



Figure 1. In 1994, Mount Rainier National Park constructed a “coldframe” to serve several purposes. Its primary function is to provide growing space to “harden off” recent transplants (established in the greenhouse) before moving them outdoors to the lathe house. During winter the space is used for stratifying seeds, mixing media, and washing pots. This spring recently potted heathers (2-3 years old) will be moved here.

The propagation of three greenhouse programs in the Pacific Northwest

By REGINA M. ROCHEFORT, MATT ALBRIGHT, AND PAT MILLIREN

Restoration of human impacts has been an integral part of park management in the Pacific Northwest for over 50 years. Photographs from the archives of Mount Rainier National Park (Washington) illustrate revegetation of damaged areas in the subalpine life zone as early as 1930. In the 1970s, backcountry hiking reached record highs in Olympic and Mount Rainier National Parks, creating the need for many of our current restoration projects.

Small beginnings

In 1970, park volunteers Joe and Margaret Miller began a project in North Cascades National Park (Washington) that provided the catalyst for the complex restoration programs that now exist in North Cascades, Olympic, and Mount Rainier National Parks. The Millers showed that greenhouse propagation of high-elevation, native plants was possible and greenhouse transplants would survive in subalpine environments. In 1989, a regional revegetation committee was established. This committee provides a forum for discussion of field restoration and greenhouse methods. Although the committee meets infrequently, restoration specialists in the three parks talk frequently and try to meet at least once a year.

Currently, all three parks have restoration programs that use both greenhouse plants and on-site techniques such as seeding, layering, and transplanting. Greenhouses in each park were funded by different sources and have different staffing levels. Restoration personnel collaborate on development of greenhouse techniques, monitoring systems, and field guidelines for collection of plant materials. Each park has different specialties: North Cascades opened the door to greenhouse propagation of native species; Olympic made high-volume production of native heathers commonplace; Mount Rainier focused on plant collection guidelines and diversity in species production. Recently, we have collaborated on a Challenge Cost Share project with Dr. Yan Linart of the University of Colorado. The goal of the project is to develop plant collection guidelines that protect genetic diversity of native species. Field research was conducted on two species common to each park: *Aster alpigenus* and *Carex spectabilis*. Our intent is to develop guidelines that can be extended to other species with similar life history characteristics. Although the mainstay of each program has been high-elevation species, we are all venturing to lower-elevations species. Our reason for writing this article is to let others know the many different routes we have used to fund our programs and continue to manage

them. We welcome questions, discussions, or suggestions from others contemplating or managing greenhouse programs.

Complex of North Cascades parks

In 1969, soon after the park was established, Superintendent Roger Contor recognized the problem of existing vegetation damage and the potential for increased damage at subalpine passes within the complex (North Cascades National Park and Ross Lake and Lake Chelan National Recreation Areas). Camping and climbing impacts were apparent at Cascade Pass, which was also an ancient trail used by native people traveling to the “east side” of the state. Other passes would become more vulnerable as State Route 20 was completed providing a route to the east side. In 1969, the superintendent hired Professor Dale Thornburgh, Humboldt State University, to survey bareground impacts at several passes and make restoration recommendations to the park (Thornburgh 1970). Subsequently, longtime park advocates Joe and Margaret Miller volunteered to begin on-site rehabilitation experiments at Cascade Pass. After spending a couple of summers in the field, the Millers started propagating native plants in their home greenhouse. By 1975, they convinced the park to build a small cold frame (48 sq ft).

See “Northwest” on page 18

In 1976, Park Ranger Bill Lester, with the Miller's help and labor from the Young Adult Conservation Corps built the park's first small greenhouse (800 sq ft) in the town of Marblemount. Lester and numerous Native Plant Society and other volunteers donated many hours of greenhouse propagation time in addition to field planting time in an effort to restore the documented im-

funds. The funds are set aside for erosion control projects around Ross Lake NRA.

Currently, the North Cascades revegetation program is supported by a ranger (Pat Milliren) in the wilderness district. Pat's position is a nine-month subject-to-furlough position; she supervises the greenhouse/wilderness revegetation program. A 12-week Student Conservation Association (SCA) volunteer position is dedicated to the program, and critical assistance is received

from Washington Native Plant Society, the Mountaineers organization, and other volunteers. Most plants are grown for impacted sites in the

dent Robert Dunnagan stated that one of their goals was a park-wide restoration program that included an active greenhouse propagation program. With advice from the North Cascades staff, the greenhouse program was initiated in 1984 with production of 2,700 plants in 1985.

Over the past 12 years, greenhouse staffing, budget, and structures have slowly increased. Our first expansion was to obtain an SCA to staff the greenhouse for 12 weeks each summer. Gradually, shade houses and small coldframes were built with leftover PVC pipes, lumber, and pallets from other projects. We built lathe houses to protect and harden-off plants during the summer before they were transplanted in restoration sites. Plant production increased each year until 1988 when 10,000 plants were



Figure 2 (above). Affording some protection from the elements, the Mount Rainier lathe house exposes seedlings to colder temperatures than they experienced in either the greenhouse or the cold frame. Plants thus accumulate carbohydrates (i.e., "harden off") and become better able to withstand adverse environmental conditions.

Figure 3 (right). A donation enabled Mount Rainier to build this 18,000 sq. ft. greenhouse in 1995. Native plants make their start in this temperature controlled facility, which also includes plumbing and benches.



pacts at Cascade Pass and other backcountry sites. Around 1990, Lester was able to supplement the greenhouse budget by obtaining a contract to grow low-elevation native plants for landscaping the site of the park's new visitor center in Newhalem.

In 1990, Lester and Resource Management Specialist Jon Jarvis obtained an NRPP (Natural Resources Preservation Program) grant to build a larger, more modern greenhouse for propagation. The new greenhouse is adjacent to the ranger station/wilderness information center so that visitors seeking information and backcountry permits can see the greenhouse and learn about the restoration program. The new greenhouse was dedicated to the Millers in 1993. It encompasses 1,728 sq ft and cost \$62,000 to construct; construction of outdoor beds, work areas, and shaded space was completed in 1998 with financial support from Seattle City Light mitigation

subalpine zone (5,000-6,500 ft elevation). Annual greenhouse production rates are currently 1,000 plants per year. Species grown include woody heather shrubs (*Phyllodoce empetriformis*, *P. glanduliflora*, *Cassiope mertensiana*), grasses, and sedges (*Carex* sp., *Phleum alpinum*, *Trisetum*), and herbs (*Antennaria* sp. and *Potentilla*). While wilderness restoration focuses on subalpine sites, the greenhouse will continue to produce plants for lower elevation sites for specific projects in developed zones.

Mount Rainier National Park

Mount Rainier's greenhouse program began in 1972 with the construction of a 240 sq. ft. greenhouse at park headquarters in Ashford (about 1,500 ft elevation). This greenhouse was used only sporadically until the park established a botanist position in 1984. When the first author of this article arrived at Mount Rainier, Superintendent William Briggles and Assistant Superinten-

produced. In 1990, production increased to 16,000 plants when funding was available to support a year-round seasonal biological technician (Davis 1991; Rochefort and Gibbons 1992). In 1994, a 20 ft x 48 ft coldframe (fig. 1, page 17; cost \$2,000) was constructed for propagation of heathers (*Phyllodoce glanduliflora*, *P. empetriformis*, and *Cassiope mertensiana*) and other shrubs that required two years in the greenhouse. The lathe house (fig. 2) was slowly expanded to cover 3,456 sq ft. In 1993, funding allowed for a permanent horticulturist position (GS-437-07) through the servicewide resource professionalism initiative. Ann Bell was the park's first horticulturist, and under her direction plant production increased from 20,000 plants in 1994 to 40,000 plants in 1996. Additionally, we received a private donation for \$17,000 that the park was able to match to build an 18,000 sq. ft. greenhouse (fig. 3) in 1995 (total cost \$38,000

for materials and construction including benches, electricity, and plumbing).

Currently, Mount Rainier grows about 20 species each year from a palette of about 50 plant species including shrubs such as heathers and huckleberry (*Vaccinium deliciosum*), sedges (*Carex* spp.), grasses, and flowers (e.g., *Aster* spp., *Potentilla flabellifolia*, *Erigeron peregrinus*). Most of our restoration sites are in subalpine areas at elevations of 5,000-7,200 ft where we use species that are easily grown from seed or soft wood cuttings. Recently, we have started growing plants for restoration projects in the low-elevation developed zone; project funding covers propagation costs of \$1-\$3 per plant. The annual budget for the greenhouse fluctuates with funding levels between \$6,000 and \$15,000 (park base) in addition to the horticulturist's salary. The greenhouse staff includes one SCA, volunteers, and often a GS-05 seasonal biological technician. Most of our seeds for greenhouse propagation are collected by volunteers from the Olympia Native Plant Society. With the construction of a new greenhouse, we have increased annual production to 70,000 plants and developed a cadre of greenhouse volunteers under the direction of Horticulturist David Palumbo.

Olympic National Park

Backcountry revegetation for the restoration of eroded and trampled sites in wilderness is not new to Olympic National Park. Through the late 1970s and early 1980s revegetation was carried out at a number of popular wilderness camping areas throughout the park. In those days we used local transplants for spot planting in impacted areas to restore local plant communities. Although current projects rely more on greenhouse plants than local transplants, revegetation with plant material collected at the site has always been an important component of Olympic's restoration program.

During 1987, the park constructed a greenhouse for the production of road-edge plants for a federal highways project along the Sol Duc road. This began a new approach in restoration at the park concurrent with greenhouse propagation programs at North Cascades and Mount Rainier National Parks. Seedlings and rooted cuttings were propagated from plant material collected from precisely defined plant communities occurring along the Sol Duc road corridor. This program enhanced

existing contracts with private growers and seed programs with the former Soil Conservation Service (now the Natural Resource Conservation Service). The greenhouse is 20 ft x 40 ft and was constructed by park carpenters during the winter. Total cost for the greenhouse is estimated at \$22,000-\$25,000; \$13,000 for materials and the remainder for labor by park carpenters. Funding was provided by park base and project funding. The success of the Sol Duc restoration program demonstrated that the park greenhouse could provide the quantity of transplants needed for large-scale revegetation projects.

In 1988, with the completion of the Sol Duc Road project, Ruth Scott, Wilderness Resource Specialist, adopted the park greenhouse facility to reestablish a wilderness restoration program in montane and subalpine areas of the park. Beginning with easy-to-propagate species such as sedges, grasses, and forbs, greenhouse manager Matt Albright then expanded the program to include the more difficult to propagate ericaceous shrubs. After initial experimentation with two subalpine heathers, *Phyllodoce empetrifolia* and *Cassiope mertensiana*, production methods from cuttings and seeds were developed for a number of highcountry ericads. Since 1991, these ericad species have comprised an increasingly large proportion of greenhouse plant production.

For several years, the greenhouse staff has maintained an annual production level of 20,000-30,000 transplants of a wide range of species including ericads, subalpine shrubs, trees, forbs, grasses, and sedges. With the initiation of the Sand Point Restoration Project along the park's wilderness coast, the greenhouse has started producing low-elevation coastal species. In the fall of 1996, 14,000 starts of lowland shrubs, sedges, and grasses were planted in the Pacific maritime spruce forest. An additional 35,000 transplants were propagated for spring and fall planting in 1997. The greenhouse is maintained by one permanent, subject-to-furlough horticulturist and one half-time employee assisted by a cadre of local and seasonal volunteers. The staff follows an annual cycle of fall cutting propagation, winter seed processing and sowing, spring and summer transplanting and fall out-planting. The single most expensive and labor intensive task in the revegetation is packing thousands of potted plants and providing for their transport to backcoun-

try destinations via helicopter. In addition to base funds, the wilderness restoration program has been supported by grant funds such as the Canon USA-National Park Foundation "Expedition into the Parks" conservation program and the Washington State Nonhighway Off-road Vehicle Access Program, and volunteers from organizations such as the local Sierra Club Service and Wilderness Volunteers.

Summary

Greenhouse propagation of native plants has been an important and integral part of restoration programs at Mount Rainier, North Cascades, and Olympic National Parks for over a decade. Due to the number and magnitude of human impacts in our wilderness and natural areas and our short growing seasons greenhouse propagation is a necessity for effective revegetation of denuded sites. Although our programs have many similarities, funding sources, staffing, and production levels vary among programs and between years. We would like to offer our assistance and experience to anyone trying to start a greenhouse propagation program. **P**

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Regina M. Rocheft is currently Science Advisor at North Cascades National Park Service Complex and can be reached at 360-856-5700, ext. 254; regina_rocheft@nps.gov. Her former position was Botanist at Mount Rainier National Park where she was responsible for managing the park restoration program.

Matt Albright is the Greenhouse Manager at Olympic National Park. He can be reached at 360-452-4501, ext. 286; OLYM_revveg_crew@nps.gov.

Pat Milliren is a Park Ranger responsible for greenhouse management at North Cascades National Park complex. She can be reached at 360-873-4590, ext. 36; pat_milliren@nps.gov.