

are dominated by edges, where conditions can differ considerably from interiors of adjacent forests or clearings. We placed Douglas-fir needles, contained in mesh litterbags, along eight transects running from deep inside 60–80 yr old mixed conifer stands into the centers of recent clearcuts. After one year, we found significant differences in needle mass loss with distance from edge along most transects. In general, decomposition rates were high in forest interiors, lower just inside edges, highest 1–5 m into clearcuts, and low in clearcut centers. Rates were strongly correlated with surface organic matter moisture content. In areas where rates were high, needles were typically heavily covered with fungal hyphae. However, rates were not correlated with number or biomass of sporocarps of decomposer fungi. We also noted evidence of surface soil erosion, which could influence decomposition in part by fragmenting fungal hyphae. Thus, there may be several reasons why litter decomposition rates at forest edges are not the same as nor simply intermediate between those of adjacent forests and clearcuts. In particular, moisture content appears to be a strong predictor of decomposition rates along these transects.

SPENCE, J. R. University of Alberta, Edmonton, AB T6G 2E3 Canada. **A long-term population study of water-striders: 15 years of bug counting and whadaya get?**

Populations of five species of adult water-striders were marked and censused weekly on a small pond in Alberta, Canada during a 15-yr period to understand gerrid demographics. Overwintered adults colonized over 8–10 weeks beginning shortly after ice-off in mid-April to early-May. Adults disappeared from the surface during early-September to mid-October. Late spring conditions strongly affected the extent of a second generation, except during hot, dry years when over-wintered breeders were locally concentrated with drying of most temporary habitats. Concentration was associated with poor recruitment, probably reflecting predator-caused mortality of juveniles. Among colonists, only *Gerris buenoi* and *Limnoporus dissortis* were regularly successful and their performance has been positively correlated. Maximum adult survival is similar to that observed in the laboratory for the common species. Weekly losses in cohorts defined by date of arrival include both death and significant levels (15–30%) of emigration. Long-winged diapause-bound bugs of both species begin leaving the pond as early as mid-July. Local populations of these gerrids are regularly linked by inter-pond movement both within and between breeding seasons. Thus, adaptive requirements for retention of characteristics promoting flight appear to dominate their life-history.

SPENCER, D., and G. KSANDER. USDA-ARS, Exotic & Invasive Weeds Research Unit, Davis, California. **Estimates of Eurasian water milfoil biomass and nutrient content in the Truckee River, California.**

Eurasian water milfoil (*Myriophyllum spicatum* L.) is present in the Truckee River in northern California near the outlet from Lake Tahoe. In August 1997, we conducted 15 video transects across the river, between Tahoe City, California and the Goose Meadows campground. Abundance of Eurasian water milfoil (frequency, f) was greatest in the section of the river upstream of Alpine Meadows ($f = 0.16$ to 0.92). No plants were observed below this point. We collected plant samples from three sites beginning in mid-April 1997 for analysis of tissue N and P. On 19 August 1998, we collected plant samples for biomass determinations. Mean biomass on this date, at three sites ranged from 84 to 656 g/m². Biomass and tissue levels of N and P were positively correlated with estimates of available N and P in the sediment. Examination of internal levels of tissue N and P indicates that growth of Eurasian water milfoil was limited by the availability of P. These findings are contrary to considerable evidence from lake studies showing that N limits growth of rooted aquatic plants.

SPERRY, J. S., U. HACKE, and J. PITTERMAN. University of Utah, Salt Lake City, UT 84112 USA. **Does xylem cavitation and refilling alter the vessels' vulnerability to subsequent cavitation events?**

Previous studies have shown that many species are able to refill cavitated and embolized xylem conduits by root pressure or other mechanisms. However, it is unknown whether the process of cavitation and refilling alters the conduit's vulnerability to cavitation. We tested stem and root xylem of several species for changes in cavitation vulnerability following an experimental cavitation and refilling cycle. Species fell into one of two categories: either the cavitation vulnerability remained constant (e.g., *Betula occidentalis*, *B. nigra*), or

increased (e.g., *Acer rubrum*, *Carpinus caroliniana*, *Populus* spp.) after one cycle. The increase seen in these "weakened" species was often substantial, with a 15–20% increase in embolism following the cavitation treatment. While it is probable that cavitation occurs by air seeding at inter-conduit pit membranes, we hypothesized that the increase in vulnerability seen in the weakened species resulted from physical rupture of the pit membrane rather than aspiration through its pores. Interestingly, the diameters of the pit membranes in weakened species (0.4–0.6 microns in *A. rubrum* and *C. caroliniana*) were considerably larger than others examined (0.3 microns in *B. nigra*), suggesting that the membrane could be more deformable and therefore susceptible to damage. Although torn membranes were visible with the scanning electron microscope, it was not possible to rule out preparation artifacts. It remains to be seen whether the weakened species are also those which do not refill in nature.

SPIES, T. A.,¹ R. J. PABST,² and A. N. GRAY.¹ ¹USFS Pacific Northwest Research Station, Corvallis, OR 97331 USA; ²Oregon State University, Corvallis, OR 97331 USA. **Shrub and herb community responses to experimental canopy gaps in Douglas-fir forests.**

The response of shrubs and herbs to canopy gap formation is not well understood in coniferous forests of western North America. For example, it is not clear to what extent the response to gap formation is controlled by gap size, within-gap position, and pre-gap species composition. Cover of shrub and herb species was measured at 1–2 yr intervals for seven years in 36 experimental gaps of different sizes created in mid-aged and old-growth Douglas-fir forests in western Oregon and Washington. Species richness on a meter-square basis was higher in gaps than in canopy controls and increased with gap size. Dissimilarity (Sorensen's coefficient) between pre- and post-gap communities at seven years ranged from 9% to 17% in the controls to 21% to 74% in the gaps. Species accounting for increases in diversity included invaders such as *Epilobium* spp. and *Cirsium* spp., and spreading, residual species such as *Rubus* spp. and *Achlys triphylla*. Species differed in rates of response to gap formation and in spatial pattern of cover within gaps. Initial conditions also appear to influence response to gap formation. For example, the greatest changes in dissimilarity between pre- and post-gap communities occurred where initial species richness was lowest. Results indicate that gap size influences shrub and herb communities, but responses to gaps are highly variable and are also controlled by initial species composition.

SPRINGER, J. D., and M. M. MOORE. Northern Arizona University, Flagstaff, AZ 86011 USA. **Soil seed bank relationship to large scale ecological restoration of southwestern ponderosa pine.**

Euro-American settlement has had a profound impact on southwestern ponderosa pine forests. Knowledge of the herbaceous and shrub species in the soil seed bank can aid in determining past and present species composition. We collected baseline soil seed bank samples under five different canopy types and in an area undergoing ecological restoration. Through use of the emergence method, we determined that at least 38 species were utilizing the soil seed bank at the study site. The most common species were *Verbascum thapsus*, *Leonurus cardiaca*, and *Conyza canadensis*. In an area undergoing ecological restoration treatments (thinning), 14 species emerged in soil seed bank samples, with an estimated density of 3152 seeds/m². The two most common species were *Collinsia parviflora* and *Verbascum thapsus*, which accounted for 45% and 30% of the germinants, respectively. Fourteen species were observed in the aboveground vegetation following restoration treatments. There were ~ 101 plants/m² in the thinned area and 0.4 plants/m² in the nearby unthinned control area. There was a significant correlation between above- and belowground vegetation in the thinned area, but not in the control. Although *Verbascum thapsus* accounted for 30% of the viable seeds in the soil seed bank samples, it accounted for only 3% of the plants in the aboveground vegetation. These results will assist us in making decisions about control of non-native species and the type of seeds to use in seeding mixtures.

Abstracts

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