Information on socioeconomic conditions of communities in planning provinces is an important step in understanding how communities change and what factors contribute to change.

Gedalof, Z., M. Pellatt, et al. (2006). "From prairie to forest: Three centuries of environmental change at Rocky Point, Vancouver Island, British Columbia." *Northwest Science* **80**(1): 34-46. Garry oak (*Quercus garryana*) savannas are among the most endangered ecosystems in Canada. In coastal British Columbia the vast majority of Garry oak savannas have been developed for residential, agricultural, or industrial use. Much of the remaining habitat is

threatened by conifer encroachment or invasion by exotics. In this study tree-ring analysis was used to reconstruct stand composition and structure of an oak savanna at Rocky Point, on southern Vancouver Island, British Columbia. At the time of European settlement, the site was largely open prairie, with a few scattered oak trees. Establishment of Garry oak at Rocky Point began shortly after settlement of the area by Europeans-probably due to the cessation of frequent burning by indigenous peoples. Since the 1950s, however, Douglas-fir and grand fir have been encroaching on the Garry oak savanna. The causes of this invasion are unclear, but the invasion signals a clear transition in the stand structure and composition. Oak seedlings are abundant, but few saplings exist-suggesting that oak is not regenerating at Rocky Point. Mechanical removal of conifers would help maintain the Garry oak community over the near future, but given the nearly complete lack of oak recruitment, some restoration of ecosystem processes-most likely fire-will be required to maintain a functioning Garry oak ecosystem. This management strategy will be severely constrained by changes in stand structure resulting from decades of fire exclusion, the potential for weedy exotics to invade the post-fire communities, and the presence of an ammunition depot nearby.

Haskell, C. A., K. F. Tiffan, et al. (2006). "Food habits of juvenile American shad and dynamics of zooplankton in the lower Columbia River." Northwest Science **80**(1): 47-64.

As many as 2.4 million adult American shad annually pass John Day Dam, Columbia River to spawn upriver, yet food web interactions of juvenile shad rearing in John Day Reservoir are unexplored. We collected zooplankton and conducted mid-water trawls in McNary (June-July) and John Day reservoirs (August-November) from 1994 through 1996 during the outmigration of subyearling American shad and Chinook salmon. Juvenile American shad were abundant and represented over 98% of the trawl catch in late summer. The five major taxa collected in zooplankton tows were *Bosmina longirostris*, *Daphnia*, cyclopoid copepods, rotifers, and calanoid copepods. We evaluated total crustacean zooplankton abundance and *Daphnia* biomass in relation to water temperature, flow, depth, diel period, and cross-sectional location using multiple regression. Differences in zooplankton abundance were largely due to differences in water temperature and flow. Spatial variation in total zooplankton abundance was observed in McNary Reservoir, but not in John Day Reservoir. Juvenile American shad generally fed on numerically abundant prey, despite being less preferred than larger bodied zooplankton. A decrease in cladoceran abundance and size in August coupled with large percentages of *Daphnia* in juvenile American shad stomachs indicated heavy planktivory. Smaller juvenile American shad primarily fed on *Daphnia* in August, but switched to more evasive copepods as the mean size of fish increased and *Daphnia* abundance declined. Because *Daphnia* are particularly important prey items for subyearling Chinook salmon in mainstem reservoirs in mid to late summer, alterations in the cladoceran food base is of concern for the management of outmigrating salmonids and other Columbia River fishes.

Johnson, E. M. and D. K. Rosenberg (2006). "Granary-site selection by acorn woodpeckers in the Willamette Valley, Oregon." Northwest Science **80**(3): 177-183.

The acorn woodpecker is among the most common primary cavity nesting bird of the Oregon white oak woodlands. In most of their range, acorn woodpeckers are dependent

on granaries for acorn storage, yet little is known about their selection of granary sites, We compared habitat characteristics within 12 m of granary and non-granary trees at 20 acorn woodpecker colonies in Benton County, Oregon during the winter of 2001. Compared to non-granaries, granary plots consistently had greater oak basal area and shorter shrub height, and granary trees were of larger diameter. Within each of the 20 sites, oak basal area was greater near granary than non-granary trees. This, together with the selection for larger diameter granaries, suggests acorn woodpeckers are more likely to locate granaries in the immediate area of high acorn production. Increased acorn production in the vicinity of granaries is likely beneficial to the birds because minimal effort is expended in caching maximum forage. Our results shed light on granary selection at the spatial scale of the immediate area surrounding granaries and suggest factors associated with acorn woodpecker distribution at the landscape scale.

Kirkpatrick, H. E., J. W. S. Barnes, et al. (2006). "Moss interference could explain the microdistributions of two species of monkey-flowers (*Mimulus*, Scrophulariaceae)." Northwest Science **80**(1): 1-8.

Two species of monkey-flowers (*Mimulus guttatus* and *M. lewisii*) differ in their microdistributions along small slow-moving streams in western Washington state: *M. guttatus* generally grows in the streambeds with moss mats whereas *M. lewisii* generally grows on the streambanks where moss does not occur. Interactions with the moss might help explain these differences in microdistribution. Moss mats that occupy the streambeds might have differential effects on either the establishment or subsequent growth of these monkey-flowers. Alternatively, different tolerances of inundation could help explain the differences in microdistribution. We carried out greenhouse experiments designed to understand the potential for moss and inundation to explain the differences in microhabitat occupation of the two *Mimulus* species. Moss mats essentially eliminated successful seedling establishment in *M. lewisii* but allowed establishment of a reduced number of *M. guttatus* seedlings. Growth of established seedlings of *M. lewisii* was enhanced by surrounding moss mats whereas growth of *M. guttatus* was unaffected or reduced. Inundation increased growth rates of both species similarly. Therefore, differential effects of moss on seedling establishment might explain the observed differences in microdistribution.

Lawrence, B. A. and T. N. Kaye (2006). "Habitat variation throughout the historic range of golden paintbrush, a Pacific Northwest prairie endemic: Implications for reintroduction." Northwest Science **80**(2): 140-152.

Although golden paintbrush historically inhabited the prairies of the Willamette Valley, Oregon, this Pacific Northwest prairie endemic is currently restricted to eleven sites in the Puget Trough of Washington and British Columbia. Recovery criteria call for the establishment of new populations throughout the species' historic range, including the Willamette Valley. We described vegetation and soil characteristics of representative golden paintbrush recovery sites in the Willamette Valley and compared them with those of remaining golden paintbrush populations in the Puget Trough. Potential golden paintbrush habitat in the Willamette Valley was ecologically distant from remaining populations. This disparity was likely related to regional differences in geology, climate, ocean proximity, and land-use history. Many of the species indicative of remaining

populations in the Puget Trough were native perennials, while those of potential reintroduction sites in the Willamette Valley were introduced annuals. Soil characteristics of golden paintbrush sites were also distinct among the two ecoregions. Puget Trough sites were located on sandy soils with generally high levels of magnesium and sulfur, while Willamette Valley sites were found on silty-clay soils with high concentrations of potassium and phosphorous. Differences in soil texture, and magnesium and potassium concentrations were associated with plant community divergence among the two regions. We suggest using a plant functional group approach when comparing vegetation assemblages among Puget Trough and Willamette Valley sites, which allows comparison of taxonomically distinct communities that share ecological characteristics.

Medler, M. J. (2006). "Comparing recent fire occurrence with historical fire return intervals in Washington's National Parks." *Northwest Science* **80**(3): 184-190.

In this study the average spatial extent of recent fires in the three National Parks in the State of Washington was quantified and compared to the average area of each park that must burn each year to maintain natural fire regimes and associated vegetation communities. Current vegetation maps and associated fire return interval data were used to calculate the aggregate annual area of fire that is necessary within each park to assure that current fire regimes and associated vegetation communities persist over time. This analysis revealed that on average, far less forest burned each year from 1986-1996 than is required over the long run to maintain natural fire regimes. In North Cascades National Park, a conservative estimated annual average of 329 hectares are expected to burn, but on average only 26 hectares per year actually burned. In Olympic National Park, a conservative estimated annual average of 654 hectares is expected to burn, compared to the annual average of only 20 hectares actually burned. In Mt. Rainier National Park, a conservative estimated annual average of 202 hectares is expected to burn, compared to the 4 hectare average that actually burned during the study period.

Meyn, A. and M. C. Feller (2006). "Fire history of forest remnants in wetter lodgepole pine dominated forests in southern British Columbia, Canada." *Northwest Science* **80**(2): 86-94.

Forest fires in British Columbia often leave patches of unburned vegetation (forest remnants) within their perimeters. These remnants help to maintain biological diversity and structural complexity in stands. To be able to maintain patterns similar to those created by fire, we need an understanding of the fire history of these forest remnants. We investigated the history of forest remnants in two study areas located in wetter lodgepole pine dominated forests in two Montane Spruce biogeoclimatic subzones in southern central British Columbia. The objectives of the study were to determine if there were any remnants that had never burned and, if not, what were the longest fire-free intervals within them. Aerial photographs, forest cover maps, and ground searching were used to investigate a total of 14% (47,000 ha) of one subzone and 17% (17,000 ha) of the other. This yielded 12 remnants in which plots were established to determine recent fire history. All twelve remnants had burned at some time. Stand history reconstruction, including dendrochronological analysis, of five of these remnants suggested that they had been formed from 3 different fires. The longest fire-free intervals within the remnants were estimated to range from 129 to 309 years. This is up to nearly twice as long as the longest fire-free intervals found for remnants in drier lodgepole pine forests in British Columbia.

Moskwik, M. P. and M. A. O'Connell (2006). "Male and female reproductive strategies in the polygynous bobolink." Northwest Science **80**(2): 108-115.

Most species of birds are socially monogamous, however approximately 8% of bird species are polygynous. By mating polygynously, females lose paternal care, but might gain access to a superior territory or male. We examined five factors that affect polygyny in bobolinks: territory size, perching sites, predation rate, insect abundance, and vegetation composition and structure. Our study site was located in the Pend Oreille River Valley in northeast Washington State. Artificial perching sites were placed in the field, male territories were mapped, nests located and monitored, and vegetation assessed from May to mid-July 2003. Approximately 55% of males were polygynous, and 45% were monogamous. Females arrived on the study site in three temporal waves that we categorized as: first - monogamous, second - primary, and third - secondary females. Monogamous territories had higher caterpillar densities, higher herbaceous coverage, and were smaller in size than polygynous territories, reflecting the patchy vegetation of the study site. The first wave of females selected small territories and were monogamous. The second wave of females selected remaining, large territories, the third wave of females mated polygynously on these larger territories. Monogamous females fledged the most young. In contrast, polygynous males fledged more young than monogamous males. Males defended large areas with perches in order to maximize chances of mating polygynously.

Murphy, K. M., T. M. Potter, et al. (2006). "Distribution of Canada lynx in Yellowstone National Park." Northwest Science **80**(3): 199-206.

Little is known about Canada lynx in Yellowstone National Park, except that the species was present at the park's inception in 1872 and may have persisted to the present. The lack of basic information in the park and this species' listing as threatened in the contiguous U.S. by the Fish and Wildlife Service prompted our 2001-2004 survey of lynx presence and distribution. We traversed track detection transects during winter and used hair snares in summer to detect lynx in select habitats. Using DNA extracted from hair or fecal samples, we confirmed the presence of a female (unknown age), an adult female with a male kitten, and an adult male, each detected in a different year in the eastern portion of the park. Eight other unconfirmed lynx snow trails were also identified, including three from the central portion. Cumulatively, our detections represented at least three individuals, including two kittens born in different years. A male we identified in 2004 was detected 76 km south the following year in the Bridger-Teton National Forest, demonstrating that significant movement of lynx occurs within the Yellowstone Ecosystem. Reproduction that we and others documented, in addition to immigrants from peripheral populations, may contribute to lynx presence in the ecosystem.

Obermeyer, K. E., K. S. White, et al. (2006). "Influence of salmon on the nesting ecology of American dippers in Southeastern Alaska." Northwest Science **80**(1): 26-33.

Salmon runs influence the ecology of several mammalian species in Southeast Alaska, but little is known about the effect of salmon runs on avian predators. We tested the prediction that reproductive performance of American dippers (*Cinclus mexicanus*) nesting along stream reaches that have seasonal populations of spawning salmon is higher

than that of those nesting along stream reaches without salmon runs. Dippers on reaches with salmon near Juneau, Alaska, had heavier fledglings and less brood reduction than dippers on reaches without salmon. Higher fledgling mass and less brood reduction were associated with the occurrence and nutritional value of young salmon in the nestling diet and not with aquatic macroinvertebrate abundance (which decreased during the salmon spawning period).

Polacek, M. C., C. M. Baldwin, et al. (2006). "Status, distribution, diet, and growth of burbot in Lake Roosevelt, Washington." *Northwest Science* **80**(3): 153-164.

The status of burbot populations in Washington State is largely unknown and little biological information has been collected regarding them. This paper is an assimilation of distribution, catch, diet, and growth data for burbot collected via gill nets and electrofishing in Lake Roosevelt, Washington. Burbot distribution was not homogenous throughout Lake Roosevelt. Catch rates were: higher in tributaries compared to offshore zones and were low from 1988-1994 ( $< 0.01$  fish/hr), peaked in 1995 and 1996 (0.18 fish/hr), and leveled off (0.04 fish/hr) between 1999 and 2001. Highest densities were in the Hawk Creek and San Poil River sections. Catch rates may have been higher in tributaries because of burbot seeking thermal refugia or food in the vicinity. Burbot diets were dominated by isopods (71%) in the offshore zones, whereas burbot sampled in the nearshore zones contained fish (28%), insects (46%), and crayfish (12%) in the spring and mostly fish in the summer (62%) and fall (78%). Burbot averaged six years in age, ranging between three and ten years old. Generally, relative weights were below the 75th percentile national average and condition factors were poor; however, relative weight and condition factors were stable from year to year indicating that conditions were not deteriorating in the reservoir. It is possible that the impact of reservoir operations on spawning and rearing habitats and low invertebrate and forage fish productivity, have led to the slow growth and condition of burbot in Lake Roosevelt.

Saunders, S. C., K. P. Lertzman, et al. (2006). "Bird assemblages associated with vine maple gaps in coastal western hemlock forests of British Columbia." *Northwest Science* **80**(3): 165-176.

Vine maple gaps represent a source of distinct structural and functional heterogeneity within a conifer-dominated forest. We considered whether these gaps provide preferred habitat for some species of birds. We surveyed birds, and measured habitat characteristics, in vine maple gaps and closed canopy plots of two coastal western hemlock forests during two breeding seasons. For one forest, vine maple gaps had more total detections in both years, and more species in one year, than did closed canopy plots. Pacific-slope flycatchers, winter wrens, and American robins were detected significantly more often in vine maple plots for one or more forest-year combinations. Numbers of winter wrens were correlated with high foliage height diversity and cover close to the ground, characteristics common to vine maple gaps of both forests. Pacific-slope flycatchers were associated with abundance of deciduous vegetation and cover at intermediate heights, features that differentiated the plot types from each other at one forest. Our results suggest that vine maple gaps are used more by certain avian species, dependent on forest and year. We recommend studying bird use of vine maple versus other gap types, and differences in avian assemblages between forests with and without vine maple gaps, to elucidate the value of maintaining vine maple gaps for bird habitat in these forests.

Schmetterling, D. A. and J. A. McFee (2006). "Migrations by fluvial largescale suckers (*Catostomus macrocheilus*) after transport upstream of Milltown Dam, Montana." Northwest Science **80**(1): 18-25.

Despite the abundance of largescale suckers (*Catostomus macrocheilus*) in western North America, little is known about their biology and ecology. Tens of thousands of largescale suckers annually congregate in the spring in the tailrace of Milltown Dam, Montana, apparently impeding upstream migrations. To determine the destination of migrants and attributes of their migrations we implanted 14 fluvial largescale suckers with radio transmitters and tracked movements after transport upstream of Milltown Dam. Fish were apparently homing to natal areas and selected one of two drainages in which to spawn. Movements to upriver-most locations varied widely, fish used diverse areas in the watershed, and moved very far to spawn (mean 55 km, range 5.1-159.2 km). After the spawning period, fish moved either up or downstream, others stayed in the same location into the fall. Only two fish moved downstream of Milltown Dam after the spawning period and potentially back to a pre-spawning location. These movements demonstrate the effects of the dam on largescale sucker populations over a large spatial scale, and suggest that providing fish passage at Milltown Dam would result in a tremendous amount of biomass transferred to upriver areas. Fish passage considerations at Milltown Dam focus only on bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*). Providing upstream passage of largescale suckers at this dam may help promote full ecosystem recovery.

Schultz, M. E. and T. L. De Santo (2006). "Comparison of terrestrial invertebrate biomass and richness in young mixed red alder-conifer, young conifer, and old conifer stands of southeast Alaska." Northwest Science **80**(2): 120-132.

Coniferous stands that regenerate following clearcutting in southeast Alaska can be characterized by the amount of soil disturbance during logging. There are indications that red alder in mixed stands mitigates some of the negative effects of clearcutting. We compared invertebrate biomass in four stands each of (1) young conifers, (2) young mixed alder and conifer, and (3) old conifers to determine if alder was beneficial to invertebrates. Collembola, then Araneae taxa were most abundant but Coleoptera had the greatest invertebrate biomass on boles of red alder, Sitka spruce, or western hemlock. Diptera taxa were the most abundant in flight traps in young mixed alder and conifer stands. Psocoptera taxa were the most abundant invertebrates collected from any foliage. Some rarer invertebrate families were unique to one or another of the tree species. Crawling invertebrate species richness was greatest on red alder and in young mixed alder and conifer stands. The greatest biomass of crawling invertebrates occurred on Sitka spruce holes. Old stands had about the same invertebrate biomass as mixed alder or conifer young stands. Flying invertebrate biomass and species richness was greatest in young stands of mixed alder and conifer. Twice as many invertebrate species were found on western hemlock or Sitka spruce foliage as on red alder foliage but invertebrate species richness was greatest on red alder. Invertebrate biomass on red alder foliage was 20-100 times greater than on the equivalent weight of Sitka spruce or western hemlock foliage. Red alder significantly contributes invertebrate species richness and biomass to young forest stands of southeast Alaska.

Shick, K. R., D. E. Pearson, et al. (2006). "Forest habitat associations of the golden-mantled ground squirrel: Implications for fuels management." Northwest Science **80**(2): 133-139.

Golden-mantled ground squirrels are commonly associated with high-elevation habitats near or above upper timberline. This species also occurs in fire-adapted, low-elevation forests that are targeted for forest health restoration (FHR) treatments intended to remove encroaching understory trees and thin overstory trees. Hence, the golden-mantled ground squirrel may be affected by FHR treatments, but little is known about its habitat associations within these forest types. We sampled mature western larch and ponderosa pine forests in western Montana to determine the macro- and microhabitat associations of this ground squirrel. At the macrohabitat scale, golden-mantled ground squirrels were absent from western larch stands which consistently had a denser understory. Because we did not detect golden-mantled ground squirrels within larch stands, it is unclear whether FHR treatments in this forest type would improve habitat conditions for these ground squirrels. In contrast, golden-mantled ground squirrels were common in ponderosa pine stands and favored more open conditions there. At the microhabitat scale within ponderosa pine stands, golden-mantled ground squirrels were captured at trap stations with fewer canopy trees, more rock cover, and less grass and forb cover compared to stations without captures. Thus, FHR treatments that open the understory of ponderosa pine stands while maintaining mature pines similar to historic conditions may increase golden-mantled ground squirrel populations. However, the extent to which golden-mantled ground squirrels are positively affected by FHR treatments in ponderosa pine stand types may be limited by the degree of their dependence on rocky structure.

Stabins, A. J., K. J. Raedeke, et al. (2006). "Productivity of great blue herons in King County, Washington." Northwest Science **80**(2): 116-119.

We studied productivity of great blue herons (*Ardea herodias*) at their nesting colonies in King County, western Washington in the 2000 breeding season. Rapid urbanization has been hypothesized to have limited heron population growth in recent years. Of the 354 active nests in 2000, 260 (74%) nests produced fledglings. Mean productivity for all active nests was 1.77 (SD = 1.37). Mean productivity for the 260 successful nests was 2.42 (SD = 1.01). Calculations of productivity for the active and successful nests are similar to or greater than results of 8 of 10 similar calculations from studies conducted in the Pacific Northwest, and one study that used band return data to determine the minimum productivity required to maintain a stable population. Herons that began incubating earlier in the season (prior to 17 April) had higher productivity than those that began nesting later in the season ( $P < 0.001$ ).

Swanson, M. E., D. C. Shaw, et al. (2006). "Distribution of western hemlock dwarf mistletoe (*Arceuthobium tsugense* [Rosendahl] GN Jones subsp *tsugense*) in mature and old-growth Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) forests." Northwest Science **80**(3): 207-217.

We investigated the landscape distribution and spatial patterns of western hemlock dwarf mistletoe in old-growth and mature Douglas-fir forests of the Wind River Experimental Forest. The study was conducted in two settings: the old-growth forest (500 year) of the 478 ha T.T. Munger Research Natural Area (T.T. Munger RNA) and the higher-elevation, predominantly 157-year old stand of the 1,400 ha Panther Creek Division of the Wind

River Experimental Forest. Existing transects and tagged trees were used in the T.T. Munger RNA to survey for dwarf mistletoe infection. We surveyed for dwarf mistletoe-infected trees in the Panther Creek Division by hiking roads, trails, and drainages. Eighty-three percent of the transect segments within the T.T. Munger RNA had some level of dwarf mistletoe infection. Dwarf mistletoe was found only in legacy old-growth patches in the Panther Creek Division, and these comprised only 2.4 percent of the division area. The three legacy old-growth patches containing dwarf mistletoe were restricted to drainage bottoms and well-watered benches. None of these patches burned completely in the 1800's, as evidenced by large, old trees > 300 yrs. Spatial analysis of transect segments (using Moran's  $I$ ) in both T.T. Munger RNA and Panther Creek Divisions showed that within both old-growth and legacy patches in mature forest, western hemlock dwarf mistletoe infection is spatially aggregated. Dwarf mistletoe is maintained on this landscape by survival in refugia, most often in riparian areas, or, in the case of the T.T. Munger RNA, in low-density, low-productivity areas that do not burn completely during wildfire events. Dwarf mistletoe must persist in these refugia until host trees recover in burned areas, a process which may take many decades in intensely burned watersheds.

Tyler, M. W. and D. L. Peterson (2006). "Vascular plant species diversity in low elevation coniferous forests of the western Olympic Peninsula: A legacy of land use." Northwest Science **80**(3): 224-238.

Timber management practices affect spatial patterns of seral stages and understory plant species diversity. We quantified diversity patterns in understory vascular plant species, including exotic plant species, across four broad age classes of low-elevation coniferous forests of the western Olympic Peninsula, Washington, USA-regeneration (age 0-19 years), young (20-79 years), mature (80-199 years) and late-seral ( $\geq 200$  years). Species richness varied significantly with age class: highest in newly regenerating stands, lowest in the young class, and increasing to the late-seral stage. We observed an age-class effect for total percent cover by growth form and for distribution of exotic plant species. Shrubs had highest cover in the regeneration category; forbs and sub-shrubs had highest cover in late-seral forest. Ferns and graminoids did not vary across age classes. Twenty percent of the species found in regeneration plots were exotic, while all species encountered in late-seral plots were native. The proportion of exotic species was intermediate in young (7%) and mature (6%) forests. On the western Olympic Peninsula the late-seral age class is the most limited in spatial extent and has the least connectivity across ownerships. Management efforts aimed at conservation of late-seral plant species at broad spatial scales will need to consider the lack of contiguity of late-seral forest and the role of ownership in its distribution.

Witmer, G., P. Burke, et al. (2006). "The biology of introduced Norway rats on Kiska Island, Alaska, and an evaluation of an eradication approach." Northwest Science **80**(3): 191-198.

Introduced, invasive rats can cause substantial damage to native flora and fauna, including ground-nesting seabirds, when they become established on islands. We tested a control method for introduced Norway rats on Kiska Island, Alaska, during April-May, 2004, by hand-broadcasting rodenticide pellets (0.005% diaphacinone) over a 4-ha area at the rate of 28 kg/ha. We also gathered data on aspects of rat ecology and distribution,

although rats were difficult to detect and capture. The rodenticide bait pellets seemed to have been effective in reducing the Norway rat population, however, this is based on a limited observation of rat sign and captures. Four rats were captured on elevational transects on the northside of the island, all below 20 m elevation. Twelve rats captured in other aspects of the study also came from lower elevations. Rat stomach contents revealed that vegetation and seabirds were important components of the diet at the north end of Kiska Island, but stomach contents varied by location depending upon the type of food most readily available. All eight females captured were pregnant and bore an average of 10 embryos. Although the control or eradication of rats at remote locations such as the Aleutian Islands is theoretically possible, there are many challenges posed to resource managers. This field study has provided insight into the ecology and management of Norway rats at Kiska Island, but also points out some of the challenges that remain.

Young, B. A. and J. Harris (2006). "Auditory sensitivity of the Northern Pacific rattlesnake, *Crotalus viridis oreganus*: Do behavioral responses conform to physiological performance?" Northwest Science **80**(3): 218-223.

Previous physiological studies demonstrated that snakes, including rattlesnakes of the genus *Crotalus*, are capable of responding to airborne sounds, but only over a relatively narrow range of frequencies. To assess the accuracy of these frequency limitations, this study presented Northern Pacific rattlesnakes (*C. viridis oreganus*) with a range of synthesized airborne tones. Significant levels of positive responses, as evinced by a suite of behaviors, were observed outside of the physiologically-determined frequency ranges. The results of the present study suggest that hearing in rattlesnakes, and perhaps other snakes, is more biologically relevant than previously appreciated.