Proceedings of a Conference on Native Plant Restoration and Management on Public Lands in the Pacific Northwest:

Rare Plants, Invasive Species and Ecosystem Management

LaSells Stewart Center, Oregon State University
Corvallis, Oregon Feb. 11-13, 2003

Edited and compiled by Thomas N. Kaye, Melanie Gisler, and Rob Fiegener

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Preface:

Native plant conservation is a multi-disciplinary field and its success requires an integrated approach. Plant restoration and management on public lands in the Pacific Northwest face many challenges but also present opportunities for cooperative projects, research, on-the-ground action, and community outreach. On February 11-13, 2003, 300 people joined together for a symposium on native plant management in the Pacific Northwest to share information and discuss experiences. Topics covered rare and endangered species conservation and reintroduction, invasive plants, species and habitat restoration, ecosystems, and policy. The meeting featured talks by experts in these fields, and the audience included biologists, land managers, non-profit organizations, and the general public.

Michael Way, a member of the International Team for the Millennium Seed Bank Project from the Royal Botanical Gardens, Kew, was our keynote speaker. Mr. Way is the International Coordinator for the Americas and is responsible for the development of seed conservation projects with partners in Mexico, Chile, and the USA. He has experience in habitat conservation, management and restoration. He spoke on "Population, species, or community: Where should land managers target plant conservation efforts?"

This conference was a success because so many people who are active in this field came together and contributed their experience and energy. We are grateful to all of them.

--Tom Kaye, Institute for Applied Ecology, 227 SW 6th, Corvallis, Oregon 97333
phone: 541-753-3099,
email: kayet@peak.org and
--Joan Seevers, Bureau of Land Management, Oregon State Office, Portland, Oregon
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SPEAKER PAPERS (ABSTRACTS) – IN ALPHABETICAL ORDER

How To Restore a Wet Prairie: Lessons Learned from 20 Years of Managing the Willow Creek Natural Area

Edward R. Alverson, The Nature Conservancy, 1820 Roosevelt Blvd., Eugene OR 97402
phone: (541) 682-4927; email: ed.r.alverson@ci.eugene.or.us

The native prairies, savannas, and wetlands that once dominated the Willamette Valley landscape have largely be relegated to a few small, scattered, and degraded remnant stands. For example, open prairies, which occupied over 1 million acres of the Willamette Valley in the mid-1800's, have been reduced to less than 1% of their historic extent. As a result, over 20 plant taxa native to the Willamette Valley, about half of which are Willamette Valley endemics, are considered to be globally at risk of extinction. Many other widespread taxa have become rare within the region.

One strategy employed by The Nature Conservancy (TNC) to protect biological diversity is to identify, protect, and restore important examples of rare or declining native habitats where populations of imperiled native species occur. TNC manages the Willow Creek Natural Area, located in Lane County, Oregon, on the western periphery of Eugene. This site supports one of the few remaining examples of native wet prairie in the Willamette Valley. Two federally listed endangered plant species, *Lomatium bradshawii* and *Erigeron decumbens* var. *decumbens*, occur in unplowed wet prairie at Willow Creek, along with other rare plant species and a diverse array of other native grasses and forbs.

Fire is believed by most ecologists to have played an important role in maintaining open prairie habitats in the Willamette Valley prior to Euroamerican settlement, and preventing gradual colonization of prairies by a dense tree canopy. A pattern of tree invasion over the last 150 years is well exhibited at Willow Creek. For example, native Oregon ash (*Fraxinus latifolia*) trees have greatly increased in abundance in and adjacent to the Willow Creek wet prairie since 1850. Continued secondary succession has been considered to be one of the top two management issues at Willow Creek since TNC began to manage the site in 1982. In fact, much of the habitat of the rare plants as well as the diverse native wet prairie community was densely stocked with seedlings and saplings of native and exotic trees. It was clear that if no active management was undertaken, the prairie would eventually turn into forest. Thus, awareness of the importance of fire in Willamette Valley prairies has resulted in a focus on restoring appropriate fire regimes in the Willow Creek wet prairie from the very start of TNC management efforts in the early 1980's.

Soon after TNC assumed management responsibility for the wet prairie at Willow Creek in 1982, a decision was made to employ prescribed fire as a management tool in the wet prairie at Willow Creek, rather than start with a program of smaller scale research burns. After an extensive of planning, preparations, and obtaining permits, the first prescribed burn was conducted in 1986. This fire was preceded by establishment of density monitoring plots for *Lomatium bradshawii*, *Erigeron decumbens*, and frequency monitoring of the wet prairie plant community. Additional prescribed burns were conducted in 1987 and 1991, along with annual implementation of monitoring plots.

Additional land acquisitions increased the area under TNC management from an initial 125 acres to 330 acres by 1994. At this time we initiated a site-wide management planning process to provide an overall vision for our management and restoration work across the different habitats present at the site. At the same time, we evaluated the monitoring data showing the response to rare plant species as well as the wet prairie community to the initial set of prescribed burns.

To refine our landscape scale goals for the entire site, we considered three potential management scenarios:

1) Restore the site to the closely replicate the habitat conditions and plant communities in the locations and abundance that existed at the time of Euroamerican settlement (ca. 1850).
2) Maintain the mix and extent of habitat conditions and plant communities existing on the site at the present time (ca. 1994)
3) Allow secondary succession to proceed over time to its ultimate state, whatever that would be (but presumable a mix of entirely forested or woody plant dominated communities).

We evaluated how each of these scenarios would affect habitat conditions for a range of native plants and animals occurring at the site. However, the goal of protecting populations of rare prairie species precluded the exclusive implementation of scenario #3. Maintaining a static state in a dynamic successional ecosystem was a problem with scenario #2. In addition, we believed that the extent of native prairie habitats existing on the site ca. 1994 was not sufficient to support populations of certain prairie wildlife species that have large area needs. And although scenario #1 would be of greatest benefit to native prairie species, it was clear that some of the former prairie habitats had been forested for over 100 years. To restore prairie in areas that had been forested for 100 years seemed like a difficult task that might not be worth the loss of mature habitats.

Ultimately we settled on a long-term management scenario that called for restoring and maintaining the historically predominant prairie and savanna in portions of the site where this was most feasible, while allowing secondary

succession to proceed in other areas where forest conditions were already well developed and prairie species were more or less absent. In addition, consideration was given to the size and shape of blocks of contiguous prairie habitat, to promote the movement of animals and plant propagules throughout the area of prairie.

In conjunction with refining our management scenario for the site, we considered the various management techniques that could be employed to restore and manage the prairie habitat. This provided another opportunity to consider the role of prescribed fire in wet prairie management. We observed the following general results from the first three prescribed burns at Willow Creek:

-The effects of fire on invading woody plants was mixed. Some trees were top-killed, some were unaffected, but nearly all of the top-killed trees re-sprouted from the stump. Only a small proportion of the woody plants (mostly small saplings) were killed outright.

-Those trees that were top-killed eventually fell to the ground, and in subsequent prescribed fires these dead fuels were often consumed by fire, creating "hot spots" that killed all of the existing herbaceous vegetation.

-The effects of fire on the rare plants *Lomatium bradshawii* and *Erigeron decumbens* var. *decumbens* were mixed, with some patches increasing in density and others decreasing. Observational data suggested that rare plant populations growing in open areas were most likely to be stable or increasing, while in some areas with a more dense woody vegetation component the rare plant densities were declining.

Following an adaptive management approach to restoration planning, we developed a strategy for managing and restoring the wet prairie at Willow Creek that relied on several general principles that we believed were appropriate for this place and time:

1) It was important to manage the site so as to maintain natural processes (fire, seasonal hydrology, etc.) associated with Willamette Valley wet prairies
2) Because of the presence of a diverse native flora, we should utilize an approach that might best be described as "restoration by subtraction", that is, removing the most habitat altering invasive or non-native species, while promoting the natural regeneration of native herbaceous species.
3) It would be necessary to first remove excess woody vegetation from invaded wet prairie habitats before resuming fire management, to avoid unacceptable collateral damage to native grasses and forbs from "hot spots" created by burning woody fuels.

This approach to restoring wet prairie at Willow Creek was begun on a trial basis in 1992, more fully in 1994, and in the past 10 years we have gradually worked to restore over 50 acres of prairie or savanna habitat. In addition, four prescribed burns have been implemented between 1994 and 2001 in areas of wet prairie from which woody vegetation has been cleared. Annual monitoring, in the form of permanent photo stations, rare plant density monitoring, and nested frequency monitoring, has helped us to document the effects of our restoration work and refine management techniques.

In the past 20 years, many factors, including but not limited to ecological management actions, have influenced the wet prairie ecosystem at Willow Creek. For example, weather and climate factors have included record rainfall in 1994, record drought in 2001, and unusually high winds in 2002. Another significant ecological influence has been high levels of small mammal abundance, especially voles (Microtus spp.), which exhibit profound influences on the herbaceous vegetation in the wet prairie during years of peak abundance. Jean Jancaitis has subjected our nested frequency plant community monitoring to hierarchical linear modeling analysis to tease out specifically the influence of our management treatments (woody vegetation removal and prescribed fire) on frequency of key native and introduced plant species in the wet prairie at Willow Creek. This analysis indicates that management treatments have benefited key species in the short term, at least.

Breeding System and Seed Production of an Endangered Plant, *Fritillaria gentneri*, in Southern Oregon

Kelly Amsberry and Robert J. Meinke, Oregon Department of Agriculture, Native Plant Conservation Program and Oregon State University, Department of Botany and Plant Pathology, 2082 Cordley Hall, Corvallis, OR 97331 phone: (541) 737-2346; email: amsberrk@bcc.orst.edu and meinker@bcc.orst.edu

Fritillaria gentneri Gilkey (Gentner's fritillary), one of Oregon's most beautiful native wildflowers, is listed as endangered by both the Oregon Department of Agriculture (ODA) and the U.S. Fish and Wildlife Service (USFWS). A Recovery Plan for this species, including recommendations for population augmentation and reintroduction projects, is currently being finalized by the USFWS from a draft plan developed by ODA. Our three-year study evaluates the seed production capability of native populations of *F. gentneri*, both to determine the potential for the use of wild-collected seed in recovery projects, and to learn more about the breeding system of this unusual lily. Seed production has been reported intermittently since the species' description in 1951, but doubts have been raised as to the parentage of the seed observed, as well as the specific identity. (*F. gentneri* is virtually indistinguishable from *F. recurva* when in fruit.) By performing controlled pollination treatments on positively identified plants, we hoped to unequivocally document the potential for seed production by *F. gentneri*.

To prevent herbivory by deer, study plants were enclosed in large-mesh wire cages at six southwest Oregon study sites prior to the initiation of manual pollination treatments. In the first year of our study, no fruits were produced in response to189 conspecific pollination treatments - treatments included selfing, open-pollination, and pollination with

pollen from conspecific plants that were near neighbors, far neighbors, and from another population. However, a capsule was produced on one of seven plants pollinated with pollen from sympatric plants of *Fritillaria affinis*. In 2001, conspecific and interspecific pollination treatments were completed on 273 flowers; unfortunately drought prevented fruit set on all study plants. In the final year of the study, fruits were produced by 52% of *F. gentneri* flowers pollinated with pollen from *F. recurva* (n = 25), 12% of *F. gentneri* x *F. affinis* crosses (n = 25), and only 2.3 % of conspecific matings (n = 132). Open-pollinated plants also occasionally produced capsules (6.4%; n = 47), but as both *F. gentneri* and *F. recurva* are visited by hummingbirds, and these two species are sympatric in some sites, the pollen parent of these fruits cannot be determined. Fruits contained an average of 87.3 (± 6.5) seeds, with a mean of 17.5 (± 5.6) of these containing apparent embryos. Pollination treatment did not affect the number of seeds produced per fruit ($p = 0.699$), or the number of embryo-containing seeds ($p = 3.63$). Fertility also varied in relation to the female parent; some plants were consistently fertile regardless of the pollen source with which they were treated, while others never produced capsules. This patchy fertility indicates that populations may be made up of individuals with varying chromosome numbers - further cytological and molecular studies are needed to answer this question.

These unexpected results suggest that *F. gentneri* may be of recent hybrid origin, with *F. recurva* and *F. affinis* as the putative parents. Future studies focusing on artificially hybridizing these two species, cultivating and observing the progeny produced, and documenting pollinator movement between them, will provide data essential for evaluating the possibility that *F. gentneri* originated from a recent interspecific hybridization event. Low seed production, combined with the inability to determine the male parent in open-pollinated progeny, limit the value of collecting native seed for recovery projects - as a result, development of transplant cultivation protocols should focus on asexual bulblet propagation.

Biographical Information: Kelly Amsberry received a MS in Botany in 2001 from Oregon State University. She has been a botanist with the Native Plant Conservation Program, Oregon Department of Agriculture since 1998.

Fire Regimes in Southwest Oregon; Ecosystem Behavior of the Biscuit and Silver fires

Dr. Thomas Atzet, US Forest Service, P.O. Box 440, Grants Pass, OR 97526
email: tatzet@fs.fed.us

Fire will continue to drive the evolution of southwestern Oregon species regardless of our human need for, and our illusion of, control. Social awareness of disturbances is essential in maintaining ecosystem health, and may help us craft strategies that enhance, rather then thwart, the full range of process diversity. In the last 200 years we have altered the selection process, through suppression. Like trying to suppress the elimination of body waste, it's unhealthy, and we cannot succeed for long. Although southwestern Oregon can be extremely dry during the summer months, sites are capable of producing dense forests, including a continuous, flammable understory. Fire eliminates the mal-adapted, while sprinkling in some chaos, but suppression reduces the extent and density of resilient species in favor or less fire tolerant and pioneer species.

Part of the Biscuit fire, like the recent stock market decline, was a "correction", related to years of suppression. Other parts burned as expected, given what we learned form the Silver fire of 1987. There was a great deal of similarity between the two fires, based on what we can gather from recent fire history. We were also able to compare managed and unmanaged forests by monitoring. Like those who studied Yellowstone and St. Helens, we learned the ecosystem was more resilient than expected, and the recovery process, although variable, was relatively fast. Salvage was applied to the Silver fire to benefit social, not ecological, needs. Management activities emphasized desired stands and landscapes, rather than removal. Numbers of snags and pieces of coarse wood met or exceeded standards, erosion rates were not accelerated, water quality and quantity (Summer flow) was enhanced, without increasing sediment, streamside shade was not removed, and pre-smolt production increased. Several road fills slumped on old roads, grass seeding inhibited natural succession, and there is a need for long-term monitoring particularly with regard to root strength of killed trees. Monitoring data, indicated the fire, in combination with the management activities, was not detrimental.

Biographical Information: Tom Atzet holds degrees in Forest Science, Physiological Ecology, and Forest Ecology. He has worked in reforestation, timber contract administration, recreation, silviculture, and planning in Colorado, California, Washington and Oregon. He has been the area Ecologist for S.W. Oregon since 1974. He produced the S.W. Oregon Plant Association guides and participated in many collaborative efforts including the Northwest Forest Plan.

A West Coast Offensive: An Aggressive Approach to Weed Control and Native Prairie Restoration on Willamette Valley National Wildlife Refuges, Oregon

Jock Beall, U.S. Fish and Wildlife Service, 26208 Finley Refuge Road, Corvallis, OR 97333
phone: (541) 757-7236; email: jock_beall@fws.gov

The Willamette Valley National Wildlife Refuge Complex (WVNWRC) has been actively working to restore and maintain both wet and upland prairie habitats over the past decade on two national wildlife refuges: William L. Finley NWR south of Corvallis and Baskett Slough NWR west of Salem. In addition, restoration work has occurred on the Oak Creek, a Fish and Wildlife Service property southeast of Lebanon. The WVNWRC was established with the primary purpose to provide habitat for wintering Canada geese. However, refuge lands also contain some of the largest remaining tracts of wetland and upland prairie/oak savannah within the Willamette Valley. These lands support a host of rare plant and animal species, including several federally listed as threatened or endangered.

Although prescribed fire has been the primary restoration tool used on refuge lands in the past , more aggressive efforts have been employed over the past three years and especially in 2002. The concern was that habitat conditions were declining at an alarming rate, especially for populations of rare species. Low intensity approaches were obviously not able to keep up with the rapid successional changes from both native and non-native species. Funding opportunities allowed the Refuge to accomplish a number of projects, focusing on the following areas:

1) Target recovery of listed species or enhancement for Species of Concern
2) Convert low goose-use agricultural fields (based on monitoring over several years) to native habitats
3) Reduce woody vegetation on wetland and upland native prairies to improve habitat for prairie plant species and grassland birds

The restoration efforts have included a wide range of treatments and techniques, some with mixed results and others undetermined. New methodologies and equipment have been used or are proposed for use each year based on monitoring. Recent restoration efforts have expanded the use of mechanical treatments on native habitats using specialized equipment. The main tool used on these efforts has been a Bobcat rubber-tracked tractor. This low ground pressure tractor has multiple implements including a front-mounted brush hog rotary mower, and grapples for removing slashed brush and trees. The Bobcat was used on many refuge sites including sensitive plant habitats where minimizing ground disturbance is a primary objective.

In 2002 the refuge took advantage of funding for fuels reduction (fire danger rating) to meet restoration objectives at the same time. Many of the treated sites were considered medium to high risk for wildland fire during the late summer period. Prescribed fire was considered too difficult to control under existing conditions. Slashing and removal treatments not only reduced the fuel loads, but returned much of the area to open prairie conditions favoring native species. Slashing work was done by contract crews, while layout and slash removal were completed by refuge staff.

Some of the most dramatic habitat changes occurred on the upland prairies of Baskett Butte on Baskett Slough NWR. Woody vegetation was slashed and removed from a number of sites, retaining only scattered oaks and other native shrubs. Both native and non-native species were removed, including hawthorn, serviceberry, cherry, Douglas-fir, and selected Oregon white oak. Additionally large poison oak patches were mowed using the Bobcat tractor. Brush was moved off-site to burn piles using the Bobcat with grapples. This work was targeted to enhance habitat for the Fender's blue butterfly, as well as listed prairie species including the Willamette Valley daisy and Kincaid's lupine.

Prescribed fire and other aggressive woody vegetation treatments were implemented at Oak Creek for the first time in 2002. The Oak Creek site supports the largest known population of Bradshaw's desert parsley, listed as endangered. Prescribed fire was used on a 7 acre open wet prairie site, while 10 acres of prairie dominated by domestic pear was slashed and removed.

Mechanical treatments were used on W. L. Finley NWR to clear Douglas-fir from the edges of a small remnant upland prairie. This eight-acre project was completed by a local logging contractor and the merchantable logs were made available to the Mid-Coast Watershed Council for in-stream fishery enhancement projects. An additional 35 acres of historic oak savannah/woodland was mechanically treated with a track-mounted brush hog. This machine pulverized specific woody vegetation including small fir, "old growth" poison oak, and cherries, retaining scattered oaks and other large trees. Following additional treatment of an adjacent area in 2003, future plans include establishing a new prescribed burn unit across 70 acres to maintain the open condition.

Middle Prairie is a native wet prairie unit within the Willamette Floodplain Research Natural Area on W. L. Finley NWR. Fire was largely excluded from this prairie unit for 20 years, such that woody vegetation has prevented effective use of prescribed fire. Thirty-eight acres were slashed and removed in 2002, with additional areas mowed with the Bobcat.

Upland sites retired from agricultural use have been the focus for establishing new prairie habitats. Although treatments have been on-going for several years, establishment of even low diversity prairie has been elusive. Treatments including discing, spraying, mowing, and prescribed fire have all been used in various combinations, yet the dominance of non-native species such as Canada thistle, annual ryegrass, and other weedy species continue to be problematic. A bright spot is the use of a Truax No-till Drill, a standard used in the Midwest for years to restore short and tallgrass prairie. The drill has proved advantageous on both wet and upland prairies because site preparation through discing is not needed. The Truax drill was used on over 150 acres in 2002, including refuge lands and other sites.

New but untested technology awaits the restoration plans for 2003. The refuge has purchased a herbicide-wicking applicator, to be pulled by an ATV. The plans are to used this to kill invasive tall oatgrass and other grass "overstory" species that exist above the remnant shorter native species. This equipment is used effectively in the grass seed industry.

Other restoration activities on the WVNWRC include grow-out of native seed, limited seed collection, grow-out of oaks from local acorns, and intensive discing of reed canary grass sites.

The effects of much of the work completed in 2002 may not be apparent for several years. The alternative to the aggressive approach would result in continued degradation of existing habitat with the encroachment of woody species. The necessity for follow-up treatment is assured, either with periodic mowing or prescribed fire, but it should be at lower intensity and at much less cost.

Several conclusions have resulted from the past three years of monitoring:

1) Non-native plant species, including residual agricultural crops, present the biggest challenge to successful restoration
2) Significant efforts and funding are sometimes required to setback succession of native vegetation, particularly woody species.
3) Every restoration site is slightly different that the previous one, and when combined with variable weather patterns of the Northwest, it re-enforces the need for flexibility.
4) Attempting to push a site into a native condition without adequate site preparation, whatever that may be, equates to flushing seed down the drain.
5) Thanks to the efforts of a number of people, localized native seed is becoming more available to make continued restoration efforts possible.

Biographical Information: Jock Beall has a BS in Wildlife Management from Humboldt State University. He has held biologist and manager positions with four federal agencies across six states over the past 25 years, working in forest management, endangered species, waterfowl, habitat restoration, and land acquisition. Currently he is the senior Refuge Biologist for USFWS at Willamette Valley NWRC in Corvallis.

Informing Conservation Plans with Monitoring Results from the Vernal Pool-Mounded Prairie and Associated Endangered Species on the Rogue River Plains, Jackson County, OR

Darren Borgias, The Nature Conservancy, 33 N. Central Avenue, Suite 405, Medford, OR 97501
phone: (541) 770-7933; email: dborgias@tnc.org

The area and distribution of vernal pool-mounded prairie on the Rogue River Plains in central Jackson County has been severely reduced and fragmented by habitat conversion. The condition was degraded by a variety of land-use including a 150-year history of livestock grazing that contributed to the establishment of non-native species and loss of summer-flowering perennials. The native and exotic annual species that persist across the landform fluctuate in abundance in response to livestock grazing, fire and annual climatic variation. A diverse array of native forbs still occurs, including two endangered species recently listed by the USFWS under the Endangered Species Act: Cook's desert parsley, *Lomatium cookii*, and the large-flowered wooly meadowfoam, *Limnanthes flocossa* ssp *grandiflora,* both associated with shallow vernal pools. The Nature Conservancy has worked since 1985 at a growing number of areas on and off our ownership to protect the two species and their habitat by securing management and active restoration of the prairie to better sustain the target species.

Monitoring over that period has been an integral part of our management. Over the initial three years of management by The Nature Conservancy, the abundance of Cook's desert parsley on the preserves increased with the duration of rest from livestock grazing. After three years, absent grazing and fire, accumulated grass thatch increasingly hindered seedling recruitment, particularly on the mounds, where the invasive annual medusahead grass (*Taeniatherum caput-medusae*) was prevalent. Periodic prescribed burning initiated in 1996 combined with the reintroduction of native perennial bunchgrasses has abated the threat of excessive thatch, and the abundance of Cook's desert parsley seedlings and juveniles has increased, stabilizing the population. Patches of plants previously lost from mounds have not recovered or re-established.

The meadowfoam dramatically increased following cessation of grazing on the same preserve and it continues to increase by colonizing unoccupied habitat. Its abundance in permanent grid-cells changes in response to patterns in annual variation in winter precipitation, and possible interactions with thatch and fire are not detected in our monitoring. Stable trends and abundance levels for the species at other currently grazed sites point to a more complicated relationship between livestock grazing and the species.

We are measuring our conservation success using seven indicators of ecological integrity that reflect key ecological factors and critical stresses that operate on the prairie targets: distribution and abundance for the endangered species, excessive thatch, soil disturbance by gophers, excessive herbivory, and status of functional plant groups. Condition classes for each indicator reflect minimum acceptable integrity thresholds, and a hypothetical optimal ecological integrity description. We are using these indicators with measures of habitat fragmentation and hydrologic integrity, in working with landowners and other stakeholders to develop a conservation plan that will sustain the target species and prairie systems across the site. We propose to integrate outright acquisition, enabling optimal conservation management on key blocks of habitat, with conservation easements on surrounding tracts to preclude critical development while secure Best Management Practices for ongoing livestock grazing.

Biographical Information: Darren Borgias has over 15 years experience in conservation within southwestern Oregon, with responsibility for the management of 13 conservation areas, where he has developed expertise in fire ecology and fire management planning, restoration, serpentine ecology, and monitoring of rare plants and natural systems. His work in southern Oregon also includes conservation area design and planning at multiple scales. Darren has a M.S. in Biology with emphasis in plant ecology from Western Washington University.

Genetic and Demographic Issues in Restoring the U. S. Threatened Mead's Milkweed

Bowles, M.L.[1], J. McBride[1], & T.J. Bell[2], [1]The Morton Arboretum, Lisle, Illinois, [2]Chicago State University, Chicago, Illinois
phone: (630) 719-2422; email: mbowles@mortonarb.org

Mead's milkweed (Asclepiadaceae:*Asclepias meadii*) is a long-lived perennial forb of undisturbed Midwestern prairies. This species is self-incompatible, and the few remaining populations in the eastern part of its range have been fragmented into small clones that no longer reproduce. Recovery requires restoration of genetically diverse populations capable of reproduction. We developed an *ex situ* nursery to produce propagules (seeds and juvenile plants) for experimental restoration in fire-managed prairie remnants and restorations. After six years, seven restored populations averaged 69 plants with about 20 different genetic lines. Seedlings averaged 35% germination and 35% survivorship, while planted juveniles averaged 26% survivorship. Less than one percent of planted juveniles have flowered. Seedlings have demonstrated little growth – with 12 or more years projected to reach a flowering size threshold. Seedling survivorship is enhanced by fire and greater than normal rainfall, while juvenile survivorship has a greater response to fire than rainfall. Because of the great longevity and low fecundity of this species, restoration management should focus on using prescribed fire to enhance survivorship and growth, as well as continued introduction of new genotypes to increase reproductive potential.

Biographical Information: Marlin Bowles is Plant Conservation Biologist at The Morton Arboretum, located in Lisle, Illinois and is also an Adjunct Teaching Associate with The University of Illinois at Urbana. He manages the Arboretum's Plant Conservation Program. In that capacity, he has been a member of federal recovery teams for the U.S. listed eastern prairie fringed orchid, Mead's milkweed, Pitcher's thistle, and leafy prairie clover. He also conducts research on propagation and population restoration of these species. His work also includes examining the effects of management on natural areas, as well as an analysis and application of public land survey data to natural area restoration and management.

The Reintroduction Planning Process for Golden Paintbrush, a Threatened Prairie Species of the Puget Lowlands and Willamette Valley

Florence E. Caplow, The Washington Natural Heritage Program, Department of Natural Resources, P.O. Box 47014, Olympia, WA 98504
phone: (360) 902-1793; email: Florence.Caplow@wadnr.gov

Golden paintbrush (Castilleja levisecta) is a perennial herb in the figwort (Scrophulariaceae) family. It was collected historically from prairies and island balds from southern Vancouver Island to the central portion of the Willamette Valley (Linn County). It is now extirpated from Oregon and restricted to 12 populations in Washington and British Columbia, six of which occur on public land. It was listed as threatened under the Endangered Species Act in 1997. The Recovery Plan for golden paintbrush (USFWS 2000) calls for the establishment of new populations of golden paintbrush within the species historic range and specifies the development of a reintroduction plan to guide this process (Caplow 2001).

Although several reintroduction experiments are described in the literature, this plan is, to our knowledge, the first full scale reintroduction plan for any federally listed plant species. Since there were no models available to us, we followed the guidelines for a rare plant reintroduction plan in Falk et al. (1996). The reintroduction plan for golden paintbrush identifies five major areas of consideration: (1) strategic and managerial, (2) site selection, (3) genetic and demographic , (4) ecological, and (5) technical (seed collection, propagation, planting). We also provided detailed guidance for seed collection, the site selection process, steps for reintroduction, and monitoring design. An important part of the genetic portion of the reintroduction planning process was an analysis of allozyme diversity in golden paintbrush, which was conducted by researchers at the University of Georgia (Godt and Hamrick, in prep.).

The biology of golden paintbrush is poorly understood, and successful reintroduction of rare plants is complex and may require many steps, including preliminary research and the establishment of experimental populations. Successful large-scale reintroductions are relatively rare. There a number of dangers associated with any reintroduction, including its use in lieu of proper protection and enhancement of existing populations and the potential overuse of existing populations for seed production. The reintroduction plan for golden paintbrush is an attempt to increase the likelihood

that reintroduction attempts will result in viable populations, will not cause harm to existing populations, and will be supported by the best available knowledge of the taxon.
The next reintroduction steps include completion of the plan, site characterization of existing populations, pilot site selection for SW Washington, the establishment of experimental populations at three Washington sites, and common garden experiments to identify potential seed sources for Willamette Valley reintroductions.

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Biographical Information: Florence Caplow is the rare plant botanist for the Washington Natural Heritage Program, and is responsible for the development of the Washington rare plant list and the coordination of conservation activities for Washington's rare plants. She has a B.S. from The Evergreen State College and fifteen years of experience conducting field studies and inventories of rare plants throughout the Pacific Northwest. She is a co-author of two species new to science: *Eriogonum codium* and *Lesquerella tuplashensis*, both from the Hanford Site in eastern Washington.

Predicting Effects of Prescribed Burning on Seedling Establishment Rates of Native Wetland Prairie Species of the Willamette Valley, OR

Deborah L. Clark, Mark V. Wilson, and Jennifer Goodridge, Oregon State University, Department of Botany and Plant Pathology, 2082 Cordley Hall, Corvallis, OR 97331-2902
phone: (541) 737-1734; email: deborah.clark@orst.edu

Native prairies of the Willamette Valley are considered among the rarest of Oregon's ecosystems and are in critical need of conservation. Management strategies for increasing the abundance of native species are urgently needed, particularly those strategies that promote the regeneration of native species from seed. Fire may be an important factor in promoting regeneration of native species from seed because of its historical role in maintaining the prairie landscape.

Field studies to determine fire effects on seedling establishment rates are logistically difficult, time consuming, and hard to generalize. An alternative approach is to establish correlations between known seedling establishment rates under specific conditions with more easily measured plant traits such as seed weight or relative growth rates. By using such correlations, we can then make predictions about unknown seedling establishment rates.

The study objectives were (1) to determine the effect of prescribed burning on regeneration of native species from seed, and (2) to establish predictive relationships between easily measured plant traits and seedling establishment rates in the field. The general approach was to sow seeds of 19 wetland prairie species during the fall into experimental field plots already established at the Danebo wetland, Eugene, OR. Seedling establishment rates were then compared the following spring between the plots that had been regularly burned every two years and unburned plots. To establish predictive relationships, these establishment rates were compared to 13 selected seed and seedling traits measured under laboratory conditions.

Overall seedling establishment rates showed no significant differences between burned (7.0%) and unburned plots (8.7%), although seven of the 19 species sowed showed positive responses to burning, with three species*, Wyethia angustifolia, Grindelia integrifolia*, and *Danthonia californica* showing statistically significant increases. Burning decreased the seedling establishment rates of four species, although the decrease was statistically significant for only one species *Sidalcea campestris*.
Of the 13 selected measured seed and seedling traits, plant biomass at seven days under laboratory conditions was the best predictor of field seedling establishment rates for both the burned plots and the unburned plots. Plant biomass explained a substantial amount of the variation in seedling establishment rate: 70% for the burned plots and 45% for the unburned plots. This model could potentially be used by managers to choose species for sowing in burned and unburned prairies or to estimate seeding rates at burned and unburned sites.

Table 1. Average seedling establishment rates (%) of 19 native wetland prairie species in June 2000, nine months after sowing in October 1999 in burned field plots, which had been burned every other year beginning in 1994 and in unburned

field plots in a native wetland prairie (Danebo wetland). Transformations were applied as necessary before analysis of variance (ANOVA). P is the probability that the differences in treatment means occurred just by chance. Significant differences (P≤ 0.1) are in bold. All means shown are from untransformed data.

Species	Treatment		
	Unburned	Burned	P
All species	7.0	8.7	0.25
Monocots			
Allium amplectens	7.1	7.1	1.00
Camassia quamash	15.3	15.1	0.95
Carex densa	0.1	2.0	0.14
Carex unilateralis	1.6	1.5	0.42
Danthonia californica	7.2	12.1	0.08
Deschampsia cespitosa	0.8	4.0	0.14
Sisyrinchium sp.	0.0	0.0	
Zygadenus venenosus	24.8	13.3	0.12
Dicots			
Aster curtus	8.4	3.4	0.29
Aster hallii	2.0	3.2	0.71
Eriophyllum lanatus	4.1	6.8	0.88
Grindelia integrifolia	10.3	25.3	0.05
Horkelia congesta	7.8	4.2	0.39
Lomatium bradshawii	0.0	0.0	
Microseris laciniata	11.7	23.8	0.16
Prunella vulgaris var. vulgaris	16.8	24.1	0.46
Sidalcea campestris	1.9	0.3	0.09
Sidalcea cusickii var. purpurea	4.3	3.3	0.63
Wyethia angustifolia	5.6	13.6	0.05

Biographical Information: Deborah L. Clark is a Faculty Research Associate with the Department of Botany and Plant Pathology, and Instructor for the Biology Program at Oregon State University. She received a Ph.D. in Botany and Plant Pathology (Ecology), Oregon State University, 1996. Her research focuses on understanding the ecology of wetland and upland prairie plants, particularly invasive and rare species, during the regeneration stage. She often works in collaboration with land management agencies in the Willamette Valley because restoration projects offer an excellent opportunity to gain this understanding of ecological processes. By the same token, scientific research can improve restoration and conservation efforts by explaining the mechanisms for plant responses to management strategies. More information about their research program on Willamette Valley Prairies can be found at http://www.onid.orst.edu/~wilsomar/Index.htm.

Making Ploidy Count in Landscape Restoration: Insights From Past and Present Studies

Richard Cronn, Pacific Northwest Research Station, USDA Forest Service, 3100 SW Jefferson Way, Corvallis, OR, 97330
phone: (541) 750-7291; email: rcronn@fs.fed.us; http://www.fs.fed.us/pnw/corvallis/rmpgen/

An expanding awareness of the importance of matching plant collections to specific environments has forced regulatory agencies to consider not only ecosystem restoration and soil resource protection, but also the genetic compatibility of introduced materials with resident populations. Traditional guides for determining the genetic compatibility among introduced and resident materials include the geographic source of the introduced material, and the magnitude of differences in adaptive traits and/or molecular markers between introduced materials and resident plants. In flowering plants, few factors have a greater impact on these guides of compatibility than the ploidy level(s) demonstrated by the species of concern. Chromosomal variation arising from structural rearrangements and changes in chromosome number can impose constraints on the frequency and success of between-population matings, influence population level fitness, and potentially give rise to cryptic variants that meet the definition of distinct “species” under the biological species concept. Despite the influence of ploidy on these barometers of compatibility, relatively little is known about the importance of polyploidy on establishment success and long-term population viability. The lack of this information stands in contrast with the widespread utilization of plants known to exhibit a high frequency of polyploidy variation (e.g., *Atriplex*, *Bromus, Calamagrostis, Elymus, Lupinus, Poa*) in restoration activities.

In this presentation, I review the key genetic distinctions between species that are diploid and those that exhibit polyploidy. The influence of fixed and variable polyploidy on intermating success, fitness, heterozygosity and inbreeding

depression will be emphasized. Case studies showing the relevance of polyploidy will be described for two restoration species, and rare plant species that are presently being evaluated for population viability. It is recommended that a regional database be established for identifying the ploidy level of common restoration species, and that particular emphasis be placed on those that exhibit ploidy variation.

Biographical Information: Richard Cronn is a research geneticist with the USDA Forest Service who studies population and evolutionary processes using molecular markers.

Native Plant Propagation, Seed Increase, and Revegetation Efforts: The Role of the Corvallis Plant Materials Center in Western Oregon and Washington

Dale C. Darris, Corvallis Plant Materials Center, 3415 NE Granger Rd., Corvallis, OR 97330
phone: (541) 757-4812; email: dale.darris@or.usda.gov

The USDA Natural Resources Conservation Service (NRCS) operates 26 Plant Materials Centers (PMCs) across the nation. Each works on finding vegetative solutions to conservation problems that occur within the geographic area they serve. The Corvallis Plant Materials Center near Corvallis, Oregon, primarily serves the ecoregions of western Washington, and western Oregon, and northwestern California. Its mission is to develop applied plant technology in the realm of native plant propagation, establishment, seed production, revegetation, and erosion control, and to increase and release plants or seed sources for rehabilitation or improvement of riparian areas, wetlands, and uplands.

In operation since 1957, the Corvallis PMC is, in part, a small agronomy seed research farm and a native plant nursery. The operation consists of four permanent staff members, 52 acres of land, two greenhouses, a laboratory/office, seed processing facility, nine wetland plant cells, and related equipment facilities. Work is conducted on and off the Center, in cooperation with Oregon State University, the state Agricultural Experiment Station, Crop and Soil Science Department Hyslop Research Farm, and various Federal, State, local, and nonprofit organizations.

There are four areas of focus at the PMC. The first is native plant and seed propagation technology development. Demonstrations and studies include determining traditional vegetative propagation protocols and seed increase practices. Most of the work in the last 20 years has concentrated on native riparian and wetland shrubs, grasses, and several legumes. Examples include rooting trials on native shrubs, agronomic grass seed increase studies on residue management, fertilization, and herbicide treatments, and seed germination studies, including scarification and stratification. *Elymus glaucus, Deschampsia caespitosa, Danthonia californica,* and *Beckmannia syzigachne* are among the grasses most researched. Legumes studied have included several species of *Lupinus* and *Lotus*.

The second major area of investigation is plant establishment: planting methods, revegetation techniques, and plant adaptation to geographic areas or soils, wetlands, and riparian zones. Significant effort has gone into evaluating the potential of native willows (Salix spp.) and shrubs for soil bioengineering practices and streambank stabilization. Since 1994, 10 streamside field trials have been installed in cooperation with others to test the performance of woody species for live fascines, live stakes, poles, and brush mattresses. Trial locations include Dairy Creek, Mill Creek, and Minihaha Creek in Oregon and Schnieder Creek in Washington. Erosion control and seeding practices incorporating mats, mulches, different seeding rates and mixes, soil amendments, and various site preparations have been evaluated. On and off farm variety trials and field plantings along roadsides and streams, on farmland, or in wetlands have been used to evaluate adaptation and performance of plant sources, species, or cultivars. Recent examples include establishing camas (*Camassia* spp.) from seed using different site preparation methods, comparing the inundation depth tolerance of native grasses, shrubs, and sedges (*Carex* spp.) in wetland cells, and testing the competitive ability of native grasses such as *Beckmannia syzagachne* with *Phalaris arundinacea*.

The third area of work at the Corvallis PMC has been native plant seed source “development” and population studies. In the 1970s and 80s native plants were sampled from 40 to 70 wild populations throughout the service area and grown in common gardens to compare growth and performance. Select populations were chosen based on form, seed yield, or other desirable traits, increased by the PMC, tested in field plantings, and released as plant cultivars, even though they had not been bred or hybridized. Because of this, all cultivars released by Corvallis are still considered native and are recommended by NRCS for revegetation in the PMC service area. Examples of PMC native plant releases are ‘Hederma’ pine lupine (*Lupinus albicaulus*), ‘Elkton’ and ‘Arlington’ blue wildryes (*Elymus glaucus*), ‘Mason’ western red osier dogwood (*Cornus sericea* var. *occidentalis*), ‘Bashaw’ Douglas spiraea (*Spiraea douglasii*), and six native willow varieties. Releases are made in cooperation with the state Agricultural Experiment Station, in this case Oregon State University, and on occasion Washington State University.

More recently, with the advent of pre-varietal seed certification procedures (source identified, selected, and tested classes) formulated by the Association of Official Seed Certifying Agencies (AOSCA 1996) and the development of pre-varietal plant release procedures by the Natural Resources Conservation Service (USDA 2000), the Corvallis PMC since 2000 has released three certified selected class, natural germplasm, native grasses: Tillamook and Willamette Germplasm tufted hairgrasses (*Deschampsia caespitosa*) (Darris and Lambert 2001), and Baskett Slough Germplasm California oatgrass (*Danthonia californica*) (Darris and Lambert 2000). A native shrub, Skamania germplasm sitka alder (*Alnus viridis* sp. *sinuata*), is targeted as the next selected class release. It represents a high quality seed source from,

and for use at, low elevations. Skamania Germplasm (as with all PMC releases) is not necessarily intended to replace "local" or on-site sources of native sitka alder for ecological restoration plantings. With the trend toward greater localization of seed sources, releases in the near future will also include five selected class populations of oceanspray (*Holodiscus discolor*) that are ecoregion specific. While all older cultivar and newer selected class releases address erosion control and revegetation objectives, NRCS makes no claims concerning their suitability for native plant restoration efforts. Individuals with such concerns for a particular environment or ecosystem should make their decisions on a case by case basis.

Since 1995, the Corvallis PMC has modified its objectives with regards to plant assemblages and selection. It now works closely with others on native plant common garden studies that evaluate phenotypic variation among populations for the purpose of seed zone and seed transfer guideline development, rather than trait selection per say. A team approach is used with a partner other than NRCS taking the lead on specialized genetic and statistical issues. Examples include broadleaf lupine (*Lupinus latifolius*) with the US Forest Service (Doede et. al. 1998), big deervetch (*Lotus crassifolius*) with the Forest Service and Bureau of Land Management, and beginning in 2002, Roemers fescue (*Festuca roemeri*) with the Institute for Applied Ecology in Corvallis, OR. It is likely these studies will also result in the release of certified source-identified as well as selected class populations as before, but the basis will be a stronger population analysis tied to ecosystem variables such as elevation, latitude, precipitation, soil type, etc.

Finally, the PMC multiplies seed and plants of its releases and conducts special seed and plant increases and revegetation studies with cooperating agencies. In the first case, the PMC increases supplies of breeder, foundation, G1, or G2 seed or propagules for further testing and for larger scale increase by commercial seed growers and private nurseries. Second, special projects are undertaken with other Agencies that include growing species or sources that are difficult to produce, high risk, or not readily available. The Center began with a small grass seed increase for Olympic National Park in 1987. The largest projects over the period 1990-2000 have been increases, revegetation studies, technical reports, and other evaluations for Crater Lake and Mt. Rainier National Parks. Material and technology produced by the PMC is used for revegetation on highway and other construction projects at mid to high elevations within the Parks. Work also began in 2002 on wetland plant production for the BLM in Eugene, OR. Another extensive, long term project may involve consulting and increase work for revegetation along the Elwah River in Olympic National Park. Lastly, the PMC has cooperated with and assisted various Tribes on culturally significant plants. Most notable are propagation and establishment studies on Tule (*Schenoplectus acutus*) with the Confederated Tribes of the Warm Springs Reservation of Oregon, as well as revegetation and seeding trials using camas.

In summary, the Corvallis Plant Materials Center, operated by the Natural Resources Conservation Service in Oregon, focuses exclusively on species native to western Oregon, western Washington, and northwestern California. Efforts are geared toward developing revegetation techniques and traditional seed and plant propagation methods, as well as identifying, releasing, and promoting seed sources for use within the region. Within the last two decades, many native species that previously had no commercial value have now become important players, if not in scale, at least in content. However, unknown or poorly tested establishment techniques and unknown, difficult, or high cost seed and vegetative production methods remain major impediments to further cultivation and the use of many important natives. The PMC has a significant role to play in addressing these needs and hopefully contributing to the health, stability, and diversity of our environment.

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Biographical Information: Dale Darris is a Conservation Agronomist for the USDA Natural Resources Conservation Service at its Plant Materials Center in Corvallis, OR. He grew up in Michigan and obtained a Bachelor of Science in

Plant and Soil Science from Michigan State University. He also did graduate work in Forest Ecology at Oregon State University. For over two decades he has increased plants, researched grass seed production, woody plant propagation, restoration, and revegetation techniques, evaluated ecotypic variation within species, and conducted plant selection, while holding research and management positions at similar facilities in North Dakota, Maryland, and Oregon. Current projects include seed germination, plant adaptation, seed and vegetative plant increase, soil bioengineering, and establishment technology for a variety of shrubs, grasses, and legumes indigenous to Pacific Northwest ecosystems west of the Cascades. He has authored and presented numerous technical publications, as well as written brochures, technical reports, and popular articles on his work.

Managing and Restoring Grasslands in the Puget Lowlands: Lessons Learned from Yellow Island, San Juan Islands, WA

Peter W. Dunwiddie, The Nature Conservancy, 217 Pine St., Suite 1100, Seattle, WA 98101
phone: (206) 343-4345 x342; email: pdunwiddie@tnc.org

Many native grasslands in the Puget Lowlands are dominated by Roemer's fescue (*Festuca roemeri*), great camas (*Camassia leichtlinii*), and a diversity of other forbs. Since 1981, the Nature Conservancy has been conducting a variety of management and restoration experiments in one such grassland on their 11-acre Yellow Island preserve. Activities have focused on a) maintaining high quality grasslands by prescribed burning, b) removing encroaching shrubs and trees from grasslands using mechanical and chemical means, and c) restoring native grassland vegetation in areas that have been overtaken by forest by clearing and planting.

Four prescribed burns have been conducted since 1987. Following each burn, responses of different species have been complex, varying in direction, magnitude, and duration. Most burns result in a reduction in fescue cover, a long-term decrease in lichen and moss cover, a short-term increase in the abundance of annuals over perennials, an increase in the abundance of forbs over grasses, and an increase in some non-native species. However, apparently similar burns in different years occasionally resulted in varied responses among the same taxa. To make informed generalizations from our results, we emphasize the need for replicating treatments over time and at different sites.

A series of studies was directed towards developing effective means for controlling and removing invading trees and shrubs, and on limiting non-native grasses and forbs. Several herbicides, including Poast, Krenite-S, and Round-up, have been successful in controlling non-native grasses and many shrubs. Mechanical treatments successfully removed conifers, but often left dense needle layers that were readily invaded by non-native species. Most shrubs and deciduous trees resprouted following cutting or burning. Even when abundant native seed sources existed in close proximity to cleared sites, non-native species usually establish more quickly following removal of trees and shrubs, and continue to dominate for many years.

We have also tried several approaches for restoring native grassland species in areas where they had been excluded by competing woody plant growth. Out-planting of propagated plants has proven most effective in rapidly re-establishing native species, but is labor-intensive. In many areas, we have successfully established a dense fescue matrix that excludes invasive species. Current efforts are now focused on enhancing the diversity of native forbs in these restored grasslands.

Biographical Information: Peter Dunwiddie began work on Yellow Island for the Nature Conservancy while a graduate student in botany at the University of Washington, where he received his doctorate in 1983. He worked for 13 years as a plant ecologist with the Massachusetts Audubon Society, and returned to Washington to join the Nature Conservancy in 1996. He currently is the Director of Research Programs in the Conservancy's Washington office.

Development and Use of Native Grass Plant Materials for Ecosystem Restoration and Management in the Blue Mountains of Oregon

Vicky J. Erickson, USDA Forest Service, 2517 SW Hailey Ave., Pendleton, OR 97801
phone: (541) 278-3715; email: verickson@fs.fed.us

The condition and extent of native forest and grassland communities are declining throughout large portions of the interior western United States, including the Blue Mountain of northeastern Oregon and southeastern Washington. A number of factors are responsible for this trend, including ungulate herbivory, invasive non-native plants, and altered fire regimes. The Forest Service and other public land management agencies have responded to declines in wildland vegetative conditions by initiating programs to collect and use native plant species in habitat restoration and revegetation projects. For native grasses, restoration needs are generally met through the collection of seed from natural populations followed by establishment of seed increase fields in agricultural environments.

At present, the primary focus of propagation efforts is on early seral species that have broad ecological amplitude, and strong rooting and growth characteristics conducive to rapid establishment on disturbed sites. Priority

"workhorse" species include blue wildrye (*Elymus glaucus*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Mountain brome, (*Bromus carinatus*), Sandberg's bluegrass (*Poa secunda*), Idaho fescue (*Festuca idahoensis*), tufted hairgrass (*Deschampsia cespitosa*), prairie junegrass (*Koeleria macrantha*), California oatgrass (*Danthonia californica*), western needlegrass (*Achnatherum occidentale*), and Lemmon's needlegrass (*Achnatherum lemmonii*). Most native seed is grown under contract by private seed producers, using multiyear "requirements" or delivery order contracts. The Forest Service furnishes the grower with wild-collected seed, and then specifies an estimated and maximum quantity of seed to be produced annually for each species and propagation area (generally 5th field watersheds). All seed must meet Oregon and Washington State certification standards pertaining to isolation requirements, germination and purity percentages, and weed contamination standards for Source Identified Seed.

Restoration seedbanks are growing rapidly as seed producers gain experience and knowledge in the culture and management of native grass species under agronomic field conditions. Critically lacking, however, is genetic information for identifying the appropriate number and distribution of collection sites, and for determining the geographic and ecological distance that seed should be transferred from original source populations. Knowledge of natural patterns of genetic variation would help ensure the adaptability and sustainability of plant materials, as well as reduce potentially adverse impacts of introductions on the genetic resources of remnant natural populations.

The development of seed collection and transfer guidelines for the more widely used species would also provide guidance and structure to the native seed production industry, resulting in improved efficiencies, increased seed supplies, and reduced seed costs. An example is Elymus glaucus, one of the most extensively used native grass species in the Blue Mountains. Our recent common garden study of populations in eastern Oregon and Washington recommends that four geographic subdivisions based largely on longitude and ecoregion subdivisions be used for blue wildrye seed transfer in the Blue Mountains province. This new framework is much less restrictive than the provisional transfer guidelines currently used by National Forests in this area. Genetic studies of other priority species are greatly needed. A common garden study involving Blue Mountain populations of Bromus carinatus will be established in Summer 2003.

Biographical Information: Vicki Erickson is a geneticist for the Umatilla, Wallowa-Whitman, and Malheur National Forests in the Blue Mountains of eastern Oregon and Washington. She also coordinates the rare plants and invasive species programs on the Umatilla National Forest.

Creating New Populations of the Pacific Northwest's Most Endangered Grass, *Pleuropogon oregonus*: Developing Introduction Protocols Based on Biogeographic Data

Steven D. Gisler and Robert J. Meinke, Oregon Department of Agriculture, Native Plant Conservation Program and Oregon State University, Department of Botany and Plant Pathology, 2082 Cordley Hall, Corvallis, OR 97331 phone: (541) 737-2346; email: gislers@bcc.orst.edu

Although eastern Oregon's abundant and diverse native flora is appreciated by many, this familiarity is wanting for one of the region's rarest and most imperiled inhabitants, the Oregon semaphore grass (*Pleuropogon oregonus*). This unique and attractive wetland grass has a global distribution comprised of only two mid-montane sites in Union and Lake Counties, Oregon, separated by nearly 250 miles and cumulatively occupying less than 15 acres of habitat (all on private property). Given the manifold threats posed by (1) extreme rarity, genetic isolation, and small population sizes, (2) grazing by livestock, (3) anthropogenic hydrologic alterations, and (4) lack of protected sites on public lands, *P. oregonus* merits distinction as the most endangered grass in the Pacific Northwest. Accordingly, it has been listed as Threatened by the State of Oregon (http://arcweb.sos.state.or.us/rules/OARS_600/OAR_603/603_073.html), and as a federal Species of Concern.

Among this species' many pressing conservation needs, the highest priority may be the creation and/or re-establishment of *Pleuropogon oregonus* populations on protected sites, in order to increase its overall abundance and offset further population declines on private ranch lands. Towards this end, the Oregon Department of Agriculture (ODA) has undertaken efforts to gather fundamental biological and ecological information about *P. oregonus*, to be used in the concurrent development and implementation of propagation and re-introduction programs for the species.

First, data was collected to evaluate the feasibility and methods of propagating *Pleuropogon oregonus* for introduction projects. These data show that, contrary to previous reports, *Pleuropogon oregonus* reproduces sexually by seeds (though seeds are produced at very low levels), as well as through asexual clonal growth. Seed germination occurs at high rates (70-93 percent) and is not meaningfully improved through cold stratification or hormonal stimulant treatments. The species is easily propagated in the greenhouse using both seeds and rhizome cuttings, and stock can be rapidly increased by repeatedly dividing mature plants. Propagation trials indicate that *P. oregonus* remains in a vegetative stage indefinitely until exposed to a vernalization (chilling) period, which then signals flowering. Collectively, these results demonstrate there are no significant propagation-related obstacles to introduction efforts for the species, and further suggest the genetic diversity and flowering status of stock introduced at a given site can be manipulated through propagation methods and outplanting choices.

Development of biogeographically-based introduction protocols for *Pleuropogon oregonus* not only requires information about reproduction and propagation, but also information on genetic issues (should extant populations be

treated as separate conservation units?) and ecological issues (how do we predict suitable introduction sites?). With regard to genetic issues, field and greenhouse data demonstrate the two extant *P. oregonus* populations differ in levels of seed production and rate of clonal increase in the greenhouse, and morphometric studies performed under common garden conditions show significant differences between populations in 9 of 17 measured morphological traits. Using these traits in a multivariate model, canonical discriminant analyses correctly classified 91.7 percent of individuals by their corresponding source population. Collectively, this information is suggestive of significant genetic differentiation between extant *P. oregonus* populations, so efforts should be taken to carefully source-identify all propagated stock in order to avoid inadvertent mixing of gene pools during introduction projects.

To learn more about what kinds of sites might be suitable for *Pleuropogon oregonus* introductions, we sampled and compared soil moisture and associated species at both extant populations. Analyses reveal equivalent soil moisture levels between populations (about 70 percent by volume in mid-summer, 2000) and also suggest a definite soil-moisture threshold limiting the distribution of the species at each site. Vegetation sampling plots show 9 associated wetland species that are common to both *P. oregonus* populations, and 16 species unique to one population or the other. While this information is suggestive of certain community differences between the two extant populations, it nevertheless provides a suite of species that may serve as useful range-wide indicators of suitable *P. oregonus* habitat.

Utilizing this biogeographic information gathered on *Pleuropogon oregonus*, ODA initiated population introduction trials (involving 4,200 *P. oregonus* tillers) at four eastern Oregon sites in 2002, with much appreciated interagency cooperation from the U.S. Fish and Wildlife Service, Lakeview office of the Bureau of Land Management, Fremont National Forest, Burns Paiute Tribe, Confederated Tribes of the Umatilla, and Natural Resources Conservation Service. Despite this cooperation, suitable-appearing introduction sites proved unexpectedly difficult to find due to widespread degradation of stream-associated wetlands in eastern Oregon (largely due to domestic grazing, stream incision and erosion, anthropogenic watercourse changes, and introduced species), combined with private ownership of many sites containing springs and streams. As 2002 was one of the driest years on record for the region, availability of introduction sites was further limited by a general drying out of wetland habitats. The first results of our preliminary *P. oregonus* introduction trials will be available following monitoring in summer, 2003. Our fingers are crossed.

It is hoped that the preliminary *Pleuropogon oregonus* introduction trials described here will provide a useful example of the development of biogeographically-based introduction protocols for rare plants, instill an appreciation for the public lands and agencies that make such restoration efforts possible, and pave the way for future population introduction and enhancement efforts for this unique and at-risk grass species. Moreover, it is hoped that this work will inspire future research into the following conservation questions: 1) are *P. oregonus* introductions and grazing incompatible land uses (field observations suggest grazing can be detrimental or beneficial under some circumstances)?; 2) might low seed set in *P. oregonus* be explained by inbreeding depression or self- incompatibility within small, largely clonal populations?; and 3) do molecular analyses support the genetic differentiation of populations implied by the morphometric data in this study?

Biographical Information: Steven Gisler received his Bachelor's degree in environmental science from Willamette University and is now completing his Master's degree in botany at OSU, focusing on hybridization and conservation issues for the threatened *Sidalcea nelsoniana* in the Willamette Valley. He was introduced to the Oregon Department of Agriculture Native Plant Conservation Program as an NPSO intern, and has continued to work for the program for the last 9 1/2 years, performing a variety of ongoing conservation and recovery projects throughout the state.

Collecting and Storing Rare Plant Seed to Enhance Survival Prospects in the Wild: Plant Conservation at the Berry Botanic Garden

Edward O. Guerrant Jr., The Berry Botanic Garden, 11505 SW Summerville Avenue, Portland, OR 97219
phone: (503) 636-4112 ext. 29; email: edguerr@rdrop.com

Conserving rare and endangered plants of the Pacific Northwest is a core mission of The Berry Botanic Garden, a small, non-profit organization in Portland, Oregon. Since 1983, the Garden has maintained the Seed Bank for Rare and Endangered Plants of the Pacific Northwest, not as an end in itself, but as a regional conservation resource to better ensure the continued survival of vulnerable plant taxa. Such off-site, or ex situ conservation efforts thus play a support role for on-site (in situ), or habitat-based efforts, which are necessarily primary. Berry BG is a charter member of the Center for Plant Conservation, a national consortium dedicated to using ex situ methods to help conserve our nation's most vulnerable plant species.

Viewed broadly, ex situ conservation comprises three main activities: a) collecting genetically representative samples, b) keeping samples alive and in good condition for a long time, and finally, c) being able to use the samples, if necessary, to reintroduce a population or species back into the wild. Many in the audience may be familiar with this overview, but there is significant new information to report on how best to undertake these activities.

Our seed collection protocols are based on the Center for Plant Conservation's (CPC) Genetic Sampling Guidelines for Conservation Collections of Rare and Endangered Plants. These guidelines are currently being updated. The revised guidelines will place a greater emphasis on the specific uses or purposes for which, and the population sizes

from which, a collection is being made. The potential negative effects of collection on a sampled population have long been a concern, and recent modeling studies have provided new insight into how much can safely be collected, and how frequently. In general, it appears that small, frequent seed harvests have less of an impact on population viability than larger, more infrequent harvests.

The Seed Bank currently has over 10,000 accessions of over 300 of our region's most vulnerable plant taxa in long-term storage. The seed processing and storage facilities are state-of-the-art, with a reinforced concrete-encased drying room maintained at a temperature of 15°C (59°F) and relative humidity (RH) of 22%. Once they are cleaned, counted, and weighed, seeds are placed in metal foil pouches for storage at –18°C (0°F). Seeds are subjected to a series of germination trials to establish suitable (if not necessarily optimal) conditions for germination. Determining the survival rate of stored seed with even moderate precision poses a serious challenge, both statistically and pragmatically, especially for small accessions.

The ultimate conservation value of ex situ collections is that, if necessary, they can provide an opportunity to re-establish an extirpated rare plant population. Samples can also be used to augment existing populations, establish new populations in unoccupied but appropriate habitat, or even to provide controlled migration among populations. Clearly, not all stored seed used in a reintroduction attempt can be expected to result in mature individuals in the field. The range and magnitude of the 'demographic cost of reintroduction' can be modeled, and the results compared with empirical studies. Based on computer modeling of empirical data on wild populations with positive growth rates, some taxa could be expected to suffer mortality rates approaching 99% before any individuals reach reproductive maturity. Some ways to mitigate and reduce these expected losses include maintaining seed from each maternal line separately, and using larger founders initially.

Biographical Information: Ed Guerrant has held the position of Conservation Director at the Berry Botanic Garden since 1989. Before that he taught ecology, evolution and genetics at Lewis and Clark College for several years after earning a PhD in Botany from the University of California at Berkeley in 1984.

Sierra Nevada Native Grass Seed Zone Program

Linnea Hanson, USDA Forest Service, Plumas National Forest, Feather River Ranger District, 875 Mitchell Ave., Oroville, CA 95965
phone: (530) 532-7425; email: *lhanson@fs.fed.us*
Jay H. Kitzmiller USDA Forest Service, Chico Genetic Resource Center, 2741 Cramer Lane, Chico, CA 95928

A critical element of ecosystem-based management on public lands is the use of native grass species for revegetation and restoration. Exotic grasses have been used successfully in protecting soil on forest and range sites; however, these exotics compete with native herbs and woody plants and may even alter natural plant succession. Seed zoning decisions have a major effect on the cost of producing seed by commercial growers. Many small zones are much more costly and more difficult to breed pure varieties than a few broad zones. Numerous seed zones also translate to higher management costs and operational complexity for resource managers. Therefore, adaptive seed zones should be defined by sound research to ensure ecological, economical, and operational success. A 1997 comprehensive common garden study was initiated to study three native grasses (*Elymus glaucus, Bromus carinatus, B. orcuttianus*) in 11 field sites across the Plumas National Forest. Results for adaptive traits after three seasons in the field phase supported the existence of three native grass seed zones in the Plumas NF: 1) west-side low elevation, 2) west-side high elevation, and 3) eastside. The seed zone program is currently being expanded for the Sierra Nevada Province.

Biographical Information: Linnea Hansen has been the Forest Botanist on Plumas National Forest from 1979 to present. She is currently Feather River District Botanist and Forest Botany Program Manager for the Plumas National Forest and program manager for special status plants, noxious weeds, revegetation, RNA's and SIA's. Her overall objective has been to maintain and conserve the biodiversity of native plant species. She is Coordinator of the Seed Zone Study of Native Grasses on the Plumas National Forest and subsequent study for the Sierra Nevada.

Restoration of Willamette Valley Wet Prairie: An Evaluation of Two Management Techniques, Eugene, OR

Jean Jancaitis, The Nature Conservancy, 751 South Danebo Ave., Eugene, OR 97402
phone: (541) 683-6413; email: jjancaitis@tnc.org

With less than one percent of Willamette Valley wet prairie remaining, proper management of extant sites is imperative. On The Nature Conservancy's (TNC) Willow Creek Natural Area in western Eugene, Oregon, managers have been using prescription burning and woody vegetation removal since 1986 to control the invasion of exotic species and woody vegetation. Data have also been collected yearly to monitor the vegetation's response to these management treatments.

I applied hierarchical linear modeling to investigate how individual species responded to restoration treatments. This approach makes efficient use of TNC's longitudinal data and their treatment schedule, which followed management needs rather than experimental protocols. Nine of 17 native species analyzed increased significantly one year after treatment and one decreased. Three of 10 exotic species analyzed increased significantly and two decreased. Fewer species showed significant responses two years after treatment, indicating effects were short-lived. The results indicate that management treatments have benefited key species in the short-term and offer lessons to guide management of Willamette Valley wet prairies.

Two tables are presented below. (Note: the tables are available in the online version of abstracts at http://www.appliedeco.org/Conf03_web_materials.htm). The first table summarizes the results of this study by listing the species studied and their observed change in frequency due to management. The second compares the results of this study to those of previous studies concerned with the effects of fire on Willamette Valley wet prairie species. For further detail on the methods and conclusions of this study, see the full document:

Jancaitis, J. E. 2001. Restoration of a Willamette Valley wet prairie: and evaluation of two management techniques. M.S. Thesis. University of Oregon, Eugene, OR

Biographical Information: Jean Jancaitis holds a B.S. in Biology from The College of William and Mary and a M.S. in Environmental Studies from the University of Oregon. She has done botanical work for the USGS and the NPS. She is presently working for TNC as a Botanist for the West Eugene Wetlands Program.

Genetic Considerations in Native Plant Material Selection

Keli Kuykendall, Native Seed Network, 227 SW 6th St., Corvallis, OR 97333
phone: (541) 753-3099; email: keli@peak.org

Determining which native plants to use for any given project is difficult. Project goals determine the structural and functional complexity of the finished planting, whether restoring habitat or using plants as building materials for revegetation. Plant selection depends on a familiarity with the surrounding landscape and the local plant community composition, current and historic distributions and attributes of individual plant species. Once plant species have been selected, genetic considerations of adaptability and appropriateness can help decide which seeds lots to purchase. Commercially available native seed comes in many classes. Certified, Source-Identified seed is collected to represent a particular wildland population, while Cultivars are developed for attribute uniformity. Adaptability helps predict whether a particular bag of seed will establish and grow successfully on a project site, and can be inferred from how environmental conditions at a project site are similar to the wildland source of a seed lot. Genetic appropriateness determines whether seeds will enhance site native biodiversity, increase gene-flow, or overpower and displace resident natives. Appropriateness answers the question: which source populations are native enough? Current and historic distributions of a plant species help predict whether inbreeding depression, outbreeding depression or swamping may be a concern for a particular species. And in the absence of genetic data, Ecoregions serve as reasonable surrogates for seed transfer zones.

Biographical Information: Keli Kuykendall, Director of the Native Seed Network, is a natural resource scientist with expertise in Pacific Northwest ecosystems, both terrestrial and wetland. She has worked for over 15 years on conservation of rare plant taxa in Oregon and Washington. Her specialties include site assessment, community classification, taxonomic identification, conservation genetics, and statistically based research design, implementation and analysis. Keli is a founding member of the Carex Working Group, an affiliation of scientists who have spent eight years documenting the distribution and taxonomy of sedges in Oregon. They recently published the Atlas of Oregon Carex in cooperation with the Native Plant Society of Oregon.

The Use of Indigenous Cultural Environmental Management Practices and Traditional Ecological Knowledge for Restoring and Conserving Native Plant Communities and Ecological Integrity of the Pacific Northwest

Lake, Frank K. Intertribal Programs Office. 334 Strand Ag. Oregon State University, Corvallis, OR 97331
phone: (541) 737-4034; email: fklake@coas.oregonstate.edu

Indigenous people have inhabited the Pacific Northwest for thousands of years. Cultural environmental management practices of indigenous people varied spatially and temporally across the landscape affecting ecological communities in varying degrees. Indigenous people used fire as a ubiquitous tool for many reasons. Plant communities, wildlife populations, hydrology, and aquatic communities were modified by the presence of Indigenous burning. Present day efforts to restore and conserve biodiversity of the region must consider the implications of historical indigenous management. Through cooperative management, the use of Traditional Ecological Knowledge of indigenous peoples and

western scientists can be integrated to assist in defining reference conditions for various ecosystems. The integration cultural and scientific information can help set a course for achieving future restoration and conservation objectives of native plant communities and management of rare and invasive plant species.

Biographical Information: Frank Kanawha Lake was born and raised in Northwestern California. He is mixed blood Native American and Mexican American. Frank was influenced in his life by the local tribes, mountains and rivers of Northwestern California. His father is part Karuk, Seneca and Cherokee and his mother is Mexican American. He has acquired a rich appreciation of the environment from both sides of his family. Frank was taught and has learned many of the traditional beliefs and customs of the Yurok and Karuk people. He received a degree from UC Davis in 1995 in Integrated Ecology and Culture with a minor in Native American Studies. Since graduation, Frank has worked as a fisheries biologist for the US Forest Service in Southwest Oregon and for the Hoopa Tribal Fisheries Department in Northwestern California on the lower Klamath-Trinity river drainage. Currently, he is earning his Ph.D in the Environmental Science program at Oregon State University. He is a founding graduate student of the Pacific Traditional Ecological Knowledge Program in the Intertribal Programs Office. He has spoken nationally and internationally on the subjects of ritual fisheries management, aboriginal fire ecology and the integration of Traditional Ecological Knowledge and Western Science to conserve biodiversity. His current research involves cultural management and fire ecology of riparian areas in the Klamath-Siskiyou bioregion. He consults as an ethno-ecologist part time and keeps active with cultural arts and traditions. A recent publication of his can be found in the Journal of Forestry's special issue on Fire (Volume 99, No. 11), and an interview in Forest Magazine, Fall 2002: Fire Lessons.

Restoration with Native Lupines: the Role of Taxonomy and Population Genetics

Aaron Liston, Dept. of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331
phone: (541) 737-5301; email: listona@bcc.orst.edu

The genus *Lupinus* (Fabaceae) is ubiquitous in non-forested habitats of the Pacific Northwest. Lupines play an important ecological role through nitrogen fixation, several species are of conservation concern, and one native southern-central California species is invasive along the northern California and Oregon coasts. Thus lupines are of interest to many native plant restoration and management efforts.

The use of lupines in habitat restoration is hindered by several biological properties: 1) Lupine species possess high levels of morphological and genetic variation. 2) Most species are able to interbreed in sympatry, leading to widespread hybridization. 3) Many species have both diploid and polyploid individuals. Diploids and polyploids are expected to have low interfertility and may also differ in ecological characteristics.

These biological features are largely responsible for the well-known taxonomic difficulty of the genus. Current floristic treatments of the genus contain conflicting taxonomic interpretations, resulting in misidentifications and poorly known geographic distributions. To address these issues, I have begun a taxonomic revision of the Oregon *Lupinus* species. Benefits of this project include facilitating the recognition of potential hybrids and understanding the ecogeographic distribution of species. This knowledge will assist in the targeting of species and populations for restoration.

Ongoing population genetic studies in my lab are focusing on the threatened Kincaid's lupine, the primary host plant of the endangered Fender's blue butterfly. We are investigating the extent of clonal growth in selected populations, in order to understand how many genetically distinct "individuals" are present. We are also examining the correlation between inbreeding depression, outbreeding depression, and genetic distances. The results of these studies will provide basic information for the restoration and augmentation of Kincaid's lupine populations.

Biographical Information: Aaron Liston is an Associate Professor in the Dept. of Botany & Plant Pathology at OSU, and the Director of the OSU Herbarium. His research areas are plant systematics and native plant genetics.

An Index for Assessing Alien Plant Species Invasion into Riparian Vegetation in Eastern Oregon

Teresa K. Magee, Dynamac Corporation, 200 SW 35th Street, Corvallis, OR 97333
phone: (541) 754-4385; e-mail: magee.teresa@epa.gov
Paul L. Ringold, U.S. Environmental Protection Agency, NHEERL-WED, Corvallis, OR 97333
Michael Bollman*, Dynamac Corporation, 200 SW 35th Street, Corvallis, OR 97333

Many riparian areas are invaded by alien plant species that affect native species composition, community dynamics and ecosystem properties. Thus, a key indicator of vegetation condition is the extent of invasion, with higher relative abundance of alien species indicating lower vegetation integrity. However, some alien species spread more aggressively or have greater influence on ecosystem function than others. To address this issue, we present a preliminary Invasion Index (II) that incorporates both abundance and a ranking score for the invasion potential (Ri) of each alien species occurring in a region or species assemblage of interest. The R value was determined by screening each alien for traits

that have been associated with invasiveness including life history attributes (n = 8), ecological tolerances consistent with riparian habitat of the study area (n = 8), and ability to alter ecosystem processes (n = 7). Presence of traits for each species was determined by review of literature and published floras. We surveyed vegetation along 1 km reaches of 31 low order streams in eastern Oregon spanning an elevation range from 670 to 1695 m. Here we focus on calculation of the II for groups of sample units representing ten species assemblages. This index could also be calculated for coarser structural classes based on dominant vegetation layer (closed conifer, open conifer, broadleaf tree and herb/shrub), or for spatial areas (e.g., individual stream reaches or groups of stream reaches within an ecoregion or watershed). Initial results indicate that drier, low elevation riparian communities were more strongly influenced by alien species than those at moister, higher elevation locations. Closed forest assemblages had lower II values than open forest, shrub or herb dominated vegetation ($p < 0.05$). We anticipate that the II will be useful in identifying relationships between vegetation status and environmental attributes, and aid in prioritizing species assemblage types, individual stream reaches, and groups of stream reaches within ecoregions or watersheds for conservation or restoration efforts.

Biographical Information: Teresa Magee is employed by the Corvallis branch of Dynamac Corporation, an environmental research firm. She received a Masters Degree in Plant Ecology from Oregon State University in 1985. Her research efforts over the last twenty years have included plant community ecology for many ecosystem types, riparian and wetland ecology, alien plant species ecology, and plant conservation biology. Her current work is focused on two primary projects: 1) the characterization of riparian vegetation condition and the development of an index to describe the severity of alien plant species invasion into riparian areas in eastern Oregon – with the U.S. Environmental Protection Agency Laboratory in Corvallis, Oregon, and 2) evaluating the ecology of invasion by a series of target alien plant species into natural ecosystems across the U.S. with the University of California-Davis and the U.S. Department of Defense.

Evaluating the Taxonomic Bias in Our Endangered Species Acts: Potential for Unprotected Diversity in the Oregon Flora

Robert J. Meinke, Department of Botany & Plant Pathology, Oregon State University, Corvallis, OR 97331-2902 *and* Oregon Department of Agriculture, 635 Capitol St. NE, Salem, OR 97310-0110 phone: (541) 737-2317; e-mail: meinker@science.oregonstate.edu

Although there are many statutes, rules, and guidelines that afford various levels of protection to individual organisms and their habitats, none are as binding or influential as state and federal Endangered Species Acts (ESAs). Designed to protect and promote the recovery of animals and plants that are in danger of becoming extinct, these landmark pieces of legislation have significantly affected land management and property use throughout the United States, particularly in the Pacific Northwest (PNW). Under state and federal ESAs, conservation mandates in Oregon for vertebrates such as the northern spotted owl and Coho salmon have appreciably altered the way public agencies and private stakeholders deal with natural resource issues. Detractors of the ESAs brand the laws as absolutist in commanding the protection of all endangered species, regardless of private property impacts or the species' ecological roles, while ESA partisans argue there is ample accommodation of landowner concerns. At times, emotions generated by the debate have been extreme.

Animal species have historically benefited from a broader level of conservation attention than plants, and are in fact protected on private lands by our current ESAs. Listed plants are not regulated outside public property, except for those very few states (none in the PNW) whose own endangered species laws are stronger than the federal statutes. Animals have also received more comprehensive protection due to the taxonomic bias inherent in the ESAs. The federal ESA (passed in 1973) initially applied only to named species, subspecies, and (for plants) varieties. However, some taxa exist as several or more reproductively-isolated subdivisions, and may encompass enough genetic diversity so that all segments are worth preserving. Anadromous fish populations, each linked with a specific stream for spawning, represent prime examples of such partitioned species, though it is often uncertain how much of this diversity is genetically based. Accordingly, the federal ESA was amended in 1978 to permit the listing of "distinct population segments of vertebrates" as threatened or endangered, even for species which (as a whole) would not have qualified for protection under the original ESA. Such populations, considered to represent "evolutionarily significant units" (ESUs), were defined by the National Marine Fisheries Service (NMFS) as being "substantially reproductively isolated from other populations of the same (taxon), and an important component of (its) evolutionary legacy." Twenty-six populations of west coast salmon and steelhead have been listed under the ESA since 1994.

Plants, however, were not included in the 1978 amendment, despite the wealth of data (even at the time) illustrating the substantial level of unnamed intraspecific variation in many species. For plant diversity to achieve equal protection under the law, all variation considered worthy of conservation would need to be described and actually named by taxonomists, a cumbersome and undesirable formality not required for animals! In Oregon, the Natural Heritage Program has identified 172 vascular plant species believed to be at risk for extinction (including 58 state-listed and 17 federally-listed) – of these, at least 48 have been shown (or are suspected) to exhibit significant variation associated with the presence of peripheral or disjunct populations, variation that is consistent with the ESU definition adopted by NMFS. Examples of listed species with prominent geographic partitioning and evidence for genetic differentiation include *Pleuropogon oregonus, Sidalcea nelsoniana*, *Fritillaria gentneri*, *Ivesia rhypara*, *Astragalus peckii*, *Aster vialis*, *Stanleya*

confertiflora, *Plagiobothrys hirtus*, and *Cordylanthus maritimus* ssp. *palustris*. Also important are species which are not necessarily rare enough to merit listing as endangered, but which are comprised of multiple isolated and divergent populations – an excellent example of this is *Mimulus jungermannioides* of the Columbia Basin. Under a conventional assessment this species does not merit listing, yet its scattered populations collectively represent a group of individually vulnerable "microspecies" that comprise a diverse genetic pool.

While the evaluation of population-level differences can reveal previously unknown taxa and lead to the recognition of new species, as in recent studies in *Perideridia* and *Mimulus*, most phytogeographic research is taxonomically less dramatic. Nonetheless, significant unnamed genetic variation exists in many plants and, as in vertebrate animal species, should be conserved. Since government policies are often responsible for depleting plant diversity, it stands to reason that policy changes are often a requisite first step for a more focused conservation effort. To move towards this goal, it is suggested that we:

- request state and federal agencies to agree on a definition for ESUs in plants, and to develop guidelines to facilitate conservation of unique plant populations under the ESAs;
- factor in the presence of evolutionarily significant population segments when making recovery prioritization decisions for currently listed species and species of concern;
- persuade state and federal agencies to give special management consideration to unlisted species that are comprised of distinct ESUs; and
- encourage researchers and funding agencies to focus on species with high levels of between-population variation when developing and selecting state- and federally-funded plant conservation projects.

Biographical Information: Bob Meinke has been the Program Leader of the Native Plant Conservation Program, Oregon Department of Agriculture, since 1988. He is a member of the graduate faculty in Botany, Department of Botany & Plant Pathology, Oregon State University (since 1995). He received a Ph.D. (Botany) at Oregon State University, Corvallis (1992).

Noxious Weed Control in Oregon: Invasive Plants and the evolution of Control Strategies in the last 25 Years

Glenn Miller, Oregon Department of Agriculture, (Main office) 635 Capitol Street, Salem, OR 97301 (Field office) 60S Pioneer Street, Lowell, OR 97452
phone: (541) 935-2129; email: gmiller@oda.state.or.us

Twenty-five years ago the Northwest economy was still very dominated by agriculture and other natural resource related industries. When people thought of noxious weeds they thought of tansy ragwort and scotch broom. The solution to these problems was deemed simple... the broadscale application of phenoxy type herbicides. Much has changed since that time. The population has become more urban, mobile, educated and with vastly different values concerning natural resources. Meanwhile, many more invasive plants have been introduced, as well as new tools to control them. Weed control has therefore evolved to encompass these new tools and public values.

In the Department of Agriculture, we have gone through several phases in our program operations dealing with weed problems. Our initial chemical program targeting ragweed and the biocontrol program for tansy ragwort evolved into utilizing biocontrol on a grand scale encompassing dozens of different weed species, and a modest chemical program targeting mainly skeletonweed, eastern Oregon tansy and some of the knapweeds.

Today we are have entered into a new management phase. Initially there were just the counties, ag producers and the ODA as the lead groups pushing a weed control agenda, now Federal and state agencies, watershed groups, Soil and Water Conservation District's, local private companies and citizen groups all have become actively involved in weed management meaning the ODA and counties are no longer the only kids on the block. The ODA has become even more active on the ground in weed control efforts, but we do so cooperatively and this has proved itself to be a much more effective way of tackling tough weed problems. All groups now utilize a broader selection of tools that fit their management goals learning skills along the way that will shape weed control practices well into the future.

We have had a few good successes over the years reducing major economic problems to minor ones but today we face even more difficult challenges: false brome, perennial pepperweed, saltcedar, Japanese knotweed, giant hogweed and many more. We ask that you all stay involved, personally get your hands dirty and lets help leave our world in a better state than the way we inherited it.

Biographical Information: Glenn Miller graduated in 1984 from Oregon State with a degree in Crop Science pest management, and has worked in the Department of Ag since then. He has a strong love and interest in the out-of-doors spent much of his youth climbing and backpacking. His real interests these days are running around in the desert with his wife and kids and gardening. We live on a 50 acre farm in Pleasant Hill with 2 cats, a dog, a 9' boa constrictor and 20 rats. We also raise filberts in our spare time.

Enhancing Lichens and Bryophytes in Young Forests of Western OR: Transferring Science Findings to Land Managers

Patricia S. Muir, Department of Botany and Plant Pathology, Cordley Hall 2082, Oregon State University, Corvallis, OR 97331-2902
phone: (541) 737-1745; email: muirp@science.oregonstate.edu

In what ways do lichen and bryophyte communities differ among forests of various ages and structures, and can management be used to facilitate the development of these communities in young stands? Are certain structural or compositional features of forests associated with particularly diverse or abundant lichens or bryophytes? Several researchers at Oregon State University have been investigating these questions by studying communities of epiphytic lichens and bryophytes and forest floor bryophytes in relation to stand structure and age in the Coast and Cascade Ranges of western Oregon. Stand ages range from 50 - > 400 years, and structures range from relatively homogeneous unthinned young stands to old-growth stands. Putative "hotspots" within stands (e.g., old remnant trees and hardwood gaps) and at the landscape scale (e.g., riparian areas and rocky outcrops) have also been included in sampling.

Species richness is generally greater in old growth than in young stands for forest floor bryophytes and for epiphytes on shrubs, but not necessarily for epiphytic macrolichens in general. Community composition is more responsive than species richness to differences in stand age and structure, and certain species are indicators for particular stand conditions. Thinned stands and relatively open, hardwood-dominated areas in unthinned stands often support greater abundances of lichens and bryophytes, and different species mixes, compared to more homogeneous unthinned forests. However, the apparent effects of conventional commercial thinning on epiphyte communities varied with starting conditions and with thinning practices. For example, in dense young stands with few epiphytes in the understory, thinning may have increased the similarity of macrolichen communities on shrubs between old-growth and young stands, but when thinning was associated with the loss of older shrub stems, negative effects on epiphytic bryophyte communities were detected. Older remnant conifers and old shrubs are important within-stand hotspots of diversity, both for the epiphytes and for forest floor bryophytes. At a larger scale, riparian areas and rocky outcrops support unusual and diverse communities of lichens and bryophytes compared to those found in relatively homogeneous young forests.

Our results have been published in numerous scientific journals, however it is unlikely that many land managers, who need this information to inform their management decisions, read these journals. This lack of communication between scientists and land managers is often problematic, particularly when the scientists are working from within academia. In an attempt to reach a larger audience, we made a videotape (with the help of OSU's Forestry Media Center) that summarizes our findings in an accessible, non-quantitative format. The video omits numerous technical details, and provides instead a high-level summary of numerous findings. It has been widely viewed and well received by land managers and scientists, and I show it here as an example of how science findings can be transferred to the people who most need to hear them; the land managers.

Biographical Information: Patricia Muir is a Professor of Botany and Plant Pathology at Oregon State University. She received her PhD in Botany (Plant Ecology) from the University of Wisconsin, Madison, in 1984. Her main research focus, currently, is on applied ecology, particularly questions about the management of forests in western Oregon. She is interested in learning whether alternative thinning regimes can be used to speed the acquisition of "old growth characteristics" in young stands, and in the roles of remnant trees in young stands. She has also worked on the effects of air pollutants on plants, and on disturbance history, particularly fire history, as it relates to plant characteristics. She teaches in the Biology Program at OSU, and for 9 yrs was Director of OSU's Environmental Sciences Undergraduate Program.

Strategic Surveys for Survey and Manage Species on Randomly Selected Plots throughout the Northwest Forest Plan Area

Bruce Rittenhouse, Bureau of Land Management – Oregon State Office, PO Box 2965
Portland, OR 97208-2965
phone: (503) 808-2984; email: bruce_rittenhouse@or.blm.gov

Survey and Manage is a mitigation measure in the Northwest Forest Plan (western Washington, western Oregon, and northern California) for over 300 species associated with late-successional/old-growth forests that are rare, uncommon or where little information is known. Strategic surveys, using 750 randomly selected Current Vegetation Survey (CVS)/Forest Inventory Assessment (FIA) plots, each were surveyed for fungi, lichens, bryophytes, vascular plants and mollusks using standardized survey protocols. The plots were split into four strata composed of a 2X2 matrix, based on land use allocation (reserve vs. non-reserve) and habitat (late-successional/old-growth vs. non-late-successional/old-growth). The objectives of the survey were to; 1) estimate the abundance of species across the range of the Northwest Forest Plan, and 2) estimate their association with late-successional/old-growth habitats and reserve land-use allocations.

These surveys began in fall 2000 and will be completed in spring/summer 2003 for all taxa groups. Each plot received four fungi visits (two spring and two fall), two mollusk visits (one spring and one fall) and one visit for lichens, bryophytes, and vascular plants. Fungi were surveyed using four adjacent 2-meter by 125-meter transects. All epigeous fungi encountered were collected and eventually identified to species. Hypogeous fungi were surveyed by digging 25 one-meter square plots (one every 5 meters) within the transects. Mollusk surveys were divided into two phases; 18 22-inch radius circular microplots, and a time-constrained survey over the 1-hectare CVS/FIA plot. Lichen, bryophyte, and vascular plants were surveyed by completely surveying a one-half acre plot. Estimated abundances, and standard errors of these estimates, will be calculated for all species detected at one or more locations. Estimations will be derived for each of the four categories. Associations with habitats and land use allocations will also be estimated from the sample. Preliminary results will be provided for some selected species. A total of 141 Survey and Manage species have been detected during this survey so far representing approximately 2,000 locations.

Biographical Information: Bruce Rittenhouse is currently the Survey and Manage Strategic Survey Coordinator in the Bureau of Land Management Oregon State Office. He has been in this position for almost two years. Prior to this he was district botanist on the Coos Bay District for nine years. He received his Master's of Science in Plant Ecology from Idaho State University and his undergraduate degree in Botany and Plant Pathology from Oregon State University.

Issues in Native Plant Conservation: Perspectives from the Native Plant Conservation Campaign and the California Native Plant Society

Emily Brin Roberson, California Native Plant Society, 1722 J. St., Suite 17, Sacramento, CA 95814
phone: (415) 970-0394; email: emilyr@cnps.org

State and Federal politics affect opportunities to conserve and recover native plant species and communities in California and nationwide. Changes to implementing regulations for the National Forest Management Act and the National Environmental Policy Act, and continuing modifications of the Federal Endangered Species Act are only some of the policy changes which threaten the ability of the scientific community and the public to work cooperatively with resource and land management agencies to promote recovery.

Plant conservation and recovery is also hampered by chronic severe underfunding and understaffing of Federal (and state) botany programs. Although plants make up the majority of the Federal endangered species list, recovery spending for listed plants lags far behind spending for other listed species. Federal agencies employ absurdly few botanists to manage millions of acres of plant communities and hundreds of sensitive plant species on public lands.

Local politics also undermine conservation and recovery efforts. For example, the Sierra Nevada Framework recently updated land management on 11 million acres of National Forest lands in California to improve protection for native plants and other resources. The Framework drew on the work of more than 100 scientists and took more than 10 years, and $22 million, to develop. Despite the strong scientific and legal foundation on which it is based, the Framework's future – and the fate of plants and other resources in Sierra Nevada national forests – is again very much in doubt as political pressure to weaken or rescind the Framework intensifies.

These problems are being addressed in many ways by the native plant conservation community. One effort, the Native Plant Conservation Campaign, is a partnership between the California Native Plant Society and the Center for Biological Diversity. Its purpose is to unite native plant societies, herbaria, arboreta and other non-governmental native plant conservation organizations into a national network which will promote science-based native plant conservation as a foundation of land use and management planning. This presentation will provide an overview of the Campaign and the ways we are working with the scientific community, elected officials, the public and agencies to address budgetary and policy barriers to plant conservation and recovery. We will also review how key policy developments in California and at the national level affect native plant conservation efforts.

Biographical Information: Emily Brin Roberson is Senior Policy Analyst for California Native Plant Society (CNPS) and Project Director for the Native Plant Conservation Campaign. She holds a bachelors degree magna cum laude in plant ecology from Harvard University and a Ph.D. in soil microbial ecology from UC Berkeley. She worked as a researcher in the plant and soil sciences in the U.S. and France for 10 years before joining CNPS in 1993. Her work focuses on native plant conservation advocacy with the federal and state land management agencies. She specializes in issues related to livestock management, weed management, riparian ecosystem conservation, and endangered species law and policy.

Sagebrush-Steppe Restoration and Biological Soil Crusts

Roger Rosentreter, Bureau of Land Management, 1387 S. Vinnell Way, Boise, ID 83709
phone: (208) 373-3824; email: roger_rosentreter@blm.gov

Restoration efforts in the sagebrush-steppe have rarely documented or considered the recovery of biological soil crusts. In a retrospective study in southern Idaho, the re-establishment of perennial bunchgrasses and lack of livestock trampling disturbance enhanced biological soil crust (bsc) recovery. Three sites were sampled and had relatively high biological soil crust cover nine years post-fire, if perennial grass cover was re-established. Areas not seeded with perennial grass were dominated by cheatgrass (*Bromus tectorum*). Vegetative structure, special patterns, and lack of trampling appear to be favorable for the growth and maintenance of biological soil crust in sagebrush-steppe habitats.

Biographical Information: Roger Rosentreter is the State Office Botanist for the Bureau of Land Management and adjunct faculty at Boise State University. He is interested in plant ecology and has worked on the rare plants of Idaho for 20 years. He is interested the taxonomy and ecology of sagebrush and the small microbiotic crusts in the steppe communities. He has a Ph.D. in Botany from the University of Montana.

The Biscuit Fire: Vegetation Changes and Post-fire Rehabilitation

Cecile Shohet, Illinois Valley Ranger District, 26568 Redwood Hwy, Cave Junction, OR 97523
phone: (541) 592-4052; email: cshohet@fs.fed.us
Wayne Rolle, Rogue River National Forest, P.O. Box 520, Medford, OR 97520
phone: (541) 858-2274; email: wrolle@fs.fed.us

This summer's half-million acre Biscuit Fire was the largest wildfire in Oregon in the last 100 years. Short-term effects to native plant species and communities are described. Initial rehabilitation of 300 miles of fire line and some sensitive interior areas has already been completed. Rationale used in choosing areas, treatment types, and plant materials for the initial rehab is presented. Proposed longer-term ecological restoration activities, timber salvage, and monitoring, are being evaluated now by the agencies.

Biographical Information: Cecile Shohet is the district botanist for the Illinois Valley and Galice Districts of the Siskiyou National Forest (since the fall of 2000). She has a M.S. in botany from Arizona State University, where she studied the reproductive biology of a rare succulent, *Graptopetalum bartramii* (Bartram's stonecrop). Prior to this she worked on the Lassen National Forest (between the Cascades and the Sierra) in northeastern California, surveying for rare plant species, and at the Lady Bird Johnson Wildflower Center in Austin, Texas establishing a herbarium. She has also dabbled in education: as an environmental educator, a high school teacher (at two ends of the spectrum - for the NYC public schools and an alternative, "hippie high" school in Northern California), and an instructor at Austin Community College.
Wayne Rolle is the Rogue River National Forest botanist. He is also a technical specialist for growing native grass and forb seed crops at J. Herbert Stone Forest Service Nursery. He earned a B.S. in general studies with an emphasis in Science/Math from Southern Oregon State College in 1985. Mr. Rolle worked in agriculture, forestry, and botanical contracting before joining the Forest Service in 1988.

Restoring Plants and Ecosystems: A National Perspective on Managing Botanical Resources in the Bureau of Land Management

Carol Spurrier, Botany Program Lead, Bureau of Land Management, Fish, Wildlife and Forests Group WO –230; 1849 C Street, NW LSB-204, Washington, DC 20240
phone: (202) 452-7736; email: carol_spurrier@blm.gov

Vegetation on public lands is the basis for many of our multiple uses. Throughout the history of the BLM we have had a forage management mandate. Except to the few botanists in BLM, botany is not considered a "real" program like wildlife management, range management or recreation. But, botanical resource management on public lands is expanding. We are just beginning to understand the necessity of maintaining whole systems and restoring damaged ones. I will discuss the historical role of range management professionals, the traditional role of botanists in the BLM, the role they play today in managing botanical resources on public lands, and their future role in native plant materials development and restoration of public lands.

BLM began building a native plant materials program in FY 2000. I will outline how native plant materials development is proceeding in BLM, how we are addressing concerns of our many use programs. I will address many of the new projects BLM is funding, including production projects and research projects as well as BLM's participation in the *Seeds of Success* project. I will discuss the use of geographically appropriate native species using the genus *Penstemon* as one example, as well as the use of sub-species and varieties, especially in taxa where rare or listed sub-species and varieties exist.

Biographical Information: Carol Spurrier is the Botany Program Lead and Seeds of Success Program Coordinator for

the Bureau of Land Management. She holds a M.S. in Biology (Botany) from New Mexico State University and a B.S. in Natural Resources (Range and Wildlife Mgt) from the University of Nebraska.

The Oregon Flora Project: Providing Floristic and Geographic Data Relevant to Native Plant Restoration and Management

Scott Sundberg and Linda K. Hardison*, Dept. of Botany and Plant Pathology, Oregon State University, 2082 Cordley Hall, Corvallis, OR 97331-2902.
phone: (541) 737-4338; email: sundbers@bcc.orst.edu / hardisol@bcc.orst.edu

The Oregon Flora Project is a comprehensive effort for the study and dissemination of knowledge on plants occurring outside of cultivation in Oregon (www.oregonflora.org). Major facets of the Oregon Flora Project are: 1) a Checklist, providing a nomenclatural framework for all species, subspecies, and varieties; 2) a Flora, an illustrated manual with identification keys, morphological descriptions, and habitat information; 3) an online Photo Gallery with multiple images of each taxon; and 4) an online Oregon Plant Atlas, which allows users to create customized distribution maps. The Oregon Flora Project will provide key information for individual vegetation restoration projects using native plants as well as for the development of the industry.

One tool the Oregon Flora Project is able produce from its databases to address the unique needs of a group, such as habitat restoration biologists, is a targeted field guide. Correct identification of plants used in restoration projects is essential, yet many of these are grasses, sedges, composites, and legumes that are difficult to distinguish from other species. Misidentifications of similar-looking alien species can result in unintended environmental damage or loss of seed crops. The selective subset of data from the Oregon Flora Project compiled into a field guide can be an indispensable resource for growers and people harvesting seed from the field. Pages of the field guide can also be used to evaluate species for their potential uses in restoration projects. A similar, prototype "Oregon Rare Plant Guide" was developed for rare species studies and is currently being prepared for public release.

Each field guide contains an introduction, glossary, and “fact sheets” for individual species. Fact sheets include a morphological description; list of characters for distinguishing the plant from similar-looking species; photographs (when available) of whole plant, flowers and fruits, and seeds; line drawings; a distribution map; and a habitat description. Of special relevance to the restoration biologist will be identification information that notes the characters present when plants are in fruit and seeds can be harvested. Fact sheets are in color (landscaped, double-sided, on 8.5x11 inch paper) and are designed to be inserted into a three-ring binder for use in the field.

Biographical Information: Scott Sundberg is a Research Assistant Professor at the OSU Herbarium. He is also the coordinator of the Oregon Flora Project, the goal of which is to write a new flora of Oregon. His interest in plant systematics began when he took a course at the University of Oregon taught by Dr. George Carroll. The course, which was rigorous, but one of the best taught ones he's taken, introduced him to the splendid diversity of flowering plants throughout the world.

Population, Species, or Community: Where Should Land Managers Target Plant Conservation Efforts?

Michael J. Way, Royal Botanic Gardens, Kew, Wakehurst Place, Ardingly, West Sussex RH17 6TN, UK phone: +44-1444-894106; email: m.way@rbgkew.org.uk

Plants have never been under such great threat from human activities. Globally, 751 plant species have been recorded as becoming extinct in the wild in the last 400 years[i], and the extinction rate is many times that observed from the fossil record[ii]. In the USA, over 5100 vascular plant species are currently thought to be at risk of extinction[iii]. Although almost 60% of the species listed in the US Federal Species Act are plants, the federal government spends 25 times more on ESA animal recovery plans compared to plants[iv]

Species extinction is the ‘tip of the iceberg’. Continuing human pressure on ecosystems causes reduction in total habitat area, fragmentation of this habitat into smaller units, and direct loss of plant and animal populations. Fragmentation of habitat can impact plants due to area and edge effects, demographic and genetic effects[v] [vi] and at the community level the effects on each plant population can impact all associated species. Public land managers are entrusted with the protection and sustainable use of public land, and are faced with differing management obligations for species, habitats and human user groups. Confronted with these challenges, the need for additional resources for plant conservation can be readily justified[vii], but how can land managers prioritize plant conservation research and action?

Species conservation has been the cornerstone of legislative protection for many years, and conservation and restoration actions have been strongly influenced by the threat (imperilment) status of individual species. Possingham *et al*[viii] demonstrate that allocation of resources for plant conservation according to threat status is inappropriate, and indeed some costly restoration actions for threatened species have given insufficient attention to their long-term sustainability in future environments. Hotspots containing concentrations of endemic species clearly merit protection and appropriate

management, but there is evidence from the UK that for several orders of flora and fauna, the rare species are not always correlated with areas of high species diversity[ix].

With the exception of keystone species known to be essential to the functioning of the ecological community, comprehensive management efforts to maintain or restore every *in situ* population of a plant may not be the best use of scarce resources. Assuming that substantially all of the genetic diversity of an out-breeding plant species is likely to be contained within a few, large, populations[x], we should instead concentrate our resources on maintaining examples of healthy, functioning communities. Much progress has been made through initiatives such as biosphere reserve designation and management, and the Important Plant Areas project[xi] which will contribute to targets of the recently adopted Global Strategy for Plant Conservation[xii]. Due to ecological redundancy, these *in situ* resources of biodiversity will contain many species in sub-optimal conditions. Such species will provide the essential 'founder stocks' in the changed environment likely to result from climate change and the spread of invasive species[xiii].

However, to compliment this *in situ* approach, we also need to invest in comprehensive *ex situ* conservation measures, such as that provided for US native plants by the Seeds of Success[xiv] program and the Center for Plant Conservation[xv]. These initiatives can provide land managers with additional tools whilst cost-effectively preserving populations that may prove to be of ecological value many decades into the future. Seed can often be stored for decades with no measurable loss of viability, and it will be available in the event of catastrophic loss or reduction of the original plant population[xvi]. I believe that use of this comprehensive *ex situ* 'insurance policy' will help land managers justify a more active approach to entire community monitoring, protection, and management without such an emphasis on 'single-species management' as we have seen in the past.

Ex situ collections also allow new insights to be gained in the biology of the conserved plants, and help to build a resource of skills and associated information required for ecological restoration, habitat creation, sustainable use and education initiatives. There is also evidence that geographical separation from the original site of collection may not prevent the successful establishment of plants from high quality seed samples[xvii] [xviii], so comprehensive *ex situ* collections may become real assets for creation and restoration actions across the breadth of our changing landscapes. Such use would need to be clearly justified and well documented, so that the historical patterns of genetic diversity are not disrupted unnecessarily[xix], but we will undoubtedly need to take these measures in the future.

In conclusion, we must continue to apply protection, management, conservation and restoration tools to conserve plants *in situ,* particularly at the community level. Putting in place comprehensive *ex situ* conservation programs will provide a valuable insurance policy for land managers. These will also provide materials for the significant interventions that may be necessary to sustain plant biodiversity in the future.

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Biographical Information: Mr. Michael Way is Americas Co-coordinator for the Millennium Seed Bank Project of the Royal Botanic Gardens Kew, UK. He has a degree in Applied and Environmental Biology from the University of York, UK, and has around 10 years experience of the science and practice of seed conservation. Before joining RBG Kew, he worked with UK landowners and public agencies on habitat protection, designation and management on behalf of English Nature, one of the UK's national conservation agencies. He is now responsible for RBG Kew's input into seed conservation projects in Chile, Mexico, and the USA, where he takes a particular interest in integrated conservation strategies. His work has also spanned the development of bilateral project partnerships including access and benefit-sharing agreements consistent with the Convention on Biological Diversity.

The Jane Goodall Environmental Magnet School - A Model for Collaboration with Middle and High School Students for Habitat Restoration and Biodiversity Monitoring

Mike Weddle, The Jane Goodall Environmental Magnet School, Waldo Middle School, 2805 Lansing Ave. NE, Salem, OR 97303
phone: 503-399-3215; email: mkweddle@attbi.com

The Jane Goodall Environmental Magnet School (JGEMS) is a school-within-a-school at Waldo Middle School in Salem, Oregon that focuses on environmental science and community service. JGEMS students collaborate with a number of government and non-government organizations in projects that are both engaging and meaningful for students and truly beneficial to the collaborating organization and the environment. Students are doing research on reed canary grass suppression for Oregon Watersheds, Oregon silverspot butterfly host plant densities at Nestucca Bay NWR for the USFWS, and a forest ecology study of a one-hectare plot in Willamette National Forest for the Smithsonian Institution's Conservation and Research Center. With careful training and support, middle and high school students can be a valuable resource. This workshop will present strategies in how to make the most of their skills and knowledge.

Biographical Information: Mike Weddle teaches conservation biology and technology at the Jane Goodall Environmental Magnet School in Salem, Oregon. He has been teaching environmental education for 10 years, focusing on linking his students with ongoing research and restoration efforts in Oregon and around the world. He is the Oregon Coordinator for Roots & Shoots for the Jane Goodall Institute, a research associate with the Conservation and Research Center for the National Zoo and Education Liaison for the Felid Taxon Advisory Group for the American Zoo and Aquarium Association. He was named as a Milken Outstanding Educator for Oregon in 1999 and received the Crystal Apple Award from the Salem/Keizer School District in 2001.

Effects of wildfire on High-Quality Shrub-Steppe Vegetation, Cleveland Natural Area Preserve, South-central Washington State

David L. Wilderman, Washington Department of Natural Resources, 713 Bowers Rd., Ellensburg, WA 98926
phone: (509) 925-8510; email: david.wilderman@wadnr.gov

Cleveland Natural Area Preserve, located in eastern Klickitat County in the *Purshia tridentata/Festuca idahoensis* zone (Daubenmire 1970), protects high-quality examples of shrub-steppe plant communities. In 1998, a lightning-ignited wildfire burned virtually the entire site at moderate to high intensity. The burned area encompassed several pre-existing plots where baseline vegetation data had been gathered, providing an excellent opportunity to assess changes in the plant communities. While many past studies have documented the responses of shrub-steppe dominants such as shrub species and bunchgrasses, there is far less information about other plant species that are commonly found in shrub-steppe communities, particularly forbs. This study tracked the responses of all vascular species in burned examples of two different shrub-steppe plant communities: antelope bitterbrush/Idaho fescue (*Purshia tridentata/Festuca idahoensis*) and Douglas' buckwheat/Sandberg bluegrass (*Eriogonum douglasii/Poa secunda*).

In both communities, native perennial grasses, shrubs, and subshrubs generally decreased following fire. *Elymus elymoides ssp. hordeoides* was the only bunchgrass that increased. Of the shrubs and subshrubs, *Purshia tridentata* and *Eriogonum douglasii* were completely eliminated from the communities, while *Eriogonum heracleoides*

resprouted and was present in substantial amounts beginning in the first year after the fire. Native perennial forbs increased substantially in both communities, although the increase appeared to be shorter-lived in the Douglas' buckwheat community than in the antelope bitterbrush community. A number of species, especially those with substantial underground storage parts such as *Lomatium* spp., *Calochortus macrocarpus*, and *Fritillaria pudica*, showed dramatic post-fire increases. *Achillea millefolium* also increased dramatically, while *Trifolium macrocephalum* remained at or above pre-fire levels. *Balsamorhiza careyana* and *Antennaria dimorpha* were the only native perennial forbs that decreased notably. Native annual forbs initially decreased slightly and then increased in the antelope bitterbrush community, while they showed the inverse pattern in the Douglas' buckwheat community. Those showing the most dramatic increases were *Collinsia parviflora, Clarkia pulchella, Collomia grandiflora,* and *Montia spathulata. Epilobium paniculatum* and *Madia* spp. both increased substantially in the 2nd post-fire year, but then decreased in subsequent years. Three species of introduced forbs varied somewhat in their patterns. *Lactuca serriola* increased dramatically in the 2nd post-fire year, but then returned to pre-fire abundance or less. *Tragopogon dubius* increased in the 1st post-fire year and essentially remained at the new levels throughout the study period. *Holosteum umbellatum* appeared to be substantially reduced by the fire. Introduced annual grasses increased in the antelope bitterbrush community, but decreased substantially in the Douglas' buckwheat community. In the antelope bitterbrush community, *Bromus tectorum* decreased in the 1st post-fire year but then increased in subsequent years. *Ventenata dubia* remained at or above pre-fire levels in the 1st post-fire year and then continued to increase.

In summary the two communities showed both similarities and differences in their overall vegetation trends. The antelope bitterbrush/Idaho fescue community appears to be shifting toward a community dominated by a single subshrub species, *Eriogonum heracleoides*, with greater importance of forbs and introduced annual grasses, and a somewhat reduced importance of perennial grasses. Re-establishment of a significant *Purshia tridentata* layer will likely take decades. The Douglas' buckwheat/Sandberg bluegrass community also appears to be shifting toward more forbs and less perennial grass, but with essentially no shrub or subshrub cover and reduced introduced annual grass.

The response of introduced annual grasses was of particular interest for this site, since one of the primary criteria for establishing it as a Natural Area Preserve was its low cover of such species. The difference in the response of introduced annual grasses in the two communities may be explained by the difference in fire intensity in the communities. The antelope bitterbrush community in this study burned at higher intensity, presumably due to greater fuel levels compared to the sparsely-vegetated Douglas' buckwheat community. This higher fire intensity may have created a more optimum seedbed for the annual grasses in the antelope bitterbrush community, resulting in their observed increase. Managers considering the use of prescribed fire in similar communities may want to ensure that fire intensities are kept at relatively low levels in order to minimize this problem.

Biographical Information: David Wilderman studied biology at University of Illinois, and then fled the flatlands for the Pacific Northwest, where he conducted rare plant surveys for the BLM and received a Master's degree in Natural Ecosystem Management, with emphasis on plant ecology, from University of Washington. He then worked on the Hanford Reservation, mapping and assessing shrub-steppe vegetation for The Nature Conservancy. He has now worked for the Washington Dept. of Natural Resources since 1995 as Natural Areas Ecologist in Eastern Washington (minus a brief stint in Eugene). His primary interests include rare plant and plant community monitoring, fire ecology, and shrub-steppe restoration.

The Status and Prospects of Kincaid's Lupine and Fender's Blue Butterfly

Mark V. Wilson, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331-2902 phone: (541) 737-5244; email: wilsonm@bcc.orst.edu

Kincaid's lupine (*Lupinus sulphureus* ssp. *kincaidii*) and the Fender's blue butterfly (*Icaricia icarioides fenderi*) are a threatened plant and an endangered insect recently listed under the federal Endangered Species Act. Kincaid's lupine is the primary larval food plant for Fender's blue butterfly. The native habitat for both is upland prairie, an endangered and dynamic ecosystem requiring active management to prevent invasion of shrubs and trees.

Population viability analysis for Kincaid's lupine is hampered by the lack of a suitable measure of abundance. Number of stems, number of inflorescences, and cover are all flawed measures. Nevertheless, Kincaid's lupine's threatened status is warranted. From the start of monitoring in 1991, some populations have been extirpated because of habitat destruction, leaving only 57 populations comprising 160 ha, many of which are along roadsides. Competition from shrubs, trees, and exotic weeds threatens all the remaining 57 populations. Shrinking and fragmented populations have led to inbreeding depression.

Habitat destruction has also eliminated some Fender's blue butterfly populations since monitoring started in 1991, leaving only 16 populations, whose numbers fluctuate widely. Population viability analysis predicts a 20% chance of species extinction within the next 40 years.

The prospects for recovery of Kincaid's lupine and Fender's blue butterfly are both bright and dim. Two of the largest sites are currently protected, but the three other large and most of the smaller sites are privately held. Because active and frequent management is needed to maintain habitat quality, prohibition of "take" is insufficient protection.

Although there is no legal inducement for habitat management on privately held lands, efforts are underway to work with private landowners. Once habitat management is implemented, however, prospects are brighter because recent research on prairie ecosystem dynamics has uncovered effective techniques for promoting Kincaid's lupine and Fender's blue butterfly. In one study, for example, prescribed burning and mowing treatments reduced the cover of woody plants 45%-65%, greatly invigorated lupine plants and led to 10 times the number of eggs on lupine plants. Population augmentation is difficult for both species. Kincaid's lupine establishments rates are low both from seed (1%-10%) and transplants (3%-7%). Captive breeding and release of Fender's blue butterfly has not been attempted, but butterflies like Fender's blue butterfly that diapause as larvae are usually difficult to rear in captivity.

Recovery will be aided by further understanding the biological characteristics of Kincaid's lupine and Fender's blue butterfly and the ecological dynamics of their upland prairie habitat. For Kincaid's lupine, the key research needs are (1) developing biologically meaningful measures of abundance that can be linked to quantitative recovery criteria, (2) understanding what controls establishment and how to promote establishment rates in recovery plantings, (3) determining the magnitude of inbreeding depression, outbreeding depression, and acceptable sources of seeds for population augmentation, (4) determining the relative contributions of disease, insect herbivory, and competition to Kincaid's lupine decline, so managers know what to target, and (5) understanding ecosystem dynamics well enough so managers can control woody plants and exotic weeds while simultaneously promoting native plants and animals like Kincaid's lupine and Fender's blue butterfly.

The goal for Fender's blue butterfly recovery for the next ten years is maintaining nine populations across its range with populations growth rates of at least 150% per year. Achieving this will require (1) active, aggressive management to improve the quality of existing habitats, (2) expansion of existing habitats to increase numbers and reduce loss of butterflies at habitat edges, and (3) creation of new populations in entirely degraded habitats as links between existing populations. Research in service of species recovery should include understanding the effect of management activities on nectar resources and Fender's blue butterfly population dynamics.

Biographical Information: Mark Wilson is an Associate Professor of Botany and Plant Pathology at Oregon State University. His research focuses on the ecology, conservation, and management of native prairies of western Oregon.

Lessons Learned from a Decade of Wetland Enhancement and Restoration by the West Eugene Wetlands Partnership

Eric N. Wold, City of Eugene Parks and Open Space Division, 1820 Roosevelt Blvd., Eugene, OR 97402 phone: (541) 682-4888; email: eric.n.wold@ci.eugene.or.us

Over the past decade, the West Eugene Wetlands Partnership has acquired 2,500 acres of connected wetlands and associated uplands at the urban-rural interface in western Eugene. This acreage includes a broad variety of habitat types, ranging from oak savanna in the drier, higher elevations, to ash and willow groves along riparian areas, to a mosaic of wet prairie, upland prairie, and vernal pools at the lower elevations. These lands provide habitat for populations of three federally listed plants, as well as populations of the federally listed animal, Fender's blue butterfly. The Partnership also owns an increasing number of previously farmed or grazed wetlands, which are the focus of intensive enhancement and restoration efforts that are funded through a wetland mitigation bank.

Management of these lands is guided by three main goals: (1) maintaining a hydrologically and ecologically connected system of wetlands over a broad landscape; (2) maintaining, enhancing, or restoring the historic plant communities that have been documented for the area; and (3) protecting and expanding existing populations of rare plants and animals. Vegetation management varies depending on the habitat types present at a particular site, existing condition of the habitat, location along the urban-rural interface, and the landowner. Under most circumstances, however, eight key steps are taken at enhancement and restoration sites. Each of the eight steps is discussed, with particular emphasis on the lessons that we have learned through ten years of experience.

Modify the hydrology. Since European settlement of the area, several key waterways, such as Amazon Creek, have been channelized and are now confined to a single, deep channel. This has resulted in disconnecting the waterways from their historic floodplains. When a restoration site is located along such a channel, opportunities are pursued to reintroduce channel sinuosity and to reconnect the waterway to a broader floodplain.

Kill or remove existing non-native vegetation. Techniques to achieve this include herbicides, disking and tilling, mechanized sod removal, and manual removal. While mechanized sod removal has proven the most effective and time-efficient technique at removing non-native vegetation and the non-native seed bank, it has unstudied consequences for the soil food web and plant productivity. The other techniques (herbicides, disking and tilling, and manual removal) must usually be used in combinations, and over a longer period of time, to achieve the desired result. Depending on the technique used, this step can be done in different times of the year.

Remove remaining thatch or dead vegetation with prescribed fire or mowing. If the site is located a safe distance from urban facilities, fire is the preferred technique because it effectively removes the thatch. Prescribed burning is usually done in late summer or early fall. Mowing is effective at reducing the height of the dead vegetation, but it

generates a thatch layer that makes seeding difficult. To remove the thatch from mowed sites, a raking treatment is sometimes used.

Seed with no-till techniques. The Partnership operates its own seed collection and processing program, through which we collect seeds of 90 species of native, southern Willamette Valley plant species. All seeds are collected from local populations. These seeds are put into mixes for distribution on restoration sites. No-till seeding techniques are used so as not to stimulate the seed bank, which is usually loaded with non-native species. Over large sites, a no-till drill is preferred, while on smaller sites, backpack blowers are used.

Out-plant propagated plants. Over the past two years, we have augmented the seeding program with the out-planting of propagated plants. The focus of the out-planting program is to plant species that have not established well via seeding. This has proven effective for certain species, but it is labor intensive and time consuming.

Implement post-planting maintenance. The first two years post-seeding are critical for controlling non-native plants. Manual removal using shovels, hoes, and machetes are commonly used, as are backpack torches. This coming summer, we will also be using a custom-built Sunburst thermal weed control unit and the Waipuna heat-foam system.

Monitor vegetation and hydrology. For up to seven years after the original seeding and planting of a site, extensive vegetation and hydrology monitoring is conducted. This includes quantitative vegetation monitoring of permanent plots, annual mapping of invasive species, analysis of photos from photo point stations, aerial photo analysis, and depth measurements from hydrology gauges. This monitoring data is analyzed and reported once a year, resulting in recommendations for future site actions.

Take remedial actions to improve site. Based on the recommendations from the monitoring program, remedial actions are often taken to improve the site. The most common remedial actions are to adjust the site hydrology, alter the non-native plant management strategy, and augment the seeding and out-planting of propagated plants.

Biographical Information: Eric Wold is the Wetlands Program Supervisor for the City of Eugene. As Wetlands Program Supervisor, Eric works with the partner agencies in the West Eugene Wetlands Partnership to manage 2,500 acres of protected wetlands and associated uplands in western Eugene. One of his major responsibilities is to manage a wetland mitigation bank, which has funded the enhancement or restoration of hundreds of acres of wetlands.

Eric received a B.S. in Biology from Lewis and Clark College and a M.S. in Ecology and Evolutionary Biology from the University of Missouri-St. Louis. He has additional graduate work in entomology from Oregon State University. Prior to becoming the Wetlands Program Supervisor, Eric worked as an agroforestry extension agent in the Dominican Republic, a wildlife biologist on the Willamette National Forest, and as a Natural Resources Planner with the City of Eugene. He is a former board member of the Native Plant Society of Oregon, the founding President of the North American Butterfly Association's Eugene-Springfield Chapter, and is a certified Ecologist by the Ecological Society of America.

Sudden Oak Death: Potential Risk to Tanoak Communities and Rare Plants in Southwest Oregon

James W. Zanzot* and Jennifer L. Parke, Department of Botany and Plant Pathology, 2082 Cordley Hall, Oregon State University, Corvallis, OR 97331
phone: (541) 737-2332; email: zanzotj@science.oregonstate.edu

Sudden Oak Death has been killing trees in California since at least 1995. The causal agent is *Phytophthora ramorum*; a fungus-like organism in the same genus as the pathogens causing potato late blight (*P. infestans*) and Port-Orford-cedar root rot (*P. lateralis*). *P. ramorum* naturally infects four species in the family Fagaceae, causing stem cankers that girdle and kill the tree. Several other species, including many in the Ericaceae, exhibit foliar symptoms only and are not usually killed by the pathogen.

In 2001, *P. ramorum* was detected in southwestern Oregon, near Brookings. The disease was found by aerial survey followed by ground sampling and laboratory identification by culture and PCR assay. A quarantine area of nine square miles was established, and eradication efforts begun. Infected trees have been cut, and host materials and buffer areas broadcast-burned. Surveys in 2002 have revealed no infections outside the nine square mile quarantine zone, although additional infected trees have been found within the quarantine area.

Tanoak (*Lithocarpus densiflorus*) is the principal host throughout most of the California and Oregon infestations. Tanoak is prevalent throughout coastal southwestern Oregon, with its range extending north to Coos Bay and inland to about 4000 feet elevation in the western Siskiyou Mountains.

The Klamath-Siskiyou ecoregion of SW Oregon and NW CA has been designated an Area of Global Botanical Significance by IUCN (World Conservation Union) and proposed as a World Heritage Site by UNESCO. With a large area of tanoak associations present, *Phytophthora ramorum* may pose a threat to valued plant communities in this area.

We use a detached leaf assay to screen plant species for potential susceptibility to *P. ramorum*. Leaves are dipped into a suspension of zoospores and incubated in a moist chamber for seven days, when symptoms are assessed. A limited number of experiments on whole plants support the findings of the detached leaf assay.

Several species of plants associated with tanoak in southwestern Oregon appear to be susceptible to *P. ramorum*. This does not necessarily mean that disease is likely to develop in the field. We lack sufficient information to

predict whether *P. ramorum* can survive and spread in these environments. However, our data may aid survey crews in the field when trying to identify *P. ramorum* infestations in the tanoak understory.
Additionally, we are interested in the potential susceptibility of rare and endemic plant taxa to *Phytophthora ramorum*, some of which are not associated with tanoak. Our data suggest that rare ericaceous Siskiyou plants, including *Arctostaphylos hispidula, Leucothoe davisiae*, and *Kalmiopsis leachiana*, are potentially susceptible to foliar infection by *P. ramorum*.

Understanding the potential susceptibility of native plants to *P. ramorum* is a first step in predicting which plant communities could be at greatest risk should the disease spread, and may help to inform management decisions concerning conservation of rare plants.

Biographical Information: James W. (Djibo) Zanzot is a graduate student working towards a MS in Botany and Plant Pathology at Oregon State University. He is also a former IAE intern.
Dr. Jennifer Parke is a research professor at Oregon State University with appointments in Botany and Plant Pathology, and Crop and Soil Science. Her work focuses on soil microbial ecology and plant pathology.

POSTER PAPERS (ABSTRACTS) – IN ALPHABETICAL ORDER

Viability Analysis of a Restored Illinois Population of the Federal Threatened Pitcher's Thistle (*Cirsium pitcheri*)

Timothy Bell[1], Marlin Bowles[2], Jenny. McBride[2], Kay Havens[3] and Pati Vitt[3]
[1]Chicago State University, Chicago IL 60628-1598, Phone: (773) 995-2442; email: TJ_Bell@csu.edu [2]Morton Arboretum, Lisle, IL, [3]Chicago Botanic Garden, Glencoe, IL

Restoring populations to prevent species extinction requires population viability analyses (PVA) to determine if restorations are successful. However, few PVA's have been applied to plant restorations. This analysis was used to project viability of a restored population of the federal threatened Pitcher's thistle (*Cirsium pitcheri*), a monocarpic herb of the western Great Lakes shoreline sand dunes. This plant was extirpated from Illinois before 1920. As part of federal and state recovery planning, suitable habitat was identified at Illinois Beach State Park, where restoration began in 1991 using southern Lake Michigan seed sources. Annual translocation of greenhouse-propagated plants was used to establish over 100 plants representing cohorts of different ages. The first of these plants flowered in 1993, and the first flowering of naturally recruited plants occurred in 1998. Population growth was monitored and compared with a natural population at Indiana Dunes State Park. The population growth rates (lambda) of both the restored and natural populations averaged >1, indicating positive growth. However, the minimum viable population (MVP) estimate of 500 plants for the restored population was nearly twice as high as the MVP estimate of 200 plants for the natural populations. This was caused by relatively high variation in transition frequencies for non-fecundity stages in the restoration, and also indicates strong environmental stochasticity. These results suggest that continued translocation of *ex situ* propagated plants is needed to reach a MVP size.

Experimental Control Methods and Local Surveys for False-Brome (*Brachypodium sylvaticum*)

Matt Blakeley-Smith & Thomas N. Kaye. Institute for Applied Ecology, Corvallis, OR 97333
phone: (541) 753-3099; email: mattbs@peak.org & kayet@peak.org

Brachypodium sylvaticum (Huds.) Beauv., false-brome, is an invasive perennial grass, native to Europe, North Africa, and parts of Asia. Since it was first reported near Eugene, Oregon in 1939, the species has spread rapidly in western Oregon. False-brome is of considerable concern due to its ability to completely dominate both shaded and open habitats, where it often forms monotypic stands, excluding native vegetation and threatening endangered species, such as*, Lupinus sulphureus* ssp*. kincaidii* and *Aster vialis*.

Our research has focused on non-herbicide control methods of false-brome, as well as a survey of the current distribution of false-brome on the McKenzie Resource Area of the Eugene District BLM. Additionally, on an experimental road closure we are testing treatment combinations of tilling, mulching to two depths, and seeding with the native perennial grass *Elymus glaucus*. Our goal is to determine which combination results in the largest reduction of false-brome and the greatest re-establishment of native plant cover.

Additional control methods for false-brome are being tested with the Waipuna, a machine which expels a super-heated, non-toxic foam. We established twenty experimental plots to test the effectiveness of the Waipuna on controlling false-brome. Preliminary visual results suggest that the Waipuna is very effective at killing above ground vegetation.

Extensive roadside and on-foot surveys have helped clarify the invasion patterns of false-brome. Initially, the grass establishes on disturbed soils on roadsides, clearcuts, and ATV trails. Vehicles, equipment, people, and wildlife act as vectors for seed dispersal as they travel the road and trail networks. Once established, false-brome radiates into undisturbed habitats and forms carpet-like mats.

We suggest that management efforts focus on aggressive control of the spread of false-brome, as well as eliminating new outbreaks before this dangerous weed proliferates. These methods will require a multi-year approach and should involve cleaning vehicles, equipment, and clothing after travel in infested areas. Additionally, roadsides should be treated before plants drop seeds onto the roadbed. Finally, surveys for false-brome should be continued to enable managers to target priority areas for control.

Effective Restoration At The Grass Roots: Strategic Partnering with the Nursery Industry, Public Agencies, Non-profits, and Local Communities

Lynda L. Boyer, Heritage Seedlings Inc., 4199 75th Ave SE, Salem, OR 97301
phone: (541) 543-5057 (cell); email: boyer2@mindspring.com

Native Seed Production

The importance of protecting and restoring native habitats within the Willamette Valley has become apparent to many public agencies, non-profits, and private landowners. Unfortunately, there has been a lack of native seed available for restoration projects. Heritage Seedlings, hoping to fill this void, has begun the propagation of native Willamette Valley grasses and forbs for seed production. Currently, there are 9 acres in production with 74 different taxa. The taxa range from upland and wet prairie to mixed woodland. Since there has been new urgency placed on upland prairie habitat, the emphasis will be to produce seed from these taxa in large quantities. Table 1 lists the taxa in propagation. Some of the seed will be used to restore 45 acres of upland prairie habitat at the Joseph St farm where the grow-out is occurring (see below). Excess seed will be listed for sale on the Native Seed Network.

Threatened And Endangered (T&E) Species Propagation

Heritage Seedlings has also begun a partnership with the Institute for Applied Ecology (IAE). They are providing greenhouse space for IAE's T&E propagation at no charge. Heritage is also propagating Nelson's Checkermallow (*Sidalcea nelsoniana)* for the Willamette Valley Refuges and Marion County Parks. Four other T&E taxa are in grow-out in hopes of finding appropriate agency sites and/or reintroduction to the upland prairie restoration site. The owner of Heritage Seedlings, Mark Krautmann, hopes others in the Nursery Industry will begin working cooperatively with various non-profit groups and agencies assisting in the propagation of Threatened and Endangered plant species.

Native Habitat Restoration At Heritage Seedlings

Heritage Seedlings is, currently, restoring a 20-acre remnant prairie at the farm property on Joseph St just east of Salem. The restoration is in cooperation with the USFW Partners for Wildlife Program. Heritage will increase the amount of upland habitat at the farm by creating native prairie and oak savanna on 25 acres of cover crop adjacent to the remnant prairie. The goals of the prairie restorations are to increase the number of natives on site and improve the habitat for native wildlife that relies on undisturbed native grasslands and oaks. Heritage is also restoring 14 acres of riparian habitat at their farm 20 miles east of Salem. The site is adjacent to Stout Creek near the confluence with the North Santiam River. The restoration is in cooperation with the NRCS's Conservation Reserve Enhancement Program. The goal of this restoration is to create a forested riparian buffer; which will improve the habitat for native wildlife and fish. In addition, the restorations are used as a living laboratory for local young people to learn about the importance of native habitats.

Upland Prairie/Oak Habitat

The prairie remnant is composed of open meadow with mostly non-native pasture grasses and forbs, meadow with clusters of young oaks, oak woodland, and oak woodland with conifers. The site has been grazed by sheep but never cultivated. The lack of cultivation has allowed the retention of areas of native forbs. Grazing, however, has stripped the meadows of native grasses; and has facilitated the infestation of many areas with invasive weeds such as thistles, blackberry, burdock, English hawthorn, and domestic cherry.

The site supports a wide variety of oak related bird species including: Bewicks Wren, Downy Woodpecker, American Kestrel, Western Wood Pee-wee, White-breasted Nuthatch, White-crowned Sparrow, Mourning Dove, and Northern Harrier. The adjacent cover cop area is a favorite hunting ground for the harriers.

The oaks have been thinned and the majority of the conifers removed. This has allowed much more light into the understory and released the suppressed oaks. To protect the soil and reduce the possibility of an increase in blackberry, the disturbed understory areas were seeded with fast growing Blue wildrye (*Elymus glaucus*), California brome (*Bromus carinatus*), and Sitka brome (*Bromus stichensis*) as well as a variety of native forbs that establish quickly. The woodland supports a large component of native shrubs and forbs so herbicide application was not an option prior to seeding. Native bunchgrass plugs will be out-planted in the fall of 2003.

Non-native shrubs and trees that were cut last spring have, unfortunately, resprouted. These will be cut again in early summer and immediately treated with a stump killer. Canadian thistle was treated in early summer with Stinger™ (chlopyralid) herbicide and blackberry in the fall with glyphosate. It is unknown at this time how successful this has been.

The meadows with the largest areas of non-natives will be treated with glyphosate for two seasons. This should ensure a clean sowing area for native seed, which often grows more slowly and has difficulty competing. The meadow areas with native forbs will be treated with a grass-specific herbicide (safe for sedges, lilies, and iris) for one season before seeding. Seed will be sown with a no-till drill. Grasses will be sown in single species patches and a mix of forbs sown perpendicular to the grasses. This will allow these areas to be efficiently harvested and thus increase the amount of seed available for future areas of restoration. Mowing and/or burning two or three years after sowing will give the area a more "natural" look.

Beginning in the spring of 2003, the cover crop area will be tilled, sprayed with glyphosate, planted to Sudan grass to hold the soil for the winter, sprayed the following spring and summer, then seeded with native grasses and forbs and planted with oak seedlings.

Riparian Restoration

In order to prepare the site for planting, the blackberry, Reed canarygrass, and Scotch broom were mowed down using a brush mower. When the Reed canarygrass was approximately 1 ft tall, it was sprayed with glyphosate. The areas next to the creek were lightly sprayed at close range to minimize the chances of hitting the water. In November of 2002, 4,000 native trees and shrubs were planted along the creek. Planting stock was purchased from Mt. Jefferson Farm of Salem as well as Heritage Seedlings. Taxa planted and their target planting zones are listed in Table 2. Planting areas were flagged and the plant names written on the flag. Each flag represented 4 trees that were to be spaced approximately 5 ft apart.

After a tree was planted it was sheltered with a blue plastic "gro-tube". The base of the tube was buried in the soil to a depth of about 2 inches. The tree tubes are designed to enhance the growth of the seedlings, protect the trees during herbicide application, and to protect the trees from damage by animals. Prior planting efforts had failed due to the removal of the cambial layer by voles and the removal of the entire tree by nutria and beaver. Heavy wooden stakes and electrical zip ties secured the tubes. The tubes will be monitored during heavy rains to ensure they are sufficiently secure.

The Reed canarygrass will be sprayed out for two summers so the trees will have less competition for water and to keep the voles away. The tree tubes are "photodegradable" but will be removed before they begin to break up in order to avoid stream pollution.

Biographical Information: Linda Boyer graduated with an MS in Plant Biology from Portland State University in 1999. Her thesis research was the taxonomic status of *Delphinium oreganum*, a rare Willamette Valley prairie endemic. She currently works for Heritage Seedlings facilitating restoration of native habitats on nursery land (40 acre upland prairie and 14 acre riparian), and managing a Native Restoration Seed program.

Greenhouses Advance Rare Plant Goals for Oregon's Plant Conservation Biology Program

Melissa A. Carr, Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331
email: carrmel@science.oregonstate.edu

The Oregon Department of Agriculture Plant Conservation Biology Program aims to conserve Oregon's native plant species through regulation of state lands and cooperation with local, state, and federal agencies to develop management plans that preserve protected plant species. The Program also provides educational opportunities for undergraduate and graduate students at Oregon State University. Although the majority of the Program's research efforts focuses on fieldwork, greenhouses at OSU also play a critical role in the Program's success. As greenhouse manager for the Plant Conservation Biology Program, I aid Program staff in cultivating rare plants for several ongoing research projects.

Little information is known about the life history of many rare plants. Growing these plants in a controlled environment can elucidate important information about reproductive ecology, seed germination requirements, relationships among taxa, and general propagation strategies—knowledge that is crucial to developing successful management plans for at-risk species. Greenhouses also accommodate large-scale rare species propagation for reintroduction programs designed to bolster wild populations. In this poster I discuss four ongoing Plant Conservation Biology Program greenhouse projects.

Graduate study by Kelly Amsberry of the OSU Botany and Plant Pathology Department has provided information about seed germination and propagation methods for the endangered *Plagiobothrys hirtus* (hairy popcorn flower). Information on seed set, breeding system, and pollination ecology was gained in a comparative study of *P. hirtus* and a common congeneric species, *P. figuratus*. Unmanipulated plants grown in the greenhouse without access to pollinators displayed little or no seed set, indicating the importance of considering insect vectors in *P. hirtus* site management. Both species exhibited inbreeding depression at the seed germination stage, necessitating maintenance of adequate population size and promotion of genetic diversity within populations to maintain their viability. Successful crosses of *P. hirtus* and *P. figuratus* were performed and I am involved in a current study of the resulting hybrid.

Greenhouses have also played an important role in many of the Program's federal conservation projects. The Oregon Department of Agriculture, United States Fish & Wildlife Service, and the Bureau of Land Management have collaborated on efforts to preserve *Fritillaria gentneri* (Gentner's fritillary, Gentner's redbells), an endangered lily. Studies indicate the species is largely sterile, exhibits low seed production, and is more likely to develop capsules from interspecific, rather than conspecific fertilization. These observations and other data indicate *F. gentneri* is a species of recent hybrid origin. I am presently participating in efforts to grow *F. gentneri* crosses from seed, as well as developing a large-scale propagation program in the greenhouse aimed at providing a sustainable supply of fritillary bulbs for population introduction and enhancement projects. Different artificial vernalization treatments are being tested to discern ideal bulblet propagation methods.

The ODA, USFWS, and The Nature Conservancy are cooperating on a reintroduction program for *Pleuropogon oregonus* (Oregon semaphore grass). The grass has been successfully cultivated from both seed and rhizome fragments in the greenhouse on a large-scale level. 4200 greenhouse-grown plants were outplanted to four new locations in an attempt to augment wild populations. In addition, propagation of the species under controlled, common garden conditions in the greenhouse has brought to light significant morphological and habit variation between the two remaining wild populations of *P. oregonus*. Further study of these presumably genetic differences is currently underway.
The ODA is collaborating with the USFWS to conserve *Astragalus applegatei*, the most endangered plant in the Pacific Northwest. The species depends on bacterial and fungal symbionts found in its native soil for healthy growth. Researchers have successfully used field soil containing native soil symbionts from sites of wild *A. applegatei* populations as an inoculum for soil in which greenhouse starts were planted. Greenhouse-grown plants have been outplanted to successfully establish new populations of *A. applegatei*. Current research uses *A. applegatei* as a bioassay to determine the abundance and geographic distribution of the species' essential soil symbionts, important information for future re-introduction efforts.

Biographical Information: Melissa Carr graduated from Oregon State University in June 2001 with a B.S. in Biology. She has participated in plant conservation fieldwork as an Institute for Applied Ecology/Native Plant Society of Oregon intern, and has been involved in environmental education as an intern with the school program at the Oregon Garden. She currently manages greenhouse projects at OSU for the ODA Plant Conservation Biology Program.

Reviewing the Biological Conservation Status of Wolf's Evening Primrose (*Oenothera wolfii*): Developing a Protocol for New Population Establishment

Rebecca Currin, Robert J. Meinke, Matthew L. Carlson and Amber Wierck , Department of Botany & Plant Pathology, Oregon State University; Oregon Department of Agriculture, Plant Conservation Biology Program Corvallis, Oregon, 97331
phone (Rebecca Currin): (541) 737-4420; email: currinr@onid.orst.edu

Oenothera wolfii (Munz) Raven, Dietrich & Stubbe (Wolf's evening primrose) is a biennial to short-lived perennial endemic to beach habitats in northwestern California and southwestern Oregon. It is currently threatened by hybridization with the common garden escape *O. glazioviana* Micheli, as well as by habitat loss and alteration due to coastal development, roadside maintenance, and competition with exotic species. Currently, Wolf's evening primrose is listed as "Rare and Endangered Throughout Its Range" by the California Native Plant Society (list 1B) and the Oregon Natural Heritage Program (list 1), as "Threatened" by the State of Oregon, and as a "Species of Concern" by the U.S. Fish and Wildlife Service. Previous *O. wolfii* studies have evaluated hybridization between Wolf's evening primrose and *O. glazioviana*, observed flower development, synchrony of sex expression, and pollinator interaction, and performed germination and off-site cultivation trials. This paper reviews our current knowledge of the species, and discusses options for upcoming research.

In the hybridization studies, data for morphometric analyses were collected from plants believed to be pure and unaffected by hybridization, from putative hybrid plants, and from sympatric or near sympatric *O. glazioviana* populations. Thirteen quantitative characters were measured in the field, with results of the analyses supporting the inference of widespread hybridization in northern California. Wolf's evening primrose was shown to be morphologically distinct from *O. glazioviana*, while the designated hybrid populations were morphologically intermediate in 12 of the 13 quantitative characters measured; however, no distinct transition was apparent between putative hybrid morphotypes and each parent. There was also no evidence to classify any previously identified Wolf's evening primrose population as a hybrid population.

Despite its showy flowers, few pollinators were observed on Wolf's evening primrose during previous work. Surprisingly, self-pollination may play an important role in the reproduction of the species. Almost all observed flowers in several populations possessed visible pollen on their stigmas shortly after opening (and in the absence of pollinators). Wolf's evening primrose flowers that were covered with pollinator exclusion bags produced ample fruits and seeds, indicating that the species is self-compatible and does not require pollinators for successful seed set, although the species can presumably outcross if pollinators are present.

Life history studies in the greenhouse indicate that Wolf's evening primrose is easily cultivated. Several studies showed either high germination rates (with no pretreatment, or one month of after-ripening) or variable germination rates when different temperature regimes were used. Wolf's evening primrose has high seed production (up to an estimated 28,000 seeds/plant), so it appears that populations are primarily limited at the seed germination, seedling establishment, and early growth stages. Off-site cultivation trials comparing different fertilizer and vernalization treatments indicated that seedlings grew best with some added fertilizer, and that the majority needed 4-6 weeks of cold treatment to flower. Establishing new wild populations in administratively protected sites is often a recovery goal for many rare species. Unfortunately, there is typically little information available on how to establish new populations in natural settings, and Wolf's evening primrose has been no exception. However, we feel that the baseline biological data gathered through previous studies now permits us to proceed with a program to create new populations of this species in suitable sites in

Oregon, away from areas where hybridization is an on-going or likely problem. Once suitable sites are selected, proposed future research goals include (1) establishing a standard protocol for seed germination and seedling cultivation, (2) growing plants and then comparing reintroduction success of Wolf's evening primrose across a range of habitat gradients, (3) comparing transplant success rates for seedlings transplanted in fall vs. spring, (4) comparing new plant establishment rates when directly sowing seeds vs. transplanting seedlings, and (5) developing a species reintroduction plan that should benefit future management and conservation use.

Biographical Information: Rebecca Currin just returned to graduate school at Oregon State University to pursue a Master of Science degree in Botany, with a focus on plant conservation. She received her undergraduate degree in Economics at the University of Pennsylvania. Since then she has been a teacher, a neighborhood organizer and most recently a volunteer coordinator for the City of Portland, as well as an avid gardener and amateur botanist.

Influence of Wildfire and Fuels Management Disturbances on Invasive Exotic Species and Associated Native Plant Communities of the Interior Northwest

Ed DePuit, Bonita Shanafelt, USDA Forest Service, Wenatchee Forestry Sciences Lab; Miles Hemstrom, USDA Forest Service, Portland Forestry Sciences Lab; Becky Kerns, Nan Vance, USDA Forest Service, Corvallis Forestry Sciences Lab; Catherine Parks, Bridgett Read, USDA Forest Service, LaGrande Forest & Range Sciences Lab

The goals of our research are: 1) improve understanding of the impacts of and relationships among wildfires and non-native invasive plant species as expressed upon native vegetation in dry forest types of the interior Pacific Northwest, 2) evaluate the influence of fuel reduction and other management practices on invasive species/populations and native plant species/communities, and 3) develop and evaluate risk assessment protocols and management tools to aid land managers in pursuing the dual objectives of improved fire management and weed control. We have begun several specific projects to address these goals, including efforts to understand species and community-level interactions of invasive plants with native vegetation, studies of the effects of fuel treatment, fire, and grazing on the interaction of invasive plants and native vegetation, and the development of landscape-level state and transition models that includes invasive plants, management, and disturbance interactions. Our work has provided insights into the autecology and community ecology of several important invasive plant species, fire's influence on the distribution of major invasive plants with regard to travel corridors in the Salmon River canyon, the effects of wildfire, prescribed fire, and grazing in ponderosa pine forests of the Blue Mountains of Oregon, and the landscape density and distribution of invasive plants in a portion of the upper Grande Ronde River sub-basin.

Geographic Patterns of Genetic Variation and Isozyme Variation in Broadleaf Lupine (*Lupinus latifolius*) on the Mt Hood National Forest

David L. Doede, USDA Forest Service, Gifford Pinchot National Forest, Trout Lake, WA, 98650; phone: (509) 395-3433; e-mail:ddoede@fs.fed.us.
Caitlin Cray, USDA Forest Service, Gifford Pinchot N.F. current address: PO Box 261, Bingen, WA, 98605; phone (509) 493-1865: email; datura@gorge.net
Joan Trindle, USDA Natural Resources Conservation Service, Plant Materials Center, 3415 NE Granger Ave., Corvallis, OR 97330; phone (541) 757-4733; email: jtrindle@drtel.net
Dale Darris, USDA Natural Resources Conservation Service, Plant Materials Center, 3415 NE Granger Ave., Corvallis, OR 97330; phone (541) 757-4733; email: dale.darris@or.usda.gov
Valerie Hipkins, USDA forest Service; National Forest Genetics Electrophoresis Lab, 2480 Carson road, Placerville, CA, 95667; phone: (530) 622-1609; email: vhipkins@fs.fed.us

Broadleaf lupine is a common native legume with potential utility for restoring degraded lands; it colonizes recently disturbed areas, has a deep root system for stabilizing soil, and adds carbon and nitrogen to the soil. In 1995 and 1996 seeds were collected from 152 mother plants growing at 82 different source locations throughout the Mt Hood National Forest. There was a two-fold purpose for this collection: 1) a common garden investigation into geographic patterns of genetic variation to enable formulating seed transfer guidelines, and 2) an investigation into population structure using isozymes.

The common garden study revealed moderate amounts of source related variation in many size and growth rhythm traits. Principle component analysis was used to reduce dimensionality and redundancy in 24 traits, with five principle components accounting for 77% of the variation.

The isozyme study found large amounts of genetic variation in lupine populations, and most of the variability is between individuals within populations. The isozyme study also revealed that lupine populations separate into two groups which correspond to ploidy level. Populations containing both tetraploids and diploids were well-differentiated from diploid

only populations. The populations containing tetraploids are geographically grouped, and this fact does affect how the common garden study results are analyzed and interpreted.
Sources were grouped into putative diploid and putative tetraploid sources based on a discriminate analysis using sources classified in the isozyme analysis as a training set, eight traits were used for discrimination. Sources classified as tetraploid tended to be less thrifty and having a more prostate form than those classed as diploid.

Weak to moderate relationships were found among principle components and geographic or climatic using regression techniques.

Future investigations will focus on developing quick methods to discriminate between tetraploid and diploid individuals during seed harvest.

Biographical Information: David Doede is a forest geneticist with the USDA Forest Service working on the Gifford Pinchot, Mt Hood, and Siuslaw National Forests. He holds a B.S. in Forest Management from Oregon State University (1976) and a M.S. in Forest Genetics from O.S.U. (1993). His interests include adaptive genetic variation in forest plants, population genetics of forest trees, and applied tree improvement.

Potential Pollinators and Insect Visitors to Threatened and Endangered *Fritillaria gentneri* (Liliaceae) and Closely Related Species *Fritillaria affinis* and *Fritillaria recurva*

Kathleen Donham and Dr. Carol Ferguson, Dept. of Biology, Southern Oregon University, 1250 Siskiyou Blvd., Ashland OR 97520
email: KDonham@Prodigy.net; email: ferguson@sou.edu

Gentner's fritillary is endemic to a restricted area in SW Oregon and listed as "threatened and endangered" by the US Fish and Wildlife. Efforts to artificially pollinate *Fritillaria gentneri* have not resulted in fruit or seed set, and there is speculation that the species is a hybrid of related sympatric species *Fritillaria recurva* and *Fritillaria affinis*. DNA analyses have not been completed, and *F. gentneri* pollinators have not been documented.

Observations of flower visitors to *F. gentneri* and two putative hybrid parents, *F. affinis* and *F. recurva,* were made during the flowering season (February-April) 2002. Anna's hummingbird (*Calypte anna*) was photographed moving from *F. recurva* to *F. gentneri*, and three solitary bees (Andrenidae) were captured, each visiting one of the three fritillary species. The andrenids visiting *F. recurva* and *F. gentneri* were both carrying pollen on the ventral thorax. Queen bumblebees, *Bombus vosnesenskii*, were frequently seen exploring for nesting sites in the immediate vicinity, but were not observed visiting flowers. Dipteran and lepidopteran larvae were discovered feeding on flower parts in *F. affinis* and *F. gentneri*, respectively. Preliminary observations using fluorescent pollen analogue dye revealed no movement of dye from *F. recurva* to either *F. gentneri* or *F. affinis*. Further information about the habitat requirements of pollinators may be critical for establishing long-term recovery plans if *F. gentneri* is found to be capable of sexual reproduction.

Biographical Information: Kathleen Donham, MS Southern Oregon University 1995, is currently a research assistant for Dr. Carol Ferguson at Southern Oregon University studying the pollination of the protected rare orchid *Cypripedium fasciculatum* by diapriid wasps. She presented that research to the International Hymenopterist's Society in 2001 (San Diego) and the Scandinavian Association of Pollination Ecologists (Copenhagen) in 2002. Current work on potential pollinators of *Fritillaria gentneri* was sponsored by a grant from the Native Plant Society of Oregon.
Dr. Carol Ferguson, PhD University of Missouri 1987, is an Associate Professor of Biology at Southern Oregon University, teaching entomology and invertebrate zoology. She has received grants from the Bureau of Land Management and US Fish & Wildlife to study the pollination of *Cypripedium fasciculatum* (Orchidaceae). She will continue that research for the US Forest Service in Colorado this summer, and initiate a grant from the Bureau of Land Management to study the pollination of *Fritillaria gentneri* this spring.

Landscape Patterns Of Adaptive And Nonadaptive Phenotpyic Variation And Population Structuring In A Selfing Grass, *Elymus glaucus* (Blue Wildrye)

Erickson, V.J., Mandel, N.L., and Sorensen, F.C.
Contact Author: Vicky J. Erickson, USDA Forest Service, Umatilla National Forest, Pendleton, OR 97801
phone: (541) 278-3715; Fax: (541) 278-3730; email: verickson@fs.fed.us

Population structure and source-related phenotypic variance was investigated in *Elymus glaucus* (blue wildrye), a self-fertile allotetraploid grass. Because the species is increasingly being collected and propagated for restoration use in the Pacific Northwest, a primary objective of this study was to assess the extent and nature of adaptive differentiation among populations and the effect on the ecological and spatial scale over which seed should be transferred from original source populations. Progeny of 188 families from the Blue Mountains Province of northeastern Oregon and southeastern Washington were grown for three years in a common garden environment and measured for a wide range of traits

involving growth, morphology, fecundity, and phenology. Variation among seed sources was analyzed in relation to physiographic and climatic trends, and to various environmental stratifications such as ecoregions, watersheds, conifer seed zones, and vegetation and edaphic classifications. Principal component (PC) analysis extracted four primary PC's that together accounted for 67% of the location variance. Trait loadings for three of the PC's separated phenotypes on the basis of both form and vigor, while a fourth PC loaded heavily for fecundity. There was strong differentiation among source locations. PC scores were moderately correlated with longitude and with climatic variables, both indicating differentiation associated with local temperature and moisture regimes. Cluster analysis separated seed sources into three distinct groups. These groups accounted for over 80% of the source-related variation in PC-1 and PC-2 scores, considerably more than explained by regression models and indicative of an ecotypic or stepped-clinal distribution of genetic variation. Discriminant analysis and hierarchical classification models showed that cluster and within-cluster location differences were best described by longitude, subspecies, and ecoregion. Four geographic subdivisions based on longitude and ecoregion are proposed for delimiting *E. glaucus* seed transfer in the Blue Mountains Province.

Biographical Information: Vicky Erickson is a geneticist for the Umatilla, Wallowa-Whitman, and Malheur National Forests in the Blue Mountains of eastern Oregon and Washington. She also coordinates the rare plants and invasive species programs on the Umatilla National Forest.

Genetic Diversity And Structure Of Isolated Populations Of Quaking Aspen (*Populus tremuloides*) In Northeastern Oregon

Erickson, V.J., Wilson, B.L., Shirley, D., and Hipkins, V.D.
Contact Author: Vicky J. Erickson, USDA Forest Service, Umatilla National Forest, Pendleton, OR 97801
phone: (541) 278-3715; Fax: (541) 278-3730; email: verickson@fs.fed.us

In the Blue Mountains of northeastern Oregon, quaking aspen (*Populus tremuloides* Michx.) occurs in small, disjunct stands that are in rapid decline and at risk of extirpation. A principal cause of aspen decline is fire suppression, which promotes conifer invasion and eliminates a disturbance agent that is critical for successful aspen regeneration. Heavy browse pressure from both domestic livestock and large herbivores also contributes to stand mortality and decline. To aid in the development of conservation and restoration strategies for aspen in the Blue Mountains, we investigated genetic variability, clonal diversity and the level of differentiation among 91 aspen stands from 7 geographic subregions. Isozyme analysis of 17 loci revealed high levels of diversity overall, with 88.2% of the loci polymorphic and an average of 3.94 alleles per locus. Individual stands were much less variable, averaging 25.9% polymorphic loci and 1.33 alleles per locus. The number of clones per stand varied from 1 to 14 (mean = 2.5). In 41 (45%) of the stands, only one genotype was detected, indicating that the contemporary structure of aspen stands in the Blue Mountains is strongly influenced by clonal spread and persistence via root suckering. Although rare, sexual reproduction does occur, as evidenced in two recent wildfire areas where nearly every sprout sampled represented a novel genotype.

Genetic diversity and clonal structure varied within and among subregions due to differences in stand size, the degree of spatial separation, and possibly also fire history. For example, in the eastern portion of the North Fork John Day subregion where stands were extremely small and highly disjunct, 73% of the stands were monoclonal and no stand consisted of more than 2 clones. Stands in the subregion were also highly differentiated, with a mean F_{st} of 0.579 compared to an overall value of 0.414. In drainages and subregions where stand diversity was exceptionally high and genetic differentiation was low, we hypothesize that wildfire events have enhanced gene migration and stand establishment from seed. Aspen historically was more abundant than at present, as inferred from our finding of three genotypes that appear to be the fragmented remnants of large, ancient clones. Each of these three genotypes occurs in what are now two stands separated by at least 200 m. Results from the study were used to identify priority stands for *in situ* and *ex situ* protection, including those that contained large amounts of genetic variation, were highly differentiated, or contained rare alleles.

Biographical Information: Vicky Erickson is a geneticist for the Umatilla, Wallowa-Whitman, and Malheur National Forests in the Blue Mountains of eastern Oregon and Washington. She also coordinates the rare plants and invasive species programs on the Umatilla National Forest.

Bald Hill Park Oak Restoration Project

Greg Fitzpatrick, The Nature Conservancy, 1328 NW 12th street Corvallis, OR 97330
phone (541) 757-0833 (cell # 740-0070); email: fitzpatg@juno.com

In this poster we discuss the oak habitat restoration project that took place at Bald Hill Park in Corvallis, Benton Co., Oregon, from November 2000 through September 2002. The restoration project was funded by NFWF and USFWS

grants and conducted on land owned by the Corvallis Parks Department, with a conservation easement held by the Greenbelt Land Trust.

Over 90% of Oregon white oak (*Quercus garryana*) habitat has either been converted to other land uses or substantially degraded, making it one of the most threatened ecosystems in the Pacific Northwest. The remaining oak habitats are highly fragmented and are threatened by continuing urbanization, fire suppression, logging, grazing and invasion of exotic species. Oak woodlands and savanna support a rich assemblage of plants, insects, reptiles and birds, many of which are declining in numbers. Oak habitat may play a critical role in the conservation of neotropical migrant birds that migrate through, or nest in, Oregon white oak woodlands.

The goals of this restoration project were to promote an oak dominated stand with an overstory of scattered large, spreading canopied oaks and to reduce the abundance of non-native trees and shrubs such as Himalayan blackberry and English hawthorn and smaller Oregon white oak trees of narrow form. Other goals included promoting the use of prescribed fires for ecological, educational and training purposes, initiating research and monitoring activities to help evaluate new restoration methods and for tracking changes during the restoration process and provide educational opportunities for the general public and students so they can learn about the importance of oak habitat.
Approximately 17 acres of Oregon white oak woodland and savanna were treated in 9 oak habitat management units between November 2000 and September 2002. The major restoration activities included cutting and removing non-native and invasive species, thinning white oak in certain areas and treating cut stumps with the herbicide glyphosate. We also used goats during the summer of 2002 to clear underbrush and we prepared three units for prescribed fires that occurred in 2001 and 2002. Native forb and grass seed was collected or purchased and sown into different management units in the fall of 2001 and 2002. Native strawberry plants were collected from Bald Hill in 2002 and were transplanted into grow-out plots for future planting.

Monitoring included qualitative and quantitative sampling. Sixty photos at 18 different photo stations were taken before and after restoration activities. Quantitative baseline vegetation data, using the point-intercept method, were taken in management units 1, 3 and 4 prior to any restoration activities. Baseline breeding bird monitoring using the point count method was done in 2000 prior to any restoration activities.
Two small studies were conducted during the project to evaluate methods of controlling English hawthorn (*Crataegus monogyna*) and false-brome, both aggressive understory species that invades native woodlands in the Willamette Valley. In 2001 we tested the efficacy of using glyphosate to treat stumps of English hawthorn as a way to reduce resprouting, and in 2002 we tested the use of spring burns (using a propane flamer) to control false-brome.

Biographical Information: Greg Fitzpatrick got his undergraduate degree from Evergreen State College in Olympia, WA in biology (1991) with an emphasis in sustainable agriculture. He then went to OSU in Corvallis and got a master's degree in entomology/ecology (1995) doing research on biological control of tansy ragwort. He has worked for The Nature Conservancy for the past 7 years in the Willamette Valley doing prairie and oak habitat restoration work and research and monitoring of invasive weeds and Kinkaid's lupine and the Fender's blue butterfly. Prior to returning to college in 1989, he was a general contractor for 10 years doing carpentry in Seattle, specializing in traditional timber framing. He also owned a plant nursery on Vashon Island outside of Seattle.

Your Web Connection: Transferring Technology and Native Plant Resources between the Scientific Community and the Native Seed Industry

Melanie Gisler, Walter Bryant, Rob Fiegener, and Keli Kuykendall, The Native Seed Network/Institute for Applied Ecology, 227 SW 6th St., Corvallis, OR 97333
phone: (541) 753-3099; email: melanie@nativeseednetwork.org, walter@nativeseednetwork.org, rob@nativeseednetwork.org, and keli@nativeseednetwork.org

The mission of the Native Seed Network (NSN) is to centralize information for scientists, collectors, growers, sellers and consumers of native species to facilitate ecological restoration of public and private lands in North America. Through a partnership with the Bureau of Land Management, NSN has created a website (www.nativeseednetwork.org) intended to provide access to economical sources of native plant materials from local genetic neighborhoods.

Technology Transfer: The NSN website provides scientific resources including: 1) detailed Level III US Ecoregion maps (Environmental Protection Agency, 2000), 2) Focus Lists of native species targeted for commercial production based on consensus among regional experts, 3) a searchable Plant Database standardized with the NRCS Plants Database, 4) Unit Calculators for metric conversions, and 5) Resource Links or internet connections to partners and related organizations. Also Feature Stories are regularly posted on the website and provide an information sharing forum for native species and restoration topics.

Marketing Services: The demand for native seed is much higher than the supply. NSN facilitates communication and commerce through our Marketplace feature. Sellers can post seed for sale on the website and are prompted to include seed origin information (e.g., state, ecoregion, aspect, elevation), certification history, quantity available, and price.

Buyers can search for appropriate seed to purchase by species, county, and ecoregion, and obtain details about each item to make informed decisions.

Database Services: Seed collections can be tracked on the NSN website from collection through cultivation and (eventually) out-planting at the restoration site. Our Seed Tracking database maintains your collection records, helps you build seed accessions, and facilitates seed certification. The website also maintains a personal database of your marketplace transactions (seed listings and purchases). All of your database records are password protected.

We are working to build an informative, stable inventory of ecologically appropriate native seed sources for restoration. We encourage your participation and comments. The Native Seed Network is a 501(c)(3) nonprofit company of the Institute of Applied Ecology.

Biographical Data: Melanie Gisler is the program manager for the Native Seed Network. She received an M.S. degree in Botany from the University of British Columbia in 1997. In Oregon she has worked as a plant ecologist at the Pacific Northwest Research Station in Corvallis, and, for two years, as the seed program coordinator for the West Eugene Wetlands Program/BLM. She has also worked for several years as a field and greenhouse botanist in Texas, New Mexico, and in British Columbia. **Walter Bryant** has twenty-five years experience in the commercial seed business. Nineteen of those years were spent managing grass seed companies in Oregon. Walter holds a Masters in Business from UCLA. He is responsible for building business relationships between producers and consumers of native seed. **Rob Fiegener** is a research associate of the Native Seed Network. **Keli Kuykendall**, Director of the Native Seed Network, is a natural resource scientist with expertise in Pacific Northwest ecosystems, both terrestrial and wetland. She has worked for over 15 years on conservation of rare plant taxa in Oregon and Washington. Her specialties include site assessment, community classification, taxonomic identification, conservation genetics, and statistically based research design, implementation and analysis.

Distribution of Common Non-native Plants in Oregon Forests: Effects of Environment and Management

Andrew N. Gray, USDA Forest Service PNW Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331 phone: (541) 750-7252, email: agray01@fs.fed.us.

Invasive non-native plants are having a tremendous ecological and economic effect on plant communities in the west. Information about the autecology of individual vascular plant species is usually pieced together from a variety of survey approaches, herbaria specimens, or intensive research on selected aspects of a species' life cycle in selected areas. A program of extensive survey plots across regional environmental and management gradients can help to determine species' distributions and examine factors that affect their abundance. The objectives of this study were to 1) summarize the abundance and distribution of common non-native plants across forest lands in Oregon, and 2) examine the influence of geography, ownership, climate, topography, and management history on the distribution of selected weed species in western Oregon.

Plant data from the systematic inventory conducted on non-federal lands in Oregon from 1995-1998 by the Forest Inventory and Analysis program were analyzed. Regression analyses were used to evaluate species presence and abundance, using a modified stepwise procedure for variable selection. While some effects of timber harvest and thinning were evident, it was not possible to attribute differences to ownership because climate and community types differed dramatically among owner groups in this landscape. Species like Scotch broom (*Cytisus scoparius*) and Himalayan blackberry (*Rubus discolor*) were sensitive to regional climate gradients, while non-native thistles (*Cirsium*) and St. John's wort (*Hypericum perforatum*) were most sensitive to tree canopy cover. However, strong environmental correlations with distributions of English ivy (*Hedera helix*) and English holly (*Ilex aquifolium*) may reflect limitations on dispersal rather than actual environmental constraints. Results suggest that systematic inventories have great potential for quantifying weed distribution and ecology.

Biographical Information: Andrew Gray is a forest ecologist with the Forest Inventory and Analysis program with an interest in forest structure and composition across the Pacific Northwest. Prior research includes studies of natural disturbance, plant autecology, and microclimate in westside forests.

A comparison of ecosystem processes in native and cheatgrass-dominated rangelands

Kristen S. Harrison, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR phone: (541)-737-9284; email: straussk@bcc.orst.edu

As large-scale restorations of degraded rangelands are initiated, land managers need to understand how decades of dominance by the invasive annual cheatgrass (*Bromus tectorum* L.) have altered ecosystem processes. One way to assess such alteration is by observing differences in decay rates, since decomposition is determined by factors such as microclimate, soil organic matter, and microbial communities. Our study examined differences in above-ground litter decay rates in native sagebrush-bunchgrass communities and cheatgrass-dominated communities on the Snake River Plain. We also examined levels of plant-available nitrate (NO_3) and ammonium (NH_4) in the soils of the native and cheatgrass-dominated communities. Our study found no differences in decomposition rates for cheatgrass and three native bunchgrasses ($F_{3,572} = 2.46$, two-sided $p = 0.062$) over 15 months in the field. Initial lignin:N ratios of the litter did not concur with decay results. There were also no significant differences in decomposition rates between litter decaying in cheatgrass-dominated communities and litter decaying in native communities under sagebrush (*Artemisia tridentata*) or in the interspaces ($F_{2,572}=0.885$, two-sided $p=0.413$). Plant-available NO_3 differed among microclimate levels, after accounting for number of days in the field ($F_{2,233}=6.127$, $p = 0.002$). NO_3 levels in the native soils under shrubs were lower than NO_3 levels in the cheatgrass-dominated soils at every date. There were no differences in plant-available NH_4 among microclimate levels, after accounting for site and days ($F_{2,228}=0.41$, $p=0.960$). The overall results of our study indicate that the years of cheatgrass dominance have had little effect on above-ground decay rates. Availability of NH_4 in the soil has not changed, but NO_3 availability had increased. Further study into below-ground decay and ecosystem processes are recommended in order for restoration attempts to be successful.

Biographical Information: Kristen Harrison graduated from Marquette University in 1998 with a bachelor of science in Biology. After graduation she went to work at Cedar Creek Natural History Area in Minnesota, where she assisted with studies on old-field succession, decomposition, and effects of elevated CO2 on plant diversity. She then moved to Washington where she worked at a commercial plant nursery for 2 years. She is currently finishing a Master's degree program with the department of Botany and Plant Pathology at Oregon State University.

Developing and Implementing a Forest-wide Native Seed Program: 10 Years of Experience on the Umatilla National Forest in the Blue Mountains of Eastern Oregon and Washington

Betsy Kaiser, Karen Prudhomme, Bill Lydie, Scott Riley, and Vicky Erickson; Umatilla National Forest, 2517 SW Hailey Ave., Pendleton, OR 97801
phone: (509) 522-6056; email: bkaiser@fs.fed.us

For many years, non-native species have been used in forest revegetation projects such as erosion control and forage enhancement. The extensive past use of non-natives has had many adverse impacts on the occurrence, diversity, and health of our native forest and rangeland ecosystems.

In anticipation of new Forest Service Region 6 policy regarding the use of native plant species in restoration and revegetation projects, a program was started in 1993 to build a seed bank of local-provenance seed for revegetation projects on the Umatilla National Forest. This new program required Forest personnel to learn a great deal about collecting, propagating, and applying native seed. Ten years later, revegetation with native species has become an operational program that is incorporated into timber, road, and recreation site management, fire rehabilitation, and noxious weed treatment. The native seed program is partially funded by all these functions. The combined expertise of botanists, foresters, hydrologists, and a geneticist is regularly applied. Creation of a seed bank has been successful; there are nearly 25,000 pounds of native grass seed on inventory which are identified by the watershed and elevation band of the collection site on the Forest.

In order to successfully collect good quality seed for the purpose of establishing increase plantations, personnel had to learn which species would be useful for revegetation by researching the biology and ecology of the local species. Today we work with eight primary grass species: mountain brome, bottlebrush squirreltail, blue wildrye, Idaho fescue, prairie junegrass, Sandberg bluegrass, bluebunch wheatgrass, and western needlegrass. Several other grass and forb species are used for special sites. There has been a lot learned about the occurrence, ripening schedules, and disease problems of the species being collected, and methods of hand collecting, drying, extracting, testing, and storage of seed. As collection and handling methods have improved, the amount of hand collected wild seed required for establishment of a grass seed plantation has decreased to 3 to 5 pounds per acre. The seed is supplied to a local grass seed contractor or a Forest Service nursery for propagation. Within one to two years, large amounts of grass seed can be available for use (yields are usually 200 to 1,000 pounds per acre of plantation). In general, the seed can be stored in a cool, dry warehouse for three to five years, after which the germination decreases. In order to maintain an inventory of fresh seed, it is best to use existing seed and keep producing for the future.

Propagation of large amounts of seed has also required learning about contract preparation, funding sources, plantation establishment timing, and certification standards for both Oregon and Washington, as the Umatilla National Forest extends into both states. As local growers have gained expertise in field management, the contract cost has gone down steadily and is now $8 to $10 per pound for the most widely used species and up to $25 per pound for more difficult species. Straw from the native grass fields has been purchased for mulching on particularly disturbed sites. We have learned that native seed has a wide variety of sizes and awns and other structures that make cleaning more difficult in

some species than in others, and that the seed must be well cleaned to be compatible with a variety of seeding equipment.

In order to maintain genetic integrity, the Umatilla National Forest reseeds grass within the 5th Field Watershed and 1,500 foot elevation band from which the parent plants originated. The exception is blue wildrye, where genetic research has shown that seed can be transferred over larger areas.

Application of seed has required learning about timing of seed application, selection of species for specific sites, application methods, and monitoring. Methods used include rotary hand seeders, seeders attached to four-wheelers, helicopters, hydroseeding, and planting of plugs. The Forest Botanist has worked with the San Dimas Technology and Development Center to develop a prototype for a machine that is being tested to accomplish road obliteration, seeding, and harrowing in one pass instead of requiring multiple methods.

The most important way to learn what works and what to change in the future is following the success in germination and survival of seeded areas. We are learning more every year about seed mixes and application methods that result in successful revegetation. Well documented photo points that are repeated annually have proven to be a good tool for documenting and sharing project results.

Much of the information gained from the Forest's experience is documented on the Native Plant page of the Umatilla National Forest web site at www.fs.fed.us/r6/uma/native. This poster will present examples of projects that have been accomplished on the Umatilla with related information and costs.

Fire Management of Native Plants for California Indian Basketweaving

Jennifer L. Kalt, California Indian Basketweavers Association, Northwestern Field Office, P.O. Box 1496, Willow Creek, CA 95573

Prior to European settlement, Native Americans used intentional burning for a wide range of resource goals, including management of plants used for food, basketry, and wildlife forage. Fire is a critical tool used by California Indian basketweavers to manage basketry plants, including hazel, beargrass, deer grass, and redbud. Many species are useless for basketweaving purposes in the absence of fire.

Landscape level declines in the abundance of grasslands and oak savannahs can be attributed to elimination of Native American burning practices in the last century. Encroachment of conifers such as Douglas fir can be documented through comparison of historical and recent aerial photographs. Due to these vegetation changes, native plants that have remained unburned for a century or more require mechanical fuels reduction prior to reintroduction of controlled burning due to heavy fuel loads.

Methods of reintroduction of fire management of hazel (*Corylus cornuta* var. *californica)* were assessed through field experiments and monitoring. Combining scientific experimentation with traditional ecological knowledge, oral history, and ethnographic accounts is essential for capturing specific information on the use of fire by Native Americans.

Biographical Information: Jennifer Kalt is the Staff Botanist and Resource Protection Associate for the California Indian Basketweavers Association's Northwestern Field Office in Willow Creek, CA. She works to protect basketweavers and gathering sites from impacts of herbicides, promotes traditional management practices to restore and manage basketweaving plants, and informs agency staff and the general public about basketweavers' concerns. She earned a B.S. in Botany and an M.A. in Biology from Humboldt State University, and is the Conservation Chair for the North Coast Chapter of the California Native Plant Society.

Genetic Variation in the Rare Endemic *Sisyrinchium sarmentosum* (Iridaceae) Based on RAPDs

Lisa Karst and Carol Wilson, Biology Dept., Portland State University, Portland, OR

Sisyrinchium sarmentosum is a rare endemic plant of the middle Cascade Mountains of Oregon and Washington, with 16 known populations, each estimated to be 50 to 8000 individuals. I have examined the genetic diversity of a subset of populations using random amplified polymorphic DNAs (RAPDs). Six
visited populations originally reported to be less than 100 plants were extirpated or intermediate with *S. idahoense*. From the remaining seven populations sampled, three distinct groups emerged, conforming to the metapopulation model of species diversity. Oregon and Washington sites showed differences in the distribution of genetic diversity within populations, and groups correlate with geography. The five largest populations appear to be thriving, in spite of over a century of cattle grazing and habitat alteration. Preliminary cDNA sequence analysis indicates that *S. sarmentosum* is more closely related to eastern species such as *S. albidum* and *S. angustifolium* than to the local congener, *S. idahoense*, indicating that it may be refugial from an earlier migration of *Sisyrinchium* into this region.

Biographical Information: Lisa Karst is developing a phylogeny of the New World genus *Sisyrinchium* for her doctoral

degree using cDNA sequences and morphologic evidence. She is in her third year of study at Portland State and this quarter is a teaching assistant for Principals of Biology and for Plant Ecology.

Invasive Plant Alert: False-Brome (*Brachypodium sylvaticum*) in the Pacific Northwest, a Major Threat to Native Plant Communities

Thomas N. Kaye and Matthew Blakeley-Smith, Institute for Applied Ecology, 227 SW 6th, Corvallis, Oregon 97333 phone: (541) 753-3099; email: kayet@peak.org

False-brome, or slender false-brome (*Brachypodium sylvaticum* (Huds.) Beauv.), is an invasive grass species that is rapidly expanding in the Pacific Northwest. This exotic perennial is native to Europe, Asia and North Africa, but is invading habitats in western Oregon, and possibly elsewhere in our region, at an alarming rate. It is capable of completely dominating understory and open habitats to the exclusion of most other native species. The earliest record of the species in North America is a 1939 collection from near Eugene in Lane County, Oregon. By 1966, the species grew in at least two large colonies in the Corvallis-Albany area of Benton County, Oregon, where it was well established (Chambers 1966, Madroño 18:250-251). Currently, it is officially known only from Oregon, where it occupies habitat in and around the Willamette Valley, coastal forest, and as far south as Josephine County (a few miles from the California border). The species seems likely to spread rapidly to California, Washington, and British Columbia.

False-brome can be distinguished from most other grasses by its hairy leaf margins and lower stems, broad (4-10 mm) lax leaves, and a long-lasting bright green color (leaves often remain green through fall and at least part of winter). It differs from native perennial bromes (*Bromus* species) in having sheaths open to the base, flowers borne in a true spike, and spikelets with no or only short stalks. The flower spikes droop noticeably. In contrast, the perennial bromes in this region have sheaths closed >1/4 of their length, their flowers are in more open, branched panicles, and their spikelets are generally strongly stalked. Although spikelets droop on one native, Columbia brome (*B. vulgaris*), the spikelets are clearly stalked.

In the Willamette Valley and surrounding foothills the species may occur with native perennial grasses such as Columbia brome (*Bromus vulgaris*), bearded fescue (*Festuca subulata*), and oniongrass (*Melica subulata*) in forest understories, and blue wildrye (*Elymus glaucus*), California brome (*Bromus carinatus*), California oat-grass (*Danthonia californica*), and California fescue (*Festuca californica*) in open areas such as upland prairies and along forest edges. False-brome does not appear to be rhizomatous, but forms large clumps that tend to coalesce, and it reproduces rapidly from seed.

The species has an exceptionally broad ecological amplitude, occupying forest floor and open environments such as pastures and prairies at a variety of aspects and elevations. Populations are known from riparian forests as well as upland hardwood and conifer forests under patchy and closed canopies at elevations of 200-3500 feet. Vigorous populations also occupy forest edges and upland prairies in full sun. When invading an area, it may first disperse along roadsides, then move out into undisturbed areas or forest clearcuts. The palatability of this grass for wildlife appears to be very low. It may inhibit tree seedling establishment and displace threatened and endangered species, such as Kincaid's lupine (host plant for the endangered Fender's blue butterfly).

One characteristic of false-brome that appears to make it successful in the Pacific Northwest is its ability to tolerate a wide range of habitats, particularly with regard to light availability. Most of the invasive plants in our region tend to favor either open conditions, shade, or edges. False-brome can successfully dominate in all of these conditions to the near-complete exclusion of native herbaceous plants.

Dense growth of false-brome may alter fire regimes, and, especially where the species builds up a heavy layer of thatch, may increase the risk and rate of spread of wildfire. The species itself appears to be fire tolerant, resprouting within two weeks of a burn. False-brome becomes a serious pest after forest harvest and may inhibit tree seedling establishment. It may also invade pastures and reduce forage quality for livestock. When the species dominates the vegetation, it may have negative effects on small and large mammals, native insects, lizards and snakes, and even song birds. Efforts to restore fish habitat may be impaired when dense patches of false-brome are present. This grass may reduce establishment of planted riparian trees that provide shade and structure to streams.

Control of false-brome should focus first on prevention of spread through cleaning of machinery used in forest management; boots, clothes and equipment of forest workers and recreationists, and removal of infestations along roadsides. Seeds from roadside patches disperse on passing vehicles, people, and wildlife.

Where the species is already established, herbicides (e.g., glyphosate/Roundup) are an effective control method in some environments, but non-chemical methods are urgently needed. Mowing and burning alone appear to be ineffective for controlling the species. Hand removal may work in small patches, but care must be taken to remove all root fragments.

Additional information on false-brome is available on the internet at these sites:

- tncweeds.ucdavis.edu/alert/alrtbrac.html
- www.ou.edu/cas/botany-micro/ben/ben277.html
- www.appliedeco.org/reports.html

Direct Seeding vs. Transplanting: Reintroduction Methods for Kincaid's Lupine (*Lupinus sulphureus* ssp. *kincaidii*), Threatened Host Plant for the Endangered Fender's Blue Butterfly.

Thomas N. Kaye and Jen Cramer, Institute for Applied Ecology, 227 SW 6th, Corvallis, Oregon 97333
phone: (541) 753-3099; email: kayet@peak.org

Lupinus sulphureus ssp. *kincaidii* was recently listed by the U.S. Fish and Wildlife Service as a threatened species. This rare lupine is a host plant of the Fender's blue butterfly (*Icaricia icarioides fenderi*), a Willamette Valley, Oregon, endemic. Because of the rarity and protected status of these species, we have been involved in partnerships to restore populations of the lupine and improve habitat for the butterfly. Steps needed to conduct lupine restoration include selection of appropriate sites (with compatible ownership, butterfly goals, habitat suitability, soil chemistry, site preparation, etc), seed collection, and acquisition of appropriate permits. If plants are to be out-planted, the plants must first be cultivated from seed, any needed site preparation or soil amendment must be conducted, and the potted plants must be put into the field. If direct seeding is used as an alternative, site preparation may still be required to control invasives and possibly reduce competition from native plants, then seed must be sown on-site. For both methods, follow up monitoring will be required and habitat maintenance will be needed.

In this work we partnered with the Eugene District BLM to compare out-planting and direct seeding as methods of augmenting existing lupine populations or establishing new ones. We tested the treatments such as adding fertilizer and *Rhizobium* sp. (bacteria that form nodules on legume roots and fix atmospheric nitrogen) for their effects on transplant survival and growth. We found that neither treatment improved out-panting success or plant size after three seasons of growth. Transplant survival ranged from 88% in the first season to 38% after the third growing season.

Sowing seeds directly on the soil surface was conducted into test plots with and without the competing vegetation removed. We also used seeds of two types: scarified to break dormancy and unscarified. Again, neither treatment altered seedling establishment or plant abundance in the plots after three seasons. Average seedling establishment was 24% +/- 5%.

Both the out-planting and direct seeding tests were performed at the same site near the West Eugene Wetlands, which allowed us to compare these methods of lupine planting. Many lupine populations have reproductive failure to due seed predation by insects, inbreeding depression, and climatic conditions, and other causes, which can limit seed availability for restoration projects. Therefore, we compared the cost of seeding vs. transplanting in terms of dollars and seeds. Seeds used to propagate plants for out-planting use produce more leaves than those used in direct seeding (42 leaves vs. 8 leaves per seed on average, respectively), but direct seeding is far less expensive ($0.07 vs. $2.81 per leaf, respectively). When ample seeds are available, direct seeding is a more cost effective and equally successful method for restoring Kincaid's lupine populations, but when seeds are scarce, they may be best propagated in the greenhouse then out-planted.

Native Grasses and Plants: From Seed Collection and Seed Increase to Restoration Projects

Douglas Kendig, Natural Resources Specialist, Butte Falls RA, Medford BLM
phone: (541) 618-2285

The native plant program is intended to provide a source of native seed and plant material in compliance with state and national Bureau of Land Management native plant policies for multiple Medford BLM programs. Medford BLM has an extensive wildland urban interface with a majority of these lands classified under Fire Condition Class 3. This past year 4 major wildfires greater than 10,000 acres each occurred on the district. In addition Medford BLM has one of the largest fuel reduction programs in the country approaching 25,000 acres treated.

The types of native plant material for grow-out include grasses, forbs, shrub and hardwood species. Currently, Medford BLM has 31 native grass seed genotypes from 16 native grass species under cultivation, along with 11 species of forbs, brush, hardwood and riparian species. Last year approximately 19,000 lbs of uncleaned native grass seed was grown on 51 acres from 17 species and 71 lots. These lots produced 1200 bales of straw. Species included *Bromus carinatus, Koeleria macrantha, Festuca californica, Melica hardfordii, Bromus vulgaris, Bromus laevipes, Danthonia Californica, Poa secunda, Festuca occidentalis, Festuca roemeri, Melica harfordii, Elymus glaucus, Pseudoregneria spicata, Deschampsia elongata, Deschampsia caespitosa, Achnatherum lemmonii, Lupinus latifolius* and *Lupinus albifrons* among others. District projects where native plants and seed are needed include restoration and rehabilitation after wildfire and fuel reduction treatments, habitat improvement, cutbank stabilization, road decommissioning, soil stabilization for ground disturbing projects, habitat restoration following noxious weed control, and riparian restoration. In addition native seed reserves are established and maintained for immediate grow-out for rehab efforts after a catastrophic fire event. In general native seed is unavailable or not available in the quantities necessary for current project needs. Currently, large amounts of non-native seed is used on these projects which spread weeds and other undesired species across the landscape.

A secondary benefit of the program is the out-sourcing of federal dollars to grass seed growers and contractors, who provide seed back to the government. Local growers benefit economically in development of this new agricultural market of native grass seed increase and the government receives the benefit of reduced costs per unit of native seed produced as orders and quantities for native seed increase. This past year, after developing an inter-agency, multiple year, indefinite quantities native grass grow-out contract, Medford BLM placed 50 acres of native grass seed under production with growers for seed production. (Also, thanks to Rachel Showalter and Anita Sedaghaty for poster "design and layout".)

Biographical Information: Douglas Kendig: Having reforested tens of thousands of acres of conifer plantations in the 80's, it became apparent to me that diverse species of local native plants are normally best suited for all federal projects (and not just the same conifer everywhere). Just as local genetic adaptations of conifers were discovered after years of testing, it seamed reasonable that other plant species would have similar local adaptations. Since then my energies have been focused for the past 8 years on developing a native plant and grass seed program that provides local genotypes for BLM projects. Along with regular work and a botany and forestry background, I've tried to integrate native plant species as a component of all ground disturbing projects. One method has been through the development of a number of novel BLM procurement contracts over the last 10 years, including recently an inter-agency, multiple year, indefinite quantities and indefinite delivery native grass seed grow-out contract to produce large quantities of native grass seed on a commercial scale.

Plant-Animal Interactions in Coastal and Montane Meadows: Rarity, Re-introduction, and Pollination of *Silene douglasii* var*. oraria*

Susan R. Kephart, Willamette University, Dept of Biology, Salem, OR 97301
email: skephart@willamette.edu

Habitat fragmentation reduces global biodiversity, influencing the richness of species interactions and the services provided by healthy ecosystems. As important hosts for migratory birds and butterflies, plants depend on nectar and pollen feeders for fruit production. Diurnal pollination is low in rare and common varieties of *Silene douglasii*, and successful reproduction in this relative of carnation is affected by other co-occurring wildflowers. However, noctuid moths visit some populations at high rates, and serve both as pollinators and seed predators. At two sites, shifts in breeding system and sexuality are apparent which appear related to low pollination and inbreeding depression. Moreover, in a three-year re-introduction effort at Cascade Head, outbred progeny exceeded inbred progeny in both survival and reproduction. Some nocturnal visitors both pollinate and lay eggs in the flowers. These research efforts span diverse "habitat islands" across years and sites, and further highlight the importance of examining rarity in a community context involving multiple populations. Human activities continue to place key plant-animal interactions at risk, leading to inbreeding and low genetic diversity in small populations.

Biographical Information: Susan Kephart is presently a Willamette University Professor of Biology. Susan involves undergraduates and Earthwatch volunteers in field research *on Silene, Asclepias,* and *Camassia*. She focuses primarily on the roles of plant-animal interactions, mating systems, and hybridization in plant evolution and conservation. In studies of variability in natural populations, she incorporates DNA-based tools.

Does Pre-Commercial Thinning Help Restore Understory Herb and Shrub Communities of Young Managed Forests to Old-Growth Composition?

Briana Lindh, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331
phone: (503) 588-7662. email: lindhb@bcc.orst.edu.

I studied the effects of pre-commercial thinning on understory herbs and shrubs in the Oregon Cascades. My objectives were to describe differences between old and young stand understory communities and to test whether thinning moved young stands closer to old-growth composition. I sampled in six treatment blocks, each containing at least one unthinned, one thinned, and one old-growth unit. Harvest units were sub-sampled with approximately one 9m radius plot per hectare (6 to 12 plots per harvest unit). In each sample plot I recorded presence/absence for all species (herbs and shrubs) and abundance and flowering for 11 focal species (herbs). Sample plots from each treatment type within each block were averaged to avoid pseudoreplication. My study sites were in the western hemlock vegetation zone in the H. J. Andrews experimental forest. Indicator species for old-growth were mostly shade-tolerant clonal herbs or orchid or ericaceous herbs that are heavily dependent on mycorrhizae. Thinned and unthinned harvest units differed from old-growth units in species composition, measured by species list or abundance or flowering of focal herb species. Thinned and unthinned stands differed from each other only in terms of total species presence/absence, and the difference was an order of magnitude smaller than that between young and old stands. Most individual focal species were more abundant in thinned

than unthinned stands, but these differences were small and non-significant given the sample size. Because thinning led to slight increases in both old-growth and second-growth associated species, that net effect was that pre-commercial thinning did not move stands any closer to old-growth composition.

Biographical Information: Briana Lindh's research interests focus on the influence of anthropogenic and natural disturbances on plant community composition, and on the statistical tools necessary to find pattern in plant community data. She is finishing her PhD at OSU and plans to continue to work in plant ecology through teaching and through consulting on data analysis projects.

Threats Assessment for *Artemisia campestris* ssp. *borealis* var. *wormskioldii* in the Priest Rapids Hydroelectric Project Area, Washington

Devin Malkin, Framatome ANP DE&S, 19125 North Creek Parkway, Suite 203 - Bothell, WA 98011

Artemisia campestris (L.) ssp. *borealis* var. *wormskioldii* (Bess.) Cronq. is a low-statured perennial endemic to the Columbia River basin of Oregon and Washington. A candidate for listing under the ESA, it is known from two disjunct populations, the largest on Priest Rapids Reservoir, near the town of Beverly, Washington. Observations of decline at this population during the 1990s prompted the taxon's listing status; hydrology, recreational pressures, and exotic weeds were all cited as potential threats. The first detailed examination of these threats finds the Beverly population to be rarely subject to flooding or scour, suggesting their potential impact is limited. In contrast, the long-term maintenance of appropriate habitats under reservoir hydrology likely poses a larger threat to the taxon over time. The exotics *Linaria dalmatica* and *Centaurea diffusa* are common in the Beverly population and threaten *A. campestris* ssp. *borealis* var. *wormskioldii*, but *Bromus tectorum* appears unlikely to do so. Although high levels of recreational use has impacted parts of the Beverly population, but available evidence suggests the taxon may be at least partially disturbance-adapted, complicating the vehicle restrictions currently in place. A demographic monitoring program is in place to empirically describe the effects of these and other potential threats to the Beverly population.

Biographical Information: Devin Malkin is a botanist with Framatome ANP DE&S, a national environmental and engineering consulting firm specializing in energy issues. Devin conducts and manages botanical work for three major hydroelectric relicensings in Washington and California, including rare plant and noxious weed inventories, management, and planning. He has a M.S. from the University of Washington, where he studied the rare perennial *Silene seelyi*.

Phylogeography of Garry Oak (*Quercus garryana*) in the Pacific Northwest

Lauren Mathewson, Lauren A. Byerley, and Keith Karoly, Biology Department, Reed College, Portland, OR 97202 phone (503) 771-1112 ext. 7846; email: kkaroly@reed.edu

Garry Oak (*Quercus garryana*) is one of the most geographically widespread oak species in North America, and is the only native oak found throughout the Pacific Northwest. We examined genetic variation at maternally-inherited, chloroplast DNA (cpDNA) markers for trees from 37 populations of *Q. garryana* from Oregon, Washington, and British Columbia to identify the genetic relationship among Pacific Northwest populations of this species. Our goal was to determine the current geographic pattern of genetic variation, and to identify the location of Pleistocene refugia for *Q. garryana*. We extracted DNA from leaf tissue and used PCR-RFLP analysis to survey the cpDNA for variable restriction-enzyme cut-sites. Our initial survey of samples from ten populations ranging from s. Oregon to Vancouver Island examined 680 bp of cpDNA and identified two haplotypes (A and B) which were distinguished from each other by four variable restriction-enzyme cut-sites. Genetic comparison of the two *Q. garryana* haplotypes with a cpDNA sample from a close relative (*Q. gambelii*) suggested that the A haplotype is ancestral to the B haplotype. In our full survey of 81 individuals from 37 populations (range: 1 to 5 trees per population), we observed the B haplotype in 12 populations that were restricted to the Willamette Valley, while the A haplotype was found in the remaining 25 populations from throughout the sampled range. For all 29 populations in which multiple trees were sampled, only a single haplotype (either A or B) was observed. We focused on a subsample of the A-haplotype trees from across the geographic range in a second genetic analysis in which we surveyed an additional 540 bp of cpDNA for variation. We did not detect any additional variable cut-sites for samples of the A haplotype, however. Using a phylogeographic (nested-clade) statistical analysis, we found that the geographic distribution of the two haplotypes departed significantly from randomness. We also found statistical support for restricted gene flow as the biological process that has generated the current population genetic structure. An alternate hypothesis would be that the genetic divergence between the two haplotypes reflects ecotypic differentiation, and that natural selection has played a primary a role in shaping the observed population genetic structure. Our observations of genetic variation within the Willamette Valley and restricted gene flow for the B haplotype strongly

suggests that a Pleistocene refugium for *Q. garryana* was located in or near the Willamette Valley. Our review of the pollen fossil-record for the Pacific Northwest is consistent with a Willamette Valley refugium for Garry Oak. Garry Oak communities in the Willamette Valley might therefore be expected to be important genetic reserves for other taxa that may have shared a Pleistocene refugium with *Q. garryana*. The genetic divergence that we observed for Garry Oak populations within the Willamette Valley may also be a factor to consider when restoring Garry Oak communities in the Willamette Valley.

Biographical Information: Lauren Mathewson graduated in 2001 with a BA in Biology from Reed College where she wrote her senior thesis under the supervision of Dr. Keith Karoly. Since graduating she has been working as a researcher in the Molecular and Medical Genetics Department at Oregon Health & Science University.

The Potential Role of Fire in Improving Population Viability in *Delphinium pavonaceum* (Ranunculaceae), an Endangered Prairie Species

Brie-Anne McKernan[1] and Robert J. Meinke[2]
[1,2] Department of Botany & Plant Pathology, Oregon State University, Corvallis, OR 97331-2902; and [2]Oregon Department of Agriculture, Salem, OR 97310-0110
phone: (541) 737-4420; email: mckernb@science.oregonstate.edu

Delphinium pavonaceum Ewan (Peacock larkspur), a rare plant of wetland prairie habitats, is endemic to the Willamette Valley and recognized as Endangered by the state of Oregon (see http://arcweb.sos.state.or.us/rules/OARS_600/OAR_603/603_073.html). Despite the conservation status of this species, the number of extant populations and remaining plants is largely unknown. Moreover, the ecology of the species is poorly documented, including the role fire might play in improving habitat and promoting population vigor. Many remaining populations of *D. pavonaceum* occur on vulnerable roadside sites, but the overwhelming majority of plants grow on W. L. Finley National Wildlife Refuge (FNWR) near Corvallis, Oregon. It is therefore of the utmost importance that the managers of any remaining habitat on public lands be provided with the best information available to facilitate the species' long-term survival. The two objectives for the present study are to (1) understand how fire regimes may influence the density and reproductive vigor of *D. pavonaceum* populations and (2) determine how many historical populations continue to persist. This paper reports the results from the first year of a proposed two-year study.

The wetland prairie managed by FNWR is divided into three prescribed fire units, including units (1) burned eight times between 1991-2000, (2) burned four times between 1991-2000, and (3) left unburned for >20 years. At the time of data collection, units 1 and 2 had last been burned in the fall of 2000, thus the results presented herein represent two-year post burn data. Larkspur populations managed with fire were denser than unburned populations. Although plants in unit 1 produced fewer flowers than plants in both unit 2 and the unburned unit, there were no differences in fruit production or fruit set among burn units. Plants subjected to a fire regime produced less seeds, but of greater mass, than plants in unburned populations. Unit 1 was burned in the fall of 2002, and we plan to repeat the above measurements in 2003. We also plan to estimate the ratio of reproductive to vegetative plants, plant biomass allocations, and associated plants among burn units.

Our 2002 field observations and recent reports filed with the Oregon Natural Heritage Program indicate that 19 of 39 historical populations are extant, and that five roadside populations have been extirpated as recently as 1978. Despite this troubling trend, the number of plants in extant populations appears to have grown dramatically since previous observations. However, it is unknown whether our survey data reflect actual increases in population numbers, which seems counterintuitive considering habitat conditions, or sampling error by previous field workers. Furthermore, the number of plants in *D. pavonaceum* populations is known to fluctuate greatly among years. All sites will be revisited in 2003 to help resolve this issue.

Our work indicates that fruits on the bottom third of *D. pavonaceum* inflorescences produce more seeds of greater mass than fruits on the top two-thirds of the inflorescence. It is therefore recommended that any seeds collected for the restoration of this species be from fruits at the base of the flowering stem.

Biographical Information: Brie-Anne McKernan is a graduate student in the Department of Botany and Plant Pathology at Oregon State University. Advised by Dr. Robert Meinke, she is working to complete her Master's Thesis on the conservation biology of *Delphinium pavonaceum*. Brie-Anne received her Bachelors degree from Hofstra University in New York.

Relationships of Fire and Exotic Species to the Rare Plant *Silene spaldingii* in an Idaho Grassland

Carolyn A. Menke and Patricia S. Muir, Department of Botany and Plant Pathology, Oregon State University Corvallis, OR 97331-2092
email: menkec@science.oregonstate.edu

Spalding's catchfly, *Silene spaldingii,* a threatened perennial forb, occurs at the 14,000-acre TNC/BLM Garden Creek Ranch Preserve in northwest Idaho. Numerous patchy *Silene* populations occur on the northerly slopes of this canyon grassland habitat. The preserve is experiencing significant invasion by several exotic species, including yellow starthistle (*Centaurea solstitialis)*, and cheatgrass (*Bromus tectorum).* Garden Creek has also recently experienced two non-overlapping wildfires, one in summer 2000 and one in summer 2001. We used stratified random sampling in invaded and uninvaded areas to collect data on abiotic environmental variables, plant community composition and gather information about *Silene* population vigor. Our objectives were to: (1) examine changes in the plant communities following fire; (2) determine whether patterns in plant communities or environment relate to site invasion by starthistle and cheatgrass; and (3) evaluate whether fire or starthistle/cheatgrass invasion appear to affect the vigor of *Silene* populations. We found that invaded sites tend to be on flatter slopes, at higher elevations and support more productive plant communities. These characteristics, in turn, may reflect differences in moisture availability, starthistle's light requirements or patterns of historical grazing. We did not detect a detrimental influence of starthistle and cheatgrass on *Silene*, however the weedy patches and *Silene* patches tended to be disjunct (either temporarily or because of competitive exclusion), thus direct interactions between the species were limited. We did not observe substantial changes in the number of adult *Silene* plants per population or substantial flushes of seed germination following fire, however we did find that *Silene* ramets in burned areas were shorter and matured a lower percentage of flowers to seed capsules. This may relate to drier conditions following fire or increased resource uptake by other recovering species within the plant community.

Keywords: rare plants, *Bromus tectorum, Centaurea solstitialis,* grassland fire, invasive species

Biographical Information: Carolyn Menke is from northern CA and completed her undergrad in plant biology at University of California, Davis in 1999. She will be finishing my MS in plant ecology with Pat Muir this winter. She likes fieldwork in beautiful places and has been lucky to work in Australia, the North Cascades, Sierras and Siskiyous, but the Snake River canyon may have been the best yet!

Native Seed Production And Upland Prairie Restoration: Lessons learned at Bonesteele Park, Marion County, Oregon

Susan Morré, Botanist, Marion County Public Works
email: : morres@onid.orst.edu

Beginning in 1999, Marion County began the implementation of a Natural Heritage Parks Program to guide the restoration of pre-European settlement ecosystems in its undeveloped county parks. Bonesteele Park, on Aumsville Highway in the Waldo Hills of Marion County, is a 30 acre upland prairie site that is now entering its fourth year of active restoration. It is comprised of 5 acres of mature Fir/Oregon Oak woodland, and 25 acres of former cropland which is being restored to its former Oak savannah habitat.

The two major challenges for this restoration were controlling invasive non-native plants and finding a source of locally native seed appropriate for the site. Therefore, initial activities centered on these two issues. Thinning of the upper portion of the woodland, prescribed burns, mowing, tilling and herbicide application as well as hand weeding have all helped to significantly reduce the percent of non-native plants on the restoration site. Various site preparation and planting methods were used over a small 2 acre area to determine the most effective approach for the rest of the site. Spraying glyphosate herbicide, tilling, allowing weed seeds to sprout, and a final glyphosate herbicide application was the most successful method for weed control prior to planting. Over 50 pounds of seed was hand-collected in 2001 from remnant native plant sites in and near Marion County. Half of it was planted at the restoration site in October 2001 and half was put into grow-out beds with partners in the nursery industry (Heritage Seedlings, Inc., Mt. Jefferson Farms, Mahonia Vineyards and Nursery, and a local farmer). The 2002 harvest from annuals and early-flowering perennials produced 336 pounds of seed. Many of the native perennial grasses will not produce seed until their second year, and some forbs will not set seed until their third year. Therefore, seed yields in future years should be significantly higher than in the 2002 harvest year. Grasses will be planted in single species swaths to facilitate mechanical harvesting and reduce the cost of seed production, while mixed forbs will be planted perpendicular to the grasses to create a more natural prairie look. Enough seed is now available to finish the planting of the entire 25 acres by fall 2003. Additional seed produced is available for purchase by other agencies and individuals interested in restoration of upland or wet prairie habitat in the mid-Willamette Valley through the website www.nativeseednetwork.org. Restoration is being funded by native seed sales and grants, with active community participation. The site is being used as a learning lab for local colleges and K-12 schools and is scheduled to open to the public in summer 2004.

Biographical Information: Susan Morré moved to Corvallis in February 2001 with her husband and daughter from Austin, Texas. For the past 25 years, she has been involved in native plant garden design and habitat restoration work through her company and in her community. She holds a Botany degree from the University of Texas, and was the CEO

of Botanica Landscapes in Austin. She was the founder and president of the Cuernavaca Conservation Association, a neighborhood association that worked to resolve numerous environmental issues in endangered species habitat. Susan has worked with many volunteer groups to establish and preserve native plant habitats at schools, public parks and on private land. She has been actively involved in hands-on restoration efforts in Oregon since June 2001 as Environmental Specialist/Botanist for Marion County Public Works. Her focus has been on developing a source of locally native seed, upland prairie restoration, roadside revegetation with native plants and efforts to control the spread of noxious weeds on public lands. She is currently a graduate student in the Environmental Sciences program at Oregon State University. She may be reached at morres@onid.orst.edu.

Plant Species at Risk in Oregon: An Evaluation of Bureau Sensitive Species Designations

Mark Mousseaux, Mabel Jankovsky-Jones, and Robin Taylor, The Bureau of Land Management, Medford District, 3040 Biddle Rd., Medford, OR 97504
phone: (541) 618-2232; e-mail: Mark Mousseaux@or.blm.gov

Starting in the early nineteen seventies law-makers and botanists through out the United States worked to determine the best actions to protect and conserve plant species. This included the development of species designations at federal and state levels to prioritize management and protection actions based on species rarity and threats. The Bureau of Land Management species designation policies tier to programs developed by the Oregon Natural Heritage Information Center, and the Oregon Department of Agriculture. Our goal is to summarize the current policy and definitions, and propose ideas that can be used when lists are updated in the future.

Biographical Information: Mark R. Mousseaux, District Botanist, Medford, Oregon, BLM; M.S. Forest Science, University of Idaho; former Forest Botanist, Idaho Panhandle National Forests, Coeur d'Alene, Idaho.
Mabel Jankovsky-Jones, Botany Data Steward, Medford, Oregon BLM; MA Plant Geography, University of Wyoming; former Wetland Ecologist, Idaho Conservation Data Center, Boise, Idaho.
Robin M. Taylor, Botanist, Grants Pass Resource Area, Medford, Oregon, BLM; M.S. Botany, Northern Arizona University; former Botanist National Park Service, Arizona.

Effects of Prescribed Fire, Herbicides, and Seeding of Native Grasses on Sulfur Cinquefoil Infested Rangelands of Northeastern Oregon

Catherine G. Parks, Research Plant Pathologist, Pacific Northwest Research Station, 1401 Gekeler Lane, La Grande OR 97850
phone: (541) 962-6531; email: cparks01@fs.fed.us

Restoration planners are interested in increasing the diversity of native species and building weed resistant plant communities in western rangelands. Fire is an integral part of these rangelands and is important for ecosystem health and function. However, fire also has the potential to promote weed invasion and expansion. Therefore, basic information on plant species and community responses to wildfire and prescribed burning are essential to resource managers to develop management strategies that restore degraded rangelands and enhance wildlife habitat.

Our research seeks to address these science gaps through: Examining the biology and ecology of invasive species, particularly sulfur cinquefoil (Potentilla recta) and smooth brome (Bromus inermus), in response to prescribed burning and rehabilitation treatments.

We seek to develop an adaptive management approach to restore degraded, weed-infested rangelands and improve wildlife habitat (large game winter range). This approach will consist of treatment combinations for long-term control, monitoring, and assessment of invasive species. Our broad objective is to assess the effects of prescribed fire, herbicides, and seeding of native grasses on the abundance and demography (growth, survival, reproduction) of sulfur cinquefoil and smooth brome.

Study sites are in Wenaha Wildlife Area, near Troy Oregon. Two sulfur cinquefoil - dominated dry meadows were selected for the experiment. Both sites were in agricultural production, but have been abandoned in recent years. A split-plot design was used in this study. At each site, three blocks (no burn, fall burn, spring burn) were established in the summer of 2002. All blocks were 60m x 90m except the fall burn block at Turkey Hill (30m x 180m). Each block was divided into six, 30m x 30m plots to determine the effects of two herbicide treatments and seeding with native grasses. Herbicide and fire treatments are being applied and vegetation data is being taken (including intensive measurements of sulfur cinquefoil in nested plots). Native grasses will be seeded in fall 2003.

Results from this study will provide insight on the efficacy of various management strategies for the control of sulfur cinquefoil and the restoration of degraded rangelands in NE Oregon.

Biographical Information: Catherine Parks is a Forest Service researcher who is heading up a new program of work for the Pacific Northwest Research Station dealing with Non Native Invasive Plants on forests and rangeland.

Ecosystem Restoration And Endangered Species Recovery At Humboldt Bay Dunes

Andrea J. Pickart, U.S. Fish and Wildlife Service, 6800 Lanphere Rd., Arcata, CA 95521
phone (707) 822-6378; email: andrea_pickart@fws.gov

Coastal dune restoration at Humboldt Bay began 20 years ago with a small-scale European beachgrass removal experiment at the Lanphere Dunes (then owned and managed by The Nature Conservancy). In the ensuing two decades, this effort has grown into a coordinated, regional, ecosystem level restoration project involving multiple properties, landowners, managers, and other stakeholders. With much left to achieve, the area is still a model of successful collaboration to achieve measurable success in the restoration of rare and threatened communities and endangered species. Regional priorities have been identified, land protection is ongoing, and collaborative efforts at fundraising have been very successful. Successes include the development of a county-sponsored beach and dunes management plan, the formation of an informal collaborative body called the Dunes Forum which is evolving into a decision-making, land management cooperative, and the restoration of hundreds of acres of dune habitats providing habitat for threatened and endangered species. The Lanphere Dunes Unit of Humboldt Bay National Wildlife Refuge, now celebrating 20 years of restoration activity, has received funding in recognition of the refuge system's centennial to complete its objectives. Once completed, this site will serve as a successful model for similar coastal sites.

Biographical Information: Andrea Pickart is the Ecologist for Humboldt Bay National Wildlife Refuge. She has worked for 17 years in dune and wetland restoration and plant ecology, and is coauthor of a book on dune restoration.

Three Decades of Growing Native Plants for Public Lands of the Western States

Wayne Rolle, Rogue River National Forest, P.O. Box 520, Medford, OR 97520
phone: (541) 858-2274; email: wrolle@fs.fed.us

Since the late 1970's, J. Herbert Stone Nursery has been a supplier of native plants for reforestation and restoration of public lands. One of 6 Forest Service Nurseries nationwide and the only Forest Service Nursery in the Northwest, the nursery has produced over 350 million seedlings, including, wetland and riparian species, rangeland grasses, forbs and shrubs, forestland trees and shrubs.
The nursery has also been a pioneer in the production native grass and forb seed since the early 1990's. Last summer we harvested just over 38,000 pounds of grass seed from source identified seed. We grow around 60 species of grasses and forb for seed production, representing over 160 seed lots.
The staff at J. Herbert Stone Nursery is available to answer questions on restoring or reforesting with native species. We can be reached at 541-858-6100.

Biographical Information: Wayne Rolle is the Rogue River National Forest botanist. He is also a technical specialist for growing native grass and forb seed crops at J. Herbert Stone Forest Service Nursery. He earned a B.S. in general studies with an emphasis in Science/Math from Southern Oregon State College in 1985. Mr. Rolle worked in agriculture, forestry, and botanical contracting before joining the Forest Service in 1988.

Management and Restoration of Native Hardwood Stands on the Umatilla National Forest in northeastern Oregon and Southeastern Washington

Diane Shirley and Kathy Campbell, USDA Forest Service, Umatilla National Forest, 2517 S.W. Hailey Avenue, Pendleton, OR 97801
phone: (541) 427-5315; email: dshirley@fs.fed.us / phone: (509) 522-6060; email: kcampbell02@fs.fed.us

Over 500 small hardwood (quaking aspen and black cottonwood) stands have been inventoried on the Umatilla National Forest. Many of these stands consist of over mature trees that are in a rapid state of decline as a result of fire exclusion, conifer encroachment, and insect and disease pressures. Regeneration from seed or vegetative sprouting is often lacking, or is suppressed by heavy browsing by both domestic livestock and wild ungulates. Stands appear to have been historically much larger; containing both mature overstory trees and younger replacement stands representing a variety of age classes. Without active management, it is estimated that 50-75% of the remaining stands and hardwood habitat will be lost within the next 10-20 years.

Hardwood plant communities fulfill habitat needs for a broad array of wildlife and bird species. Aspen and cottonwood stands provide forage for wild ungulates, cavity nesting for both primary and secondary cavity nesters, cover and forage for upland game birds, as well as habitat and cover for many small mammals such as snowshoe hares, porcupine, and beavers. In addition, hardwood stands benefit streams, as well as the fish occupying those streams, by providing shade and increasing nutrients into streams through leaf fall.

Current surveys of stands across the forest show evidence that there were once large, contiguous hardwood corridors. A landscape approach to restoring these rapidly declining aspen stands is being implemented using the following strategies:

1. *Reduce grazing pressure:* Many stands are protected using buck and pole fences constructed of lodgepole pine and western larch from local sources. These fences protect aspen and cottonwood regeneration from browse damage from livestock, deer, and elk while permitting access to small mammals and birds. It is imperative to protect some portion of the stand so that it may continue to reproduce, grow and feed the root system. Fencing has provided an immediate, and often remarkable response, in growth and resurgence of aspen and cottonwood.
2. *Planting containerized seedlings:* To supplement natural regeneration of aspen on the North Fork John Day Ranger District, root segments are excavated from existing aspen stands and sent to J. Herbert Stone Nursery for culturing. These segments yield hundreds of containerized aspen starts for planting between existing aspen stands and to fill in unoccupied areas of existing enclosures. These areas are then protected from browsing until sufficient growth is obtained. Efforts to increase cottonwood representation across the forest have included plantings of cottonwoods and other hardwood shrub species along stream corridors such as Granite and Clear Creek on the North Fork John Day Ranger District and Jarboe Creek on the Walla Walla Ranger District.
3. *Reduce competition by encroaching conifers:* Silvicultural treatments are used to encourage different age classes. Some stands are maintained in a heavily stocked, sapling stage to provide cover for elk calving and rearing of young grouse. Carefully planned thinning of other stands will assist young aspen and cottonwood to move more quickly into larger diameter classes, providing cover, release from browse damage, and homes for cavity nesters. To reduce competition by encroaching conifers, all conifer trees from within and immediately surrounding the hardwood stands are felled. Most downed trees are cut and left in place to allow more growing space, light, water, and nutrients for aspen and cottonwood to promote natural regeneration. Conifer removal also increases water retention and raises the water table in areas surrounding hardwood stands and nearby meadows.

Biographical Information: Diane Shirley grew up in Michigan where she received a Bachelor's degree in Forestry from Michigan State University. She continued her education at the University of Washington, receiving a Master of Science degree in Forest Genetics and Silviculture. She practiced Forestry in Montana, Washington and Australia before settling in northeast Oregon. She is currently a Reforestation Technician on the North Fork John Day Ranger District of the Umatilla National Forest. **Kathy Campbell** began her career with the Forest Service in 1978 on the Angeles National Forest in California. She has worked on the Umatilla National Forest since 1983, including a six-year detail to the Interior Columbia Basin Ecosystem Management Project. She currently manages the Hardwood Restoration Program on the Walla Walla Ranger District. She holds a Bachelor's degree in Communications from Walla Walla College and an Associate's degree in Natural Science from Citrus College.

Sagebrush Restoration Projects in the Northern Great Basin

Nora Taylor, Burns District, Bureau of Land Management, 28910 Highway 20 West, Hines, OR 97738
email: nora_taylor@or.blm.gov

Big sagebrush communities in the Burns District have declined in condition and health from historical levels for a variety of reasons, including but not limited to, lack of fire leading to catastrophic fires, conversion to cheatgrass, overgrazing, and juniper encroachment.

The Burns District, Bureau of Land Management has implemented several techniques to improve the condition of big sagebrush communities in southeast Oregon. Cutting and prescribed fire have been used to reduce western juniper competition with understory shrubs and herbaceous plants. Brush beating has been used to vary the age classes of decadent Wyoming big sagebrush and increase vigor of understory species. A combination of disking, seeding and snow fencing is being used to establish Wyoming big sagebrush in cheatgrass dominated sites.

Seeds of several native forb species have been collected in the vicinity of the cheatgrass dominated sites and provided to Forest Service and BLM nurseries for seed increase. The nursery grown seeds will be planted in the snow fence/seeding areas to reestablish forbs in cheatgrass dominated areas.

Biographical Information: Nora Taylor has been a botanist and rangeland management specialist with the Burns District for 21 years.

Recovery Efforts for Golden Paintbrush (*Castilleja levisecta*)

Ted Thomas, U.S. Fish and Wildlife Service, 510 Desmond Drive, Lacey, WA 98503
phone: (360) 753-4327; email: ted_thomas@fws.gov
Florence Caplow, Washington Department of Natural Resources, 1111 Washington St SE, Olympia, WA 98504
Peter Dunwiddie, The Nature Conservancy, 217 Pine St., Suite 1100, Seattle, WA 98101
Scott Pearson, Washington Department of Natural Resources, 1111 Washington St SE, Olympia, WA 98504

Castilleja levisecta was federally listed as a threatened species in 1997. Historically, the species occupied prairies and coastal grasslands throughout the Puget Sound and the Willamette Valley. It is now known from 12 sites in Washington and British Columbia. Listing the species has generated considerable interest in efforts to recover the species. Even prior to the recovery plan being finalized in 2000, several planning and restoration efforts were undertaken to enhance the species' habitat. Since completing the recovery plan, the U.S. Fish and Wildlife Service (FWS) has partnered with more than a dozen agencies (County, State and Federal), non-governmental organizations, universities, and countless local volunteers to accomplish recovery tasks. The ultimate goal of these efforts is to remove *Castilleja levisecta* from the endangered species list. To date, management plans for six protected populations have been completed. A draft reintroduction plan is available for review. New lands containing *Castilleja levisecta* have been acquired and others are under consideration for acquisition. Populations have been monitored and counted annually. Research projects have been initiated on soil properties, host plant requirements, ecological and reproductive processes, and the effect of various restoration treatments on germination and growth. Finally, genetic analysis was completed in December 2002 that will be used to determine appropriate seed sources for introduction and reintroduction of the species into its former range in southwestern Washington and the Willamette Valley, Oregon. Additional research is needed on pollination, insects and diseases, and herbivory.

Early restoration activities concentrated on the only mainland prairie population of *Castilleja levisecta* at Rocky Prairie, a Washington Department of Natural Resources (WDNR) Natural Area Preserve in southern Thurston County, Washington. During the mid-1980s, restoration at Rocky Prairie was a grassroots effort organized by the Nature Conservancy (TNC) and volunteers, with the primary focus on removing Scot's broom (*Cytisus scoparius*). FWS, WDNR, and The Nature Conservancy (TNC) subsequently partnered to generate funds to continue management of the site. More than 300 conifers were harvested and removed from the site by helicopter, which created approximately 10 acres of additional habitat for the species. Other management activities included mechanical and chemical treatment of invasive, native and nonnative forbs (*Hieracium pilosella)*, and woody shrubs, mowing, prescribed burning, and the planting of >40,000 Roemer's fescue and grassland associated forbs. Since 2000, recovery activities expanded to *Castilleja* populations on Whidbey Island and on San Juan Island. The only effort to create a new *Castilleja* population was conducted at Ebey's Bluff on Whidbey Island where TNC and volunteers planted more than 1,100 seedlings, in two stages, using seed originating from a local source population, less than 1 mile away. Approximately 90% of these seedlings survived the first year suggesting that this may be a successful method for establishing new *Castilleja* populations. As a result of these efforts, we can now see this beautiful and rare species in places where it was absent for more than 60 years. Conservation, protection, and restoration efforts for *Castilleja levisecta* are examples of the recovery plan at work and could only have been accomplished through coordinated efforts of numerous partners and committed volunteers.

Biographical Information: Ted Thomas is an Ecologist for the U.S. Fish and Wildlife Service. He holds a M.S. in Forest Science from Oregon State University. Ted has been involved in research, management and regulation of Natural Resources for more than 2 decades. During the past decade he has focused on the assessment, protection and recovery of threatened and endangered species.

Hidden Flora: Mycorrhizal Fungi and Garry Oaks (*Quercus garryana*)

Lori Valentine, Carolyn Petersen, Heather Tugaw, Aaron Hart, Harold Berninghausen, and Darlene Southworth; Department of Biology, Southern Oregon University, Ashland, OR 97520
email: southworth@sou.edu

Oaks do not live alone. Although the plant associations in which they occur are visible above ground, another invisible association lies below ground: mycorrhizal fungi associated with oak roots. All oaks are associated with mycorrhizal fungi. Some of these fungi form sporocarps—fruiting bodies such as mushrooms or cup fungi— but most mycorrhizal fungi do not appear above ground or do so rarely. Mycorrhizal communities associated with non-timber genera, such as *Quercus,* have received little attention. Here we address the question of the diversity of mycorrhizal fungi associated with *Quercus garryana* (Oregon Oak or Garry oak).

Mycorrhizae are literally "fungus-roots" composed of tree root tissue plus fungal tissue. They develop as the fungus and root grow together forming shorter, more branched structures than roots without fungi. Ectomycorrrhizae, the most common type of mycorrhizae on oaks, have a mantle and Hartig net. The mantle, a layer of fungal tissue covering

the surface of the root tip, may have hyphae that extend into the soil. The Hartig net is a meshwork of fungal hyphae that penetrate the root and surround individual cortical cells. The Hartig net interface between fungal cells and root cortical cells is the site of nutrient exchange between tree and fungus. Mycorrhizal fungi take up water and minerals from soil and transfer them to the tree that, in turn, gives carbohydrates to the fungi.

We investigated the diversity of ectomycorrhizal fungi associated with *Quercus garryana* at Whetstone Savanna Preserve in southwest Oregon. The primary method used for analyzing diversity was morphotyping—describing the mycorrhizae by a set of standard definitions. In addition molecular techniques were used to validate the distinctions among morphotypes, to compare mycorrhizal root tips to fungal fruiting bodies for purposes of identification, and to sequence portions of fungal DNA to identify mycorrhizal fungi through the use of DNA databases.

Thirty-six ectomycorrhizal morphotypes were described and entered into a database. Five ectomycorrhizal morphotypes were found in 5% or more of soil samples. *Cenococcum geophilum,* the most abundant morphotype, was found in 75% of soil cores. Uncommon morphotypes were responsible for the majority of ectomycorrhizal diversity on *Q. garryana*. Our species/area curve indicates that increases in sample size would not yield proportional increases in ectomycorrhizal morphotypes. We compared morphotypes on seedlings with those of the mature tree above them. The Sorenson index of similarity was 0.44-0.50 with 1-2 shared morphotypes between seedlings and mature tree.

We now have baseline data to use in categorizing the below-ground mycorrhizal community in habitats of varying degrees of degradation. Also we can determine which of the mycorrhizal fungi might be involved in common mycorrhizal networks that link trees in a nutrient sharing assembly.

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Isozyme Variation In *Elymus glaucus:* Implications For Restoration

Barbara L. Wilson[1], Jay Kitzmiller, Wayne Rolle, and Valerie D. Hipkins[2].
[1]Barbara Wilson: Institute for Applied Ecology, 227 SW 6th St., Corvallis, OR 97333
phone (541) 753-3099; email: wilsonba@msn.com
[2]Valerie Hipkins: National Forest Genetic electrophoresis Laboratory, USDA Forest Service –NFGEL, 2480 Carson Road, Placerville, CA 95667
phone: (530) 622-1609; email: vhipkins@fs.fed.us.

Genetic variation in the self-fertile grass *Elymus glaucus* was assessed using isozymes in 115 populations from southwestern Oregon and 18 from central California. *Elymus glaucus* was highly (98.5%) homozygous but also highly variable; 77% of loci were polymorphic, and the mean number of alleles per locus was 2.96. As expected in a selfing plant, populations were highly differentiated, with 40% of variation among populations. Geographic and genetic distances among populations were not correlated, except that populations collected within 5 km were often more similar than average. Genetic distance among populations could not be predicted from geographic distance, geographic location, foliage pubescence, serpentine substrate, or habitat moisture. However, two genetic clusters did emerge, related to elevation (below or above 1500 meters). The taxonomic status of *E. glaucus* ssp. *jepsonii* (Burtt Davy) Gould, as defined by leaf pubescence, was not supported. This isozyme analysis suggests that *E. glaucus* seed from low and mid elevations can be transferred widely within the region sampled, but that seed should not be moved between low and high elevation sites.

Biographical Information: Barbara Wilson is a geneticist/taxonomist at the Institute for Applied Ecology, Corvallis, Oregon. She has worked on taxonomy and biogeography of grasses and sedges, and conservation genetics of native species.

The Effect of Spatial Arrangement and Diversity on the Biomass of Five Willamette Valley Prairie Species

Catherine Worster, 2082 Cordley Hall, Botany and Plant Pathology Department, Oregon State University, Corvallis, Oregon, 97330
phone: (541) 757-3534; email: worsterc@bcc.orst.edu

Various spatial arrangements can be found within natural grassland plant populations and communities. Theory and observation suggest that the spatial arrangement of plant diversity may influence the productivity of agricultural and native plant ecosystems due primarily to competitive interactions. However, little is known of the influence varying spatial arrangements have on agricultural or native plants. A biomass experiment allowed for an examination of how native plants are influenced by their spatial arrangement when planted in two-way combinations. The experiment included a series of native Willamette Valley prairie species, California brome (*Bromus carinatus*), tufted hairgrass (*Deschampsia caespitosa*), blue wildrye (*Elymus glaucus*), American vetch (*Vicia americana*), and streamside lupine (*Lupinus rivularis*)

in three different spatial arrangements of combinations of two species within a functional group, and two species of two functional groups (grasses and legumes). The spatial arrangements were alternating single rows, alternating paired rows, and mixed within rows in groups of 12 rows ten feet long at two sites on Willamette Valley sandy/loam soil.
I hypothesized that, if nutrient cycling and escape from competition are influential in natural spatial arrangements, then spatial patterning of the paired combination of the most dissimilar plants—grasses plus legumes—will differ most from their pure stands. In addition, the largest biomass will be found in the alternating paired rows spatial arrangement because this most closely resembles clumping found in natural ecosystems. Results were found in terms of total biomass and also in terms of Land Equivalent Ratio calculated as (yield m^{-2} of cultivar or species A in mixture/yield m^{-2} of cultivar or species A in monoculture) + (yield m^{-2} of cultivar or species B in mixture/yield m^{-2} of cultivar or species B in monoculture). I found that the spatial arrangement is significant only in a few treatments and exhibited no clear trend. The specific species combination had the most consistent influence on aboveground biomass. Overyielding, or a higher biomass yield in combination than pure stand, was observed particularly among plots containing a grass and a legume.

Biographical Information: Kate Worster grew up in Eastern hardwood forests, Pacific tropics, and, most recently, the Great Plains of Kansas, Iowa and Wyoming. She is seeking a Masters of Science at Oregon State University where she has been studying plant ecology. Previous to graduate school she worked for The Land Institute, an agricultural research and education organization in Salina, Kansas and The Nature Conservancy at the Tensleep Preserve in the Bighorn Mountains of Wyoming.

Tissue Culture Propagation of *Hackelia venusta* (Piper) St. John (Boraginaceae), an Endangered Species on Federal Land

Laura Zybas, University of Washington Rare Plant Care and Conservation Program, Box 354115 Seattle, WA 98195
phone: (206) 616-0780; email: lzybas@u.washington.edu
Gregory Peterson, PhD, UW Rare Plant Care and Conservation Program, Box 354115 Seattle, WA 98195
email: gregoryp@earthlink.net

Hackelia venusta was designated as an Endangered Species under the Federal Endangered Species Act on March 8, 2002. This designation came nearly 20 years following a severe decline in the one known population in the Cascade Range of Washington. Approximately 500 plants are found entirely on USDA Forest Service land of less than one hectare of steep, unstable, granite scree.

Threats to *H. venusta* include collection, human disturbance, competition and shading from native trees and shrubs, noxious weed invasion, and low seedling establishment. *H. venusta* has a history of low seed production. In 1984 it was observed that 60% to 70% of the fruits did not develop.

Because of the shortage of available seed, micropropagation techniques were developed by John L. Edson et al. at the University of Idaho and published in 1996.

Anticipating the future listing of *H. venusta*, the Rare Plant Care and Conservation Program began culturing the plant in 1999. We have since produced clones for experimentation and future reintroduction efforts.

Biographical Information: Laura Zybas is the Program Manager for the Rare Plant Care and Conservation Program at the University of Washington. She received her Master's degree in Horticulture 2000. **Greg Peterson** volunteers his time for Rare Care. He received his PhD from Texas A&M University in plant breeding and plant physiology in 1990.