

Weed Control and Revegetation Alternatives

for Whitman Mission National Historic Site

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NATIONAL PARK SERVICE

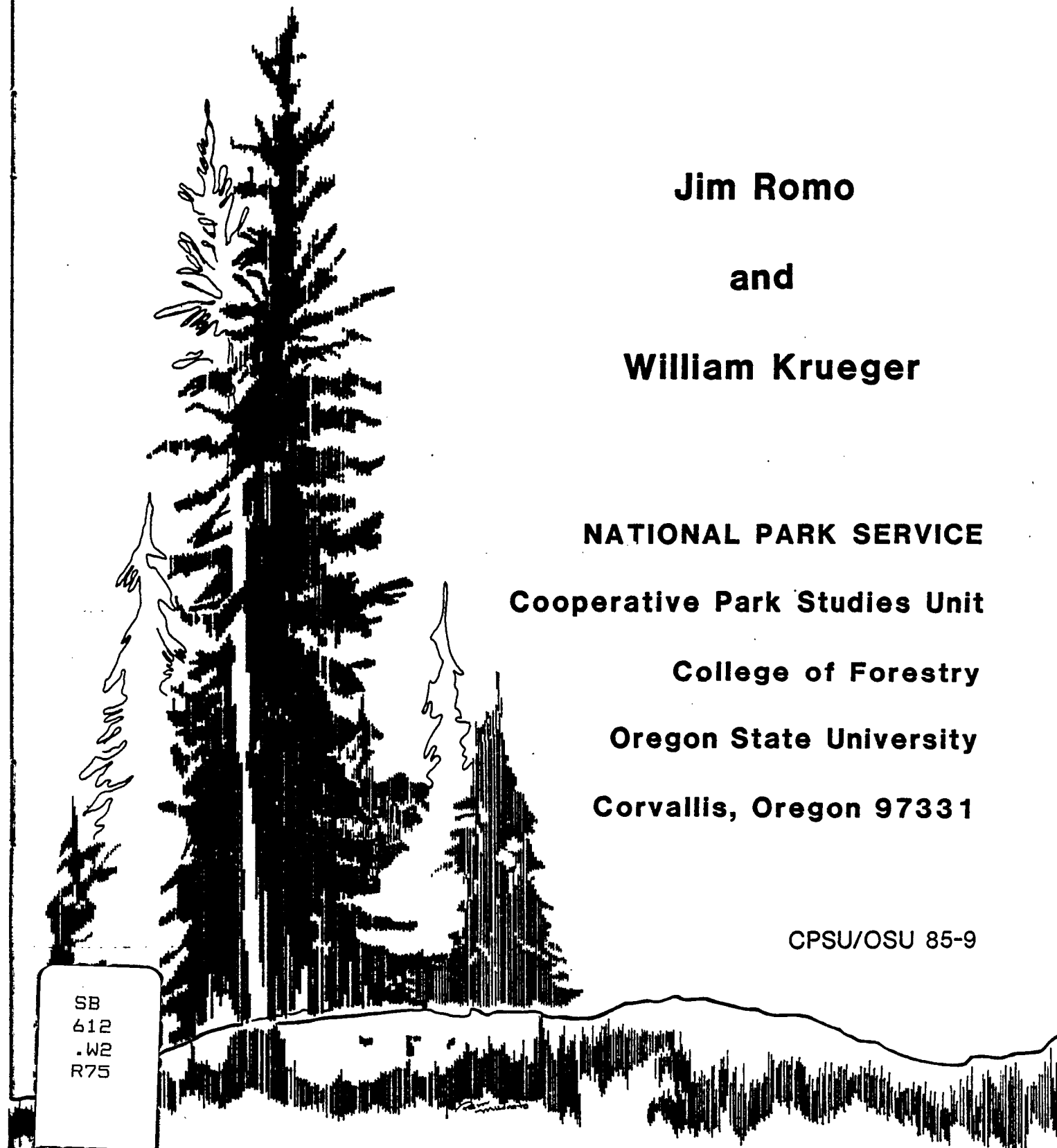
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WEED CONTROL AND REVEGETATION ALTERNATIVES
FOR WHITMAN MISSION NATIONAL HISTORIC SITE

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INTRODUCTION

Whitman Mission National Historic Site (WMNHS), located approximately 7 miles west of Walla Walla, Washington lies in the Palouse Prairie. Although we will never know the exact nature of the native vegetation on the historic mission, it is possible to predict what native vegetation was by comparing the vegetation of areas possessing similar climate, soils, and topography. With approximately 150 years of heavy grazing, indiscriminate use of fire, cultivation, and introduction of exotic plants, very little of the vegetation on the Park approximates its native state. Presently the land supports a mixture of introduced annual, biennial, and perennial weeds with scattered native perennial bunchgrasses, forbs, and shrubs.

Daubenmire (1970) studied many stands of Palouse Prairie vegetation in close proximity to Whitman Mission. Many of the stands were assumed to represent near pristine conditions. Fortunately Daubenmire also recorded soil series and topographic position of the stands he studied. Vegetation at WMNHS was probably dominated by the basin wildrye-saltgrass (1) association and the bluebunch wheatgrass-native bluegrass association (Daubenmire 1970). Basin wildrye was probably most widespread and present on the bottomland sites at the Mission. Bluebunch wheatgrass and native bluegrass were probably common on the Hill and the higher non-saline and non-alkaline terraces.

It must be emphasized that introduced weeds are a permanent component of the flora of WMNHS. Even in Palouse Prairie that is assumed to represent near pristine conditions, introduced weeds have been absorbed and they successfully spread and regenerate. If at any time disturbance opens available sites in perennial plant communities, introduced weeds rapidly invade, or increase and dominate.

The presence of introduced plant species in the Palouse Prairie has altered plant succession to a point that native species are prevented from regenerating or they are very slow to reestablish after disturbance. If native vegetation is severely depleted, such as at WMNHS, the natural seed source is often insufficient to insure recruitment of new plants, therefore artificial seeding is necessary. Many introduced weeds are competitively superior to indigenous species by virtue of their ability to exploit resources, primarily water, in time and space. The result is perpetuation of plant assemblages that are closed to natural establishment of native perennial species.

(1) Scientific names of plants are presented in Table 1.

The timing and intensity of precipitation limits establishment of many perennial grasses on semiarid rangelands. Soil moisture is closely related to weed densities and it is the most important resource to manage when attempting to replace introduced weedy species and establish perennial grasses. Any revegetation attempts should include an aggressive approach to reduce weed populations by using fire, mechanical treatments, biological control, chemical control, or combination of these treatments. Once perennial vegetation is reestablished, the land manager is challenged to manage perennial vegetation in a manner that puts weedy species at a competitive disadvantage. The easiest and most cost effective management alternative available for limiting success of weedy species is to maintain vigorous perennial vegetation. If at any time, the vigor of perennial vegetation is severely reduced or voids in the community are enlarged, introduced species will increase and preclude establishment of most native perennial bunchgrasses.

WEED SPECIES AND ALTERNATIVE METHODS FOR CONTROL

The following is a list of the most serious and common weed species and alternatives for controlling them on WMNHS. In all cases if the species is annual or biennial, the objective of the weed control method is to prevent seed production. If reproduction of annuals and biennials is suppressed, the population will eventually be reduced through attrition of seed reserves. Perennial weeds are more difficult to control than annuals, thus long-term control plans must be implemented. Perennial weeds should be controlled with herbicide application and maintenance of vigor in competitive perennial grasses. When herbicides are recommended, read and follow label directions, and consult state regulations governing the use of herbicides.

QUACKGRASS--Quackgrass, an aggressive perennial, reproduces by seeds and rhizomes. It occupies the more fertile and mesic sites at WMNHS. Seedlings of seeded perennial grasses will have difficulty establishing unless quackgrass densities are reduced before seeding.

1. Mechanical control--Repeated disking of quackgrass during hot dry conditions and removing exposed rhizomes can be used for control. This method is effective only if a long term control program is developed. This method is very time consuming and it must be done repeatedly. By using this method, the site will need to be left in fallow for several years. Mechanical control of quackgrass is not recommended at WMNHS.

2. Chemical--Chemical control of quackgrass is the preferred alternative. Roundup (Glyphosate) should be applied at a rate of approximately 3 pounds active ingredient per acre when quackgrass is in the boot stage or flowering. Good control can be achieved with one year of application, but two years of application is recommended to kill plants that survive the first year of application.

3. Fire--Fire is ineffective in controlling quackgrass. Burning quackgrass increases its vigor and stand density.

CHEATGRASS--Cheatgrass, an annual, reproduces by seeds. Reducing seed production by cheatgrass and establishing competitive perennial grasses are required for controlling cheatgrass. Never seed perennial grasses in a stand of cheatgrass in which its densities have not been reduced. If perennial grasses are seeded without controlling cheatgrass their establishment will be very low. Cheatgrass most often germinates in the fall; however, if moisture conditions are not favorable, germination may be delayed until winter or spring.

1. Mechanical control--Cheatgrass can be controlled by repeated disking. To reduce populations to levels in which most perennial grasses can establish, cheatgrass must be disked before seed formation, and again in the fall after rains are received and seedlings have emerged. Two or 3 diskings for a year will usually reduce cheatgrass to densities where seeded perennial grasses can establish. As a general rule, cheatgrass should be reduced to less than 50 plants per square foot to enable establishment of perennial grasses; lower densities of cheatgrass increase the probability of perennial grass establishment.

2. Chemical control--Cheatgrass can be controlled with Atrazine and Roundup. If litter accumulations are high, efficacy of herbicides may be low because litter and standing dead plant material intercepts herbicides and prevents contact with living plants. If herbicides are used, it may be necessary to burn the site and allow seedlings to emerge before spraying. Careful consideration must be given before selecting herbicides. For example, in some areas of WMNHS, some desirable plants remain and it is desirable to retain them if possible. If non-selective herbicides are used, desirable plants may be killed.

A. Atrazine--Atrazine is a non-selective foliar and soil active herbicide; established plants normally are not killed by Atrazine. Atrazine should be applied in the fall before precipitation is received at 0.5 to 1.0 pounds active ingredient per acre. If applied at these rates, residual Atrazine will kill germinating seedlings for up to 12 months. Normally, the levels of Atrazine will be sufficiently low so the site can be seeded the fall after application.

Atrazine can be used to reduce annual grass competition with developing perennial grass seedlings. Atrazine can be applied at 1/2 pound active ingredient per acre the year after seeding if cheatgrass densities exceed approximately 50 plants per square foot. Atrazine should be applied when perennial seedlings have developed beyond the 4 leaf stage.

B. Roundup--Roundup is a non-selective herbicide that is deactivated upon soil contact. Roundup will kill some forbs as well as grasses. Roundup is not recommended for controlling cheatgrass where desirable perennial plants are remaining because they may also be killed. To get best control of cheatgrass with Roundup, it should be applied in the spring or fall at 1 pound active ingredient per acre. Spring application will probably give best results because the largest percentage of the population will have emerged. If applied in the fall, it should be done after considerable precipitation has been received and seedlings have emerged.

3. Fire--Fire is the preferred method for cheatgrass control at WMNHS. Since cheatgrass reproduces by seed, the key to successful control is to burn when seeds are retained on plants to maximize the kill of seeds. Burning must be done when plants have turned red, but before seeds have shattered from inflorescences. When cheatgrass is in the red stage, seeds are sufficiently developed, physiologically, to germinate. If seeds are not destroyed, they can germinate when conditions become favorable. Cheatgrass should be burned during a 2 to 3 week period sometime between late May and late June at WMNHS. A hot and slow fire is necessary; backfires should be used. A hot fire will kill seeds on the plants, reduce litter accumulations, and destroy seeds that are present in the litter. Removal of litter creates temperature and moisture conditions that are less favorable for germination and establishment of cheatgrass. Burning at any other time of the year (when seeds have shattered) is ineffective in controlling cheatgrass. If cheatgrass is burned after seeds have shattered from inflorescences, seed kill will be low and postburn cheatgrass densities will be nearly equal to pre-burn densities.

If cheatgrass is burned when plants are in the red stage, the site should be planted the following fall. When a burn is properly conducted cheatgrass densities will be too low to carry a fire the year after the initial burn. If the site is not seeded the first fall following burning, cheatgrass populations will increase to preburn levels within 2 to 3 years and outcompete seeded species.

DIFFUSE KNAPWEED and YELLOW STAR THISTLE--Diffuse knapweed, an introduced annual or biennial, reproduces by seed. Yellow star thistle is an annual that reproduces by seed. Both species have extended flowering and seed maturation periods. Diffuse knapweed blooms from June through September, seeds mature over the same period and most seeds are retained by the plants and they are shed over an extended period. Yellow star thistle blooms in June through September and seeds shatter rapidly after maturing in late summer. The key to suppressing diffuse knapweed and yellow star thistle after their control is to maintain a vigorous and dense stand of competitive perennial grasses.

1. Mechanical control--Diffuse knapweed and yellow star thistle can be killed by repeated disking. However, because both species develop extremely high seed reserves in the soil and these seeds acquire dormancy, repeated disking will be necessary to kill plants and prevent seed production on plants that emerge after disking. Disking will be required until seed populations are reduced to levels where perennial seedlings can establish; reduction of seed reserves may take 3 to 5 years.

2. Chemical control--Diffuse knapweed and yellow star thistle can be controlled with Tordon 22K (Picloram) or 2,4-D.

A. Tordon 22K (Picloram)--Tordon 22K is the preferred method for controlling diffuse knapweed and yellow star thistle. Tordon 22K kills broadleaf plants and many grass seedlings with fewer than 3 to 4 leaves. Tordon 22K kills plants after it is absorbed and translocated, and it remains active in the soil. Because Tordon 22K is persistent, it will kill seedlings of diffuse knapweed and yellow star thistle that develop from seed reserves in the soil. Tordon 22K should be applied in the spring at approximately 1/4 pound active ingredient per acre. Best results are achieved when Tordon 22K is applied when plants are in the rosette stage or before sending up flower stalks. If applied in the spring, the site can be seeded the following fall.

B. 2,4-D--2,4-D is a selective, non-residual herbicide that kills broadleaf species. Diffuse knapweed and yellow star thistle can be killed by applying approximately 1 pound active ingredient per acre of low volatile ester 2,4-D when plants are in the rosette stage. Applying 2,4-D at later stages of growth is ineffective. If 2,4-D is used, applications will be necessary yearly and throughout the growing season to kill seedlings that emerge after application. Caution must be exercised when applying low volatile ester 2,4-D. Under conditions which cause volatilization (temperatures above approximately 80°F with vertical winds), the herbicide can drift several miles. Before spraying, consult the local weed control district for advice on whether conditions are likely to cause volatilization. Be particularly careful if broadleaf crops are growing close to WMNHS.

3. Fire--Fire is ineffective in controlling diffuse knapweed and yellow star thistle because fuels are usually not fine enough or high enough to carry fire. Also fire is not effective because most seeds have shattered from plants and they are in the soil or litter when the plants can be burned.

POISON HEMLOCK--Poison hemlock, a biennial with a deep seated taproot, reproduces by seed. Poison hemlock is toxic to humans therefore workers should thoroughly wash their hands before handling food. Competitive perennial grasses will suppress poison hemlock.

1. Mechanical control-- Poison hemlock can be controlled by grubbing or disking. Plants should be cut off below ground level before seeds are formed. Poison hemlock is a biennial species, therefore grubbing will be required annually to kill plants that reestablish from seed.

2. Chemical control-- Poison hemlock is difficult to kill with chemicals because leaves are waxey, finely dissected, and plants have a small leaf area. Herbicides are most effective if applied when plants are in the rosette stage or before flower stalks develop. Dicamba, and 2,4-D are most effective for controlling poison hemlock.

A. Dicamba--Dicamba should be applied in the spring when plants are in the rosette stage at 6 fluid ounces in 15 to 20 gallons of water per acre. Residual Dicamba will kill seedlings that emerge after herbicide application.

B. Low volatile ester 2,4-D should be applied at a rate of 2 to 3 pounds active ingredient per acre. 2,4-D should be applied in spring or early summer when plants are just beginning to grow, or in the fall before plants go dormant. If applied in the fall, the plant will translocate herbicide to the roots and mortality will be high. Yearly applications of 2,4-D are necessary to control plants that emerge after herbicide application.

C. Dicamba + 2,4-D--Use of Dicamba + 2,4-D effectively controls poison hemlock. Application should be made before plants send up flower stalks in the spring or in the fall before plants enter dormancy. The Dicamba and 2,4-D will kill actively growing plants and residual Dicamba will kill seedlings after the herbicide application.

3. Fire--Poison hemlock can be burned in the fall or spring after plants have dried, and if fuels from other species are sufficient to carry a fire. However, fire is ineffective because most seeds have probably shattered and replenished seed reserves in the soil before the plant will burn.

CANADA THISTLE--Canada thistle, a deep rooted perennial, reproduces by seed, rhizomes, and root fragments. Canada thistle is the most difficult weed to control at WMNHS. Total elimination of Canada thistle is nearly impossible.

1. Mechanical control--Limited control of Canada thistle results from repeated disking. Canada thistle reproduces from root fragments, therefore it often spreads after disking and colonies may be enlarged. Many years of disking are required to reduce populations and plants will probably increase when disking is terminated. This alternative is not recommended.

2. Chemical control--A long term chemical control program is recommended for Canada thistle. Chemicals available for controlling Canada thistle include Roundup, Dicamba, and Picloram. A new chemical, glean (Chlorsulfuron), is scheduled to be registered for rangeland use in 1986 or 1987. When released for use, it may be the most effective chemical for controlling Canada thistle. Do not use glean until it is registered for use on rangelands.

A. Roundup--Roundup must be applied when plants are in the rosette stage or developing buds and beginning to flower. It should be applied at 1 1/2 to 2 1/4 pounds active ingredient per acre. The disadvantage of using Roundup is its non-selectivity; however this shortcoming can be overcome by spot application or applying Roundup with a wick applicator. If associated desirable perennial species are killed, more area will be opened to invasion by Canada thistle.

B. Dicamba--Dicamba can be applied at 2 pounds active ingredient per acre any time when Canada thistle is growing. Dicamba is a non-selective, water soluble, and a soil active herbicide; the chemical will be active the year after application. Because it is water soluble and persistent, care must be used when applying it near water.

C. Tordon 22K--Tordon 22K should be applied at a rate of approximately 1 pound active ingredient per acre when plants are beginning growth in the spring, or in the fall before plants enter dormancy. If applied in the fall, the herbicide will be translocated to the roots before plants enter dormancy and the kill can be high. Tordon 22K will not kill established perennial grasses and this is desirable because they can invade where Canada thistle is killed, thereby limiting its spread. Tordon 22K is water soluble therefore careful consideration must be given before applying it near water.

3. Fire--Fire is not effective in controlling Canada thistle. Fire only removes standing dead plant materials and it has minimal effect on perennating plant parts. Plants will develop from the deep seated roots after burning. However if perennial grasses are abundant, their vigor may be increased by prescribed fire and they may suppress Canada thistle.

TEASEL--Teasel is a biennial that reproduces from seed. In its first year of growth, teasel forms a rosette that overwinters and it flowers the second year of growth. When teasel is controlled, populations can be suppressed by establishing perennial grasses.

1. Mechanical control--Teasel can be controlled by cutting plants off below ground level before flowering. Teasel forms large reserves of seeds in the soil, therefore it will be necessary to grub plants for several years to deplete seed reserves.

2. Chemical control--Teasel can be controlled with Tordon 22K or Dicamba.

A. Tordon 22K--Tordon 22K should be applied at a rate of 1/2 pound active ingredient per acre before plants send up flower stalks or in the fall after seedlings emerge, but before they enter dormancy. Residual Tordon 22K is soil active and it will kill teasel seedlings that emerge after application, but it will not kill established perennial grasses.

B. Dicamba--Dicamba is the preferred herbicide for controlling Teasel. Dicamba should be applied at 1/2 to 1 pound active ingredient in 15 to 20 gallons of water per acre. The herbicide should be applied in the spring when seedlings are in the rosette stage. Plants that survive the herbicide application should be cut off below ground level before flowering.

3. Fire--Fire is ineffective in controlling teasel except where perennial grasses are well established. Fire will increase the vigor of the perennial grasses and they will suppress teasel.

SCOTCH THISTLE--Scotch thistle, a biennial or short-lived perennial, reproduces by seed. In its first year of growth the plant forms a rosette; flowers develop the second year of growth. Maintaining vigorous perennial grasses limits the numbers and spread of Scotch thistle.

1. Mechanical control--Scotch thistle can be controlled by repeated grubbing. Because Scotch thistle is not present in large numbers on WMHNS, mechanical control is probably the preferred method of control. Plants should be severed below ground level before flowering.

2. Chemical control--Scotch thistle can be controlled by applying Tordon 22K and Dicamba.

A. Tordon 22K-- Apply 1/4 pound active ingredient per acre in the spring before plants develop seed stalks. Residual herbicide will kill seedlings that emerge after herbicide application.

B. Dicamba--Dicamba should be applied at a rate of 1/2 to 1 pound active ingredient per acre. Residual Dicamba will kill seedlings that emerge after the herbicide application. Dicamba should be applied in the spring before plants develop flower stalks.

REVEGETATION MANAGEMENT ALTERNATIVES

In the Landscape Study and Management Alternatives for Revegetation on Whitman National Historic Site (Gilbert 1984), 6 land units were delineated for WMNHS and the adjacent area. This classification does, however, need refinement for vegetation rehabilitation management. Gilbert's management units have been subdivided for purposes of developing revegetation alternatives (Figure 1). This refinement is based on soils (Figure 2), topography, the potential vegetation the land may support, existing vegetation, and the ease of applying improvement practices. The only area which has not been subdivided is Unit B. It must be emphasized that prescriptions are based on the vegetation existing in 1985. It is possible that vegetative composition will change through time. If vegetative composition changes drastically, the prescriptions may require modification.

In all revegetation alternatives suggested, low maintenance, long-lived native perennial grasses are recommended. Introduced species that are adapted have also been identified. By using long-lived species, inputs such as fertilizer and irrigation will not be necessary, and continual revegetation should be avoidable unless unforeseeable catastrophic events eliminate the recommended species. Perennial species will require management through grazing or fire to maintain healthy stands. Species that are recommended for WMNHS have been developed with a wide amplitude of tolerance, thus they are capable of growing in environments with wide range of soils, fertility, and climatic conditions. Species have been selected that will not require fertilization or irrigation. In fact, in the Palouse Prairie, fertilization actually enhances the competitiveness of introduced weeds. Repeated application of fertilizers can shift plant community composition from high seral perennials to low seral perennials or alien annuals.

Species have also been selected that can provide forage if WMNHS includes livestock grazing as part of their land use management plan. If grazing is included in future management, grazing management plans should be developed for each management unit. Grazing systems are not presented in this revegetation management plan because specific management plans are dependent on the species selected for revegetation. All of the park could be grazed except the Units C1, C2, C3, and D4. If grazing systems are developed, the pastures should be delineated depending on the dominant species in each, and rotational grazing systems should be employed.

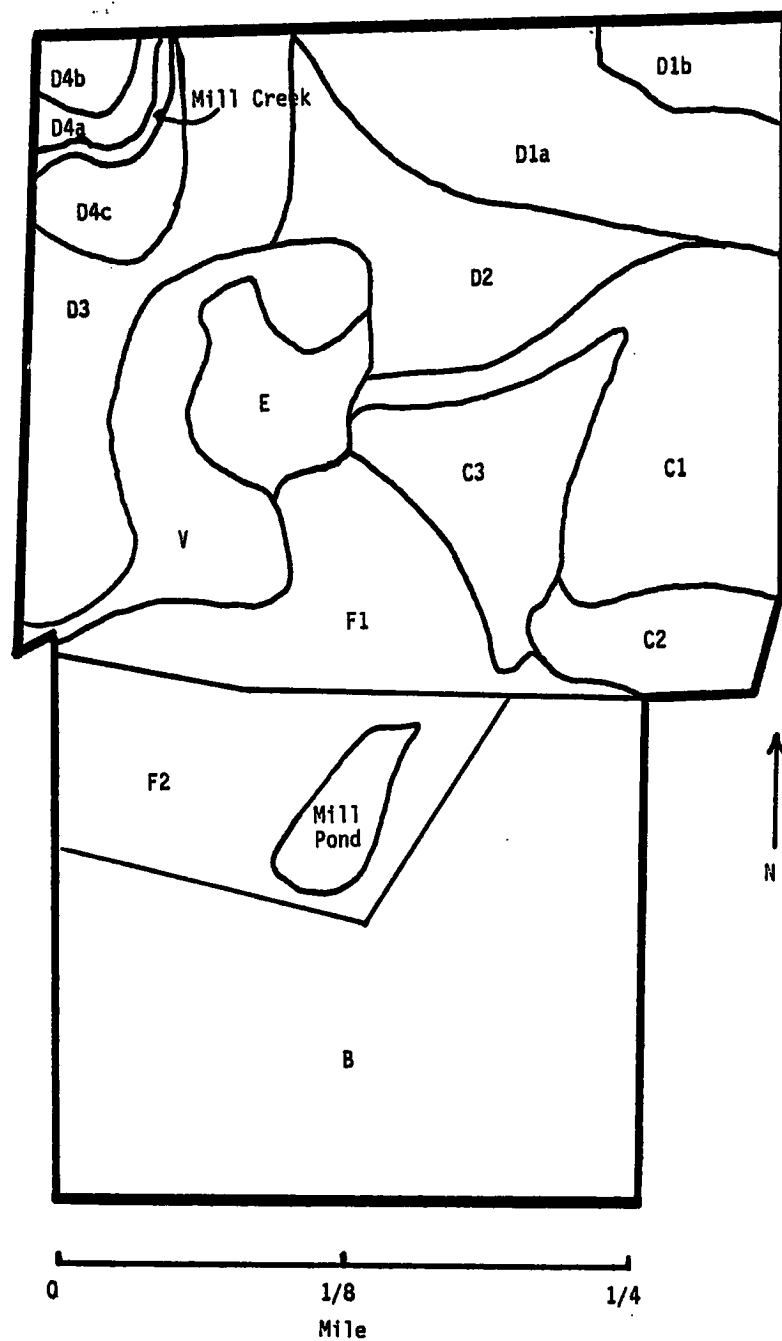


Figure 1. Revegetation management units at Whitman Mission National Historic Site.

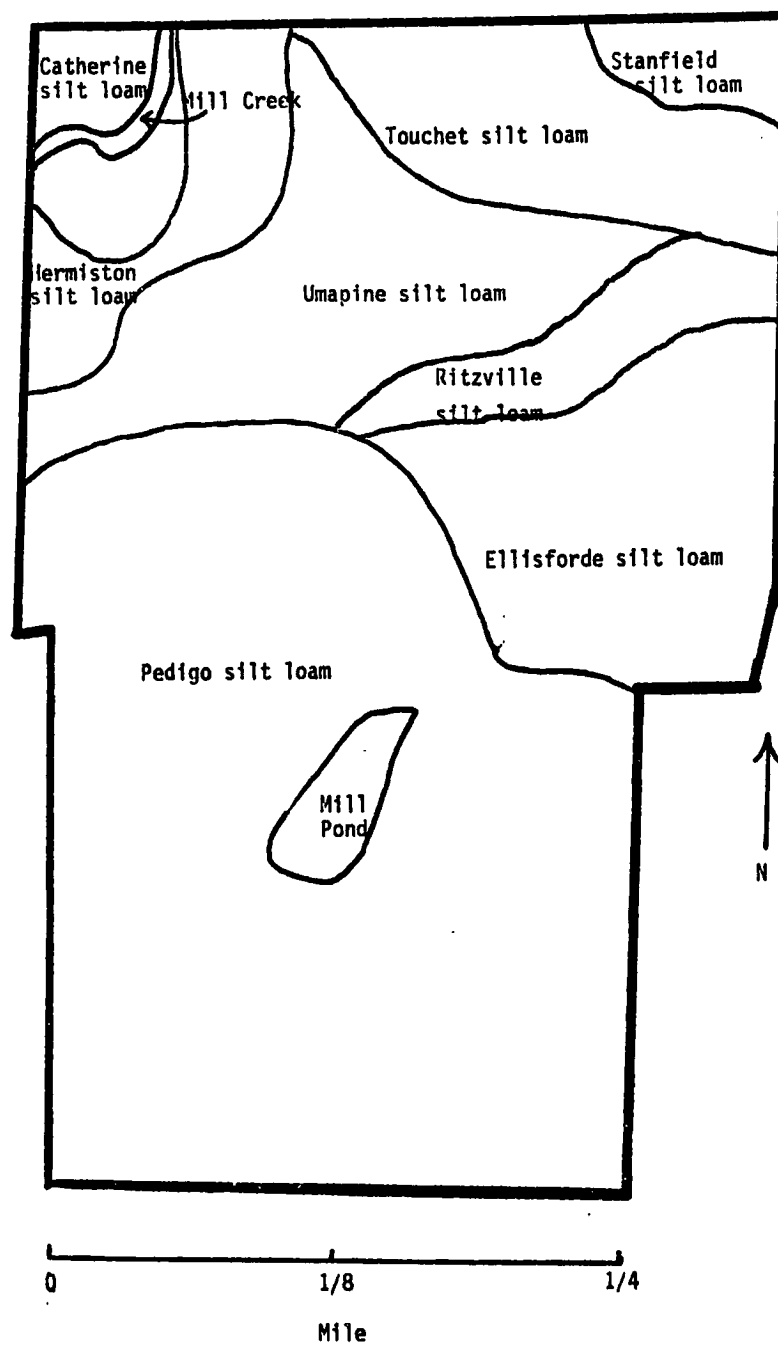


Figure 2. Soils of Whitman Mission National Historic Site.

REVEGETATION UNITS AND REVEGETATION RECOMMENDATIONS

UNIT B

Unit B includes approximately 28 acres of pasture in the southern unit of the Park (Figures 1 and 3). Soils are Pedigo silt loam (Figure 2). Presently the site supports Kentucky bluegrass, orchardgrass, and quackgrass. The unit will be grazed from April 1 through October of 1985. At present, weeds are not a serious problem in Unit B, but the potential for invasion is high. The area surrounding Unit B, on the south side of the Park, is heavily infested with teasel, poison hemlock, and Scotch thistle. Grazing should be continued on Unit B until the revegetation plan is implemented. Grazing will maintain the vigor of perennial grasses and it will limit invasion of weeds.

WEED CONTROL AND SEEDBED PREPARATION

The most abundant species on Unit B are Kentucky bluegrass and quackgrass; both are aggressive rhizomatous perennial species. When replacing these species with other perennial species, the combined use of grazing, herbicides, and mechanical seedbed preparation are recommended. Kentucky bluegrass and quackgrass are not easily killed with mechanical treatments.

1. Grazing-- The year before initiating the revegetation plan, the area should not be irrigated, but it should be grazed. The year of implementing the revegetation plan, graze the area up to the time of herbicide application. If grazing is not used, the area will require burning to remove the dead plant material and improve the efficacy of herbicides.

2. Herbicides--Roundup is the preferred herbicide for eliminating Kentucky bluegrass and quackgrass. In the year of initiating the revegetation plan, do not irrigate the pasture. Apply Roundup in late spring when Kentucky bluegrass is in the boot stage or beginning to flower. Apply Roundup again in the second year of the revegetation plan when Kentucky bluegrass is in the same stage of development as described above.

3. Mechanical--After applying Roundup the second year of the revegetation plan, allow approximately 2 weeks for the herbicide to be translocated in the plant. The area should then be disked and allowed to remain in fallow until fall. Disk the unit in the fall after rains have been received and annual weeds have emerged. Seed immediately after the fall disking.

SEEDING

1. Adapted species

Introduced species--Tall wheatgrass, tall fescue, and orchardgrass are adapted.

Native species--Magnar basin wildrye is adapted.

2. Seeding methods--A. If this pasture is to be irrigated, tall fescue or orchardgrass are recommended; B. use Magnar basin wildrye or tall wheatgrass if the pasture is not irrigated. Seeding should be done in the fall immediately after disking. Seeds can be broadcast or drill seeded. If broadcast seeded, sow 40 PLS (2) per square foot and pack the soil with a brillion or cultipacker. Plant 20 PLS per square foot if drill seeded. The area can be irrigated in the spring to improve germination and establishment of seeded species. After seeding allow at least two growing seasons of grazing deferment to allow plants to develop and establish.

(2) See Table 2 for conversion.



Figure 3. View of Unit B from Unit C. Subunit C3 is in the foreground.

UNIT C

Unit C (Monument Hill) is approximately 15 acres and it has been subdivided into three management units (Figures 1 and 4). Gilbert (1984) stated that reestablishment of native vegetation would be difficult. Furthermore, she suggested that efforts to reestablish native species should be concentrated along the trail network. If there are plans to revegetate the entire hill, the notion of working only along the trails should be dismissed. If only a small portion of the hill is revegetated initially, followed by additional revegetation efforts, the established perennial grasses along the trail may be destroyed or add inconvenience during revegetation of other parts of the hill.

Native bunchgrasses can be reestablished on the Hill; several introduced perennial grasses are also adapted. Species that are recommended have been selected with tolerance to a wide range of environmental conditions. Reducing introduced weeds is requisite for establishing perennial grasses whether native or introduced. Presently Unit C supports a dense stand of cheatgrass, ripgut brome, diffuse knapweed, and yellow star thistle with scattered bluebunch wheatgrass, basin wildrye, red threeawn, lupine, and snow buckwheat. As a result of recurrent wildfires, green rabbitbrush and grey rabbitbrush, species that resprout from the root crown after fire, are abundant on the bench and north aspect.

When the hill is revegetated, the entire hill should be revegetated in one effort. Controlling exotic species is the main concern during site preparation. Their populations should be reduced by herbicide application, burning, and disking. Rabbitbrush should also be reduced.



Figure 4. View of Unit C from Unit B. Subunit C2 is right center and subunit C3 is left center.

SUBUNIT C1

Subunit C1 is approximately 8 acres and is located on the bench and the north slope of the hill (Figures 1 and 5). Soils of C1 are Ritzville silt loam and Ellisforde silt loam (Figure 2). The upper portion, Subunit C1, was cultivated in the past for crop production. Because no apparent revegetation attempts were made after cropland abandonment, introduced annual and biennial weeds dominate the site. Cheatgrass, green rabbitbrush, and grey rabbitbrush are abundant on the north slope; they presumably have increased from wildfires. On the upper slopes native vegetation was probably dominated by bluebunch wheatgrass; lower slopes were probably dominated by basin wildrye. Native forbs that were previously abundant on the hill include balsamroot, blue flax, yellowbell, and shooting star (June Cummins, personal communication). An inventory of any threatened and endangered plant species should be compiled for this area before work commences. Maintaining native forbs on Unit C may be difficult because of herbicide use on nearby agricultural lands. Presently Subunit C1 supports a stand of the weedy species, cheatgrass, diffuse knapweed, yellow star thistle, and a colony of teasel; native species include lupine, native bluegrass, red threeawn, grey rabbitbrush, and green rabbitbrush. Subunit C1 offers opportunities to use mechanical treatments for seedbed preparation and seeding. The combined use of herbicides, fire, and mechanical treatment for controlling weedy species and preparing the seedbed must be used.

WEED CONTROL AND SEEDBED PREPARATION

1. Herbicides

A. Tordon 22K--Yellow star thistle and diffuse knapweed can be controlled with Tordon 22K (Picloram). In the first year of implementing the revegetation plan, Tordon 22K should be applied in the spring before yellow star thistle and diffuse knapweed develop flower stalks. The residual effects of Tordon 22K, applied at 1/4 pound active ingredient per acre, should control seedlings that emerge after herbicide application.

B. Tordon 22K and 2,4-D--Yellow star thistle, diffuse knapweed, and rabbitbrush should be controlled by spraying a mixture of 2,4-D and Tordon 22K in the first year of implementing the revegetation plan. Apply 2 pounds of active ingredient of low volatile ester 2,4-D and 1/4 pound active ingredient of Tordon 22K when new growth on twigs of rabbitbrush is approximately 1/2 inch long and new leaves are exposed. This method would eliminate the need for deep plowing and repeated disking.

2. Fire--In the first year of implementing the revegetation plan, the area should be burned in late spring or early summer when cheatgrass is in the red stage and soils are dry. Fire is being recommended to reduce seed production and cheatgrass populations. When fire is properly timed, fire will reduce cheatgrass densities to levels where seedlings of perennial grasses can establish. A hot fire (backfires) is necessary to kill as many seeds as possible and destroy litter accumulations which favor establishment of annuals. Backfires should be used, and when burning the slopes the fire should burn down slope to minimize the rate of spread. When burning is completed, the site should be almost entirely devoid of vegetation.

3. Mechanical treatment--In the second year of the revegetation effort (the year after applying the herbicides) subunit C1 should be disked. The subunit should be disked at least 2 times. It should first be disked: 1) in early May before cheatgrass has turned red; and, 2) in the fall (probably in late September or early October) after rains are received and cheatgrass has germinated. The site should be disked to a depth of 6 to 8 inches to increase the probability of severing rabbitbrush below the root crown. Rabbitbrush sprouts from the root crown therefore, shallow disking will kill few plants and many plants will resprout. The combination of fire, herbicides, and disking should reduce rabbitbrush to levels that will not limit establishment of seeded perennial species. Rabbitbrush plants that survive seedbed preparation will add visual and biological diversity to the site after they regrow and perennial grasses have established.

SEEDING

1. Adapted Species

Introduced species--Fairway crested wheatgrass, Nordan crested wheatgrass, and hard fescue are adapted.

Native species--Secar bluebunch wheatgrass and Whitmar bluebunch wheatgrass, improved varieties of the native bluebunch wheatgrass, and Magnar basin wildrye, an improved variety of the native basin wildrye, are adapted.

2. Secar bluebunch wheatgrass and Whitmar bluebunch wheatgrass are recommended for upper portion of this subunit. Magnar basin wildrye is recommended for the lower portion of the north slope. Seed can be drilled or broadcast. Regardless of which method of seeding is chosen, seeds should be sown in the fall immediately following the last disking. Seeds should be planted at a depth of approximately 1/4 to 1/2 inch. If seeded with a drill, seeds should be sown at a rate of 20 PLS per square foot. Broadcast seeding should be done at 40 PLS per square foot, followed by packing with a cultipacker or brillion.

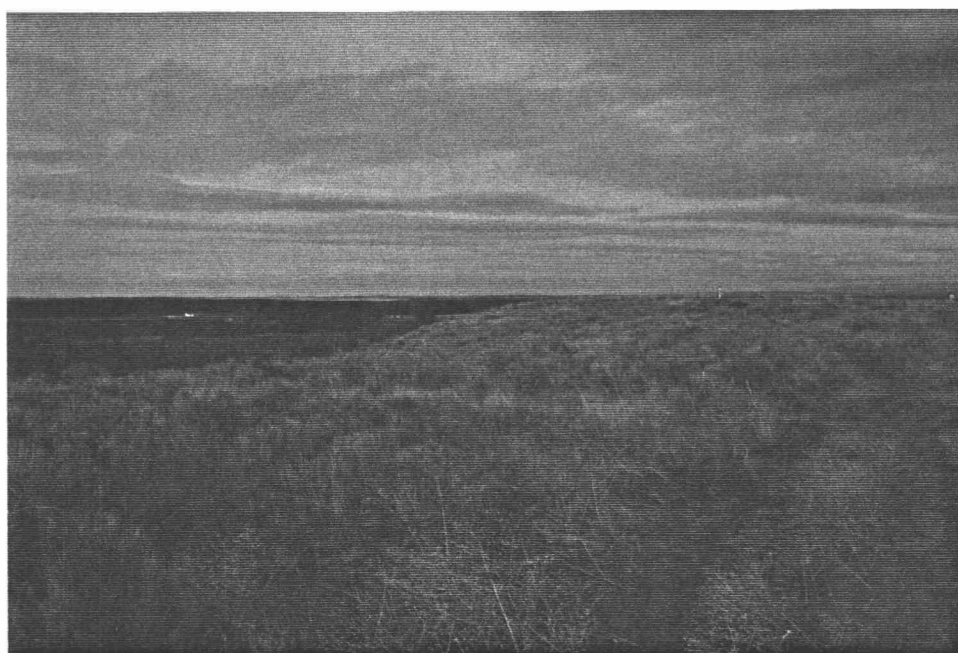


Figure 5. View of subunit C1. The dominant plants are diffuse knapweed, yellow star thistle, cheatgrass, and grey rabbitbrush.

SUBUNIT C2

Subunit C2 includes approximately 3 1/2 acres on the steep southerly aspect of the hill (Figures 1 and 6). Soils of subunit C2 are Ellisforde silt loam (Figure 2). This unit has scattered bluebunch wheatgrass, sand dropseed, and snow buckwheat. The most common annual weeds are cheatgrass and horseweed. Seedbed preparation must be directed toward reducing cheatgrass densities. Because the subunit is small, slopes are steep, and the erosion potential is high, use of equipment is not advised.

WEED CONTROL AND SEEDBED PREPARATION

1. Mechanical--Mechanical treatment is not advised because this subunit is small, slopes are steep, and the erosion potential is high.

2. Chemical--Use of herbicides is not recommended on this unit because residual native broadleaf species may be killed.

3. Fire--Fire is the recommended alternative for seedbed preparation in subunit C2. In the first year of the revegetation effort, this subunit should be burned when cheatgrass is in the red stage when seeds are still retained on plants. Use a backfire and burn down the slope. A small percentage of the native species may be killed, or their vigor reduced, but they should recover.

SEEDING

1. Adapted Species

Introduced Species--Fairway crested wheatgrass, Nordan crested wheatgrass, and hard fescue are adapted.

Native species--Secar bluebunch wheatgrass, Whitmar bluebunch wheatgrass, and Magnar basin wildrye are adapted.

2. Combined seeding and containerized seedlings--This is the preferred method of establishing perennial grasses in subunit C2. Seeds of Secar bluebunch wheatgrass, Whitmar bluebunch wheatgrass, and Magnar basin wildrye should be broadcast over the unit before planting containerized seedlings. Seeds should be raked into the soil after broadcast seeding. If seeds are not raked into the soil, germination will be low because of extremes in temperature and moisture availability, and depredation by birds and rodents can be high. The activity during planting of containerized seedlings should churn and pack the soil and position seeds in the seedbed where they can germinate. Plant containerized Secar bluebunch wheatgrass and Magnar basin wildrye seedlings on 1 foot centers.

3. Planting containerized seedlings--Containerized seedlings of Secar bluebunch wheatgrass, Whitmar bluebunch wheatgrass, and Magnar basin wildrye should be planted in the fall after rains have been received, but before soil temperatures at approximately 10 inches are lower than 10C. Soil temperatures can be determined with a soil probe thermometer. If planted when soil temperatures are lower than 10C, seedlings will have limited opportunity for growth before entering winter dormancy. Containerized stock should be probably be planted in October. Based on results at John Day Fossil Beds, containerized seedlings should be planted on 1 foot centers. Approximately 44,000 containerized plants will be needed per acre.

4. Seeding Methods--Secar bluebunch wheatgrass and Whitmar bluebunch wheatgrass are recommended for the upper slopes of this subunit; Magnar basin wildrye is recommended for the toe of the slope. Seeds should not be planted without scarifying the seedbed. If seeding is chosen, seed should be broadcast at a rate of approximately 40 PLS per square foot and the seeds should be covered by raking them into the soil. Seeding should be done in the fall before rains are received. Approximate date of planting is mid-September to mid-October.



Figure 6. View of subunit C2. The dominant plants are yellow star thistle, and cheatgrass. Native species are bluebunch wheatgrass, sand dropseed, and snow buckwheat.

SUBUNIT C3

Subunit C3 is approximately 3 1/2 acres and it is located on the west slope of Shaft Hill (Figures 1 and 7). Soils are Ellisforde silt loam (Figure 2). Unit C3 presently supports a dense stand of cheatgrass and riggut brome with scattered basin wildrye and bluebunch wheatgrass. Unit C3 is small, slopes are steep, and the erosion potential is high; use of equipment is not recommended. Seedbed preparation and seeding will be completed in one year.

WEED CONTROL AND SEEDBED PREPARATION

1. Mechanical treatment--Mechanical treatment is not recommended because the subunit is small and the slopes are steep.

2. Herbicides--Atrazine applied at a rate of 3/4 pound active ingredient per acre may give good control of cheatgrass without damaging native species. Because some native bunchgrasses and forbs are present on this site, herbicides are not recommended for this subunit.

3. Fire--In the first year of the revegetation effort, this subunit should be burned to reduce cheatgrass. Burn when cheatgrass is in the red stage; use a backfire and burn downslope. Fire may temporarily reduce vigor of the native bunchgrasses.

SEEDING

1. Adapted Species

Introduced species--Nordan crested wheatgrass, Fairway crested wheatgrass, and pubescent wheatgrass are adapted to the subunit.

Native species--Whitmar and Secar bluebunch wheatgrass, and Magnar basin wildrye are adapted to this subunit.

2. Seeding Methods

A. Combined seeding and planting of containerized seedlings--This is the preferred alternative for reestablishing perennial grasses in subunit C3. Seed of the Magnar basin wildrye and Secar bluebunch wheatgrass should be broadcast at a rate of 40 PLS (20 PLS of Secar and 20 PLS of Magnar) per square foot immediately before planting containerized seedlings. The seeds should be raked into the soil to insure coverage of seeds with soil. Containerized seedlings should be planted after seeding as described above.

B. Planting containerized seedlings--Containerized seedlings of Magnar basin wildrye and Secar bluebunch wheatgrass should be planted in the fall after rains have been received, but before soil temperatures at approximately 10 inches have dropped below 10C. Containerized seedlings should be planted on 1 foot centers, with seedlings of each species planted in alternate in positions.

C. Broadcast Seeding--Seed can be broadcast on this unit. After broadcasting, the seeds should be raked into the soil to cover seeds to increase germination and establishment. Seed should be sown at a rate of 40 PLS per square foot. A mixture of Secar bluebunch wheatgrass and Magnar basin wildrye is recommended for seeding. Seeds should be planted at 20 PLS of Secar bluebunch wheatgrass and 20 PLS of Magnar basin wildrye per square foot.

D. Drill seeding--Drill seeding is not recommended because slopes are steep and the unit is too small to accommodate seeding equipment.

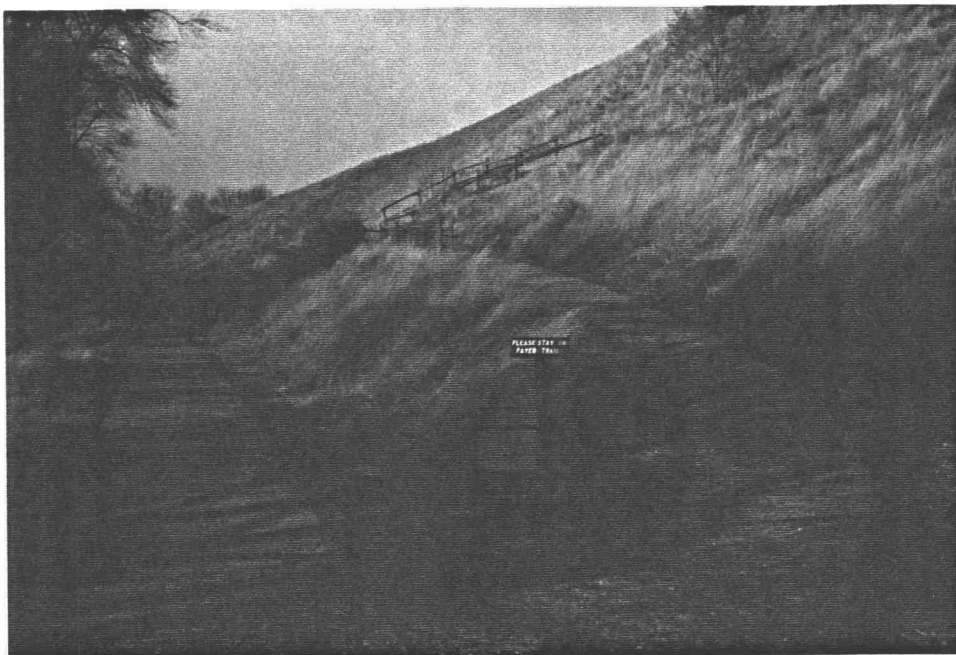


Figure 7. View of subunit C3. The dominant species are cheatgrass and ripgut brome. Native species include bluebunch wheatgrass and basin wildrye.

UNIT D

Unit D occupies approximately 31 acres in the northern and western portion of the north unit of WMNHS (Figure 1). Unit D is subdivided into 4 revegetation subunits. The size of the subunits and the topography of Unit D are conducive for use of equipment for seedbed preparation and seeding. Great basin wildrye was probably the dominant species on this unit before it was disturbed. Presently this unit supports a mix of annual, biennial, and perennial weeds with very few native species present.

Units D1, D2, and D3 can be grazed. Unit D4 should not be grazed. Unit D1 supports canarygrass and it should be grazed in late spring and early summer. Units D2 and D3 can be grazed during late spring, summer, fall, and winter.

UNIT D1

Unit D1 is approximately 7 acres in the extreme northeastern corner of the Park (Figures 1 and 8). This unit is bordered on the north by the railroad right of way, and on the south by a diversion ditch from the main irrigation ditch from Doane Creek. Soils are poorly drained Touchet silt loam (D1a) with an inclusion of Stanfield silt loam (D1b) (Figure 2). The Stanfield soil occupies the higher ground in unit D1 and is approximately 1 acre (Figure 2). Subunit D1a (Figures 9 and 10) supports a dense stand of canary grass; D1b (Figure 10) supports teasel and poison hemlock, and is on a ridge that is about five feet higher than the surrounding and wetter area. The Touchet soils (D1a) supports a dense stand of canary grass. Within the canary grass there are small colonies of Canada thistle and teasel. The ridge (D1b) supports a dense stand of teasel and poison hemlock, with a sparse stand of cheatgrass.

Any attempts to revegetate D1a would be very difficult. The best management alternative for this subunit is to control weedy species by enhancing growth of canary grass. If a dense stand of canary grass is maintained, invasion of the site by weedy species should be low. Canary grass is a very aggressive perennial that reproduces by seeds and rhizomes, but its spread will be limited to mesic areas. The probability of it spreading to the higher and drier D1b is low. Unit D1b should be revegetated to reduce weeds.

Unit D1 was burned on March 19, 1985. Subunit D1 was sprayed with Dicamba at 16 fluid ounces in 15 to 20 gallons of water in the spring of 1985. This herbicide application should control teasel and poison hemlock. Canada thistle should be controlled as described below.

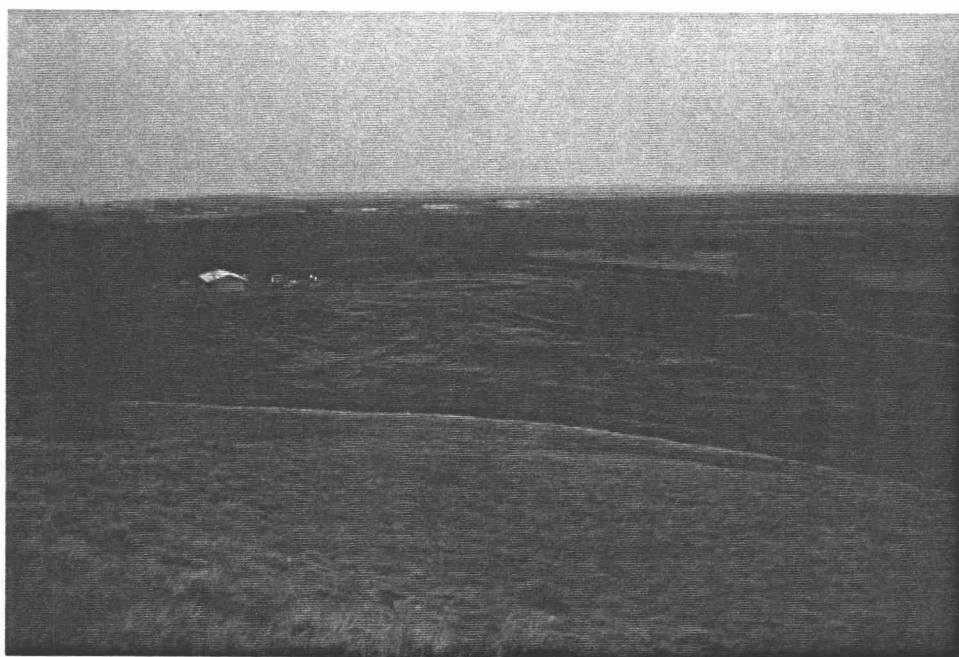


Figure 8. View of Units D1 and D2 from subunit C1 after burning on March 19, 1985. Unit D1 is right center and Unit D2 is left center.

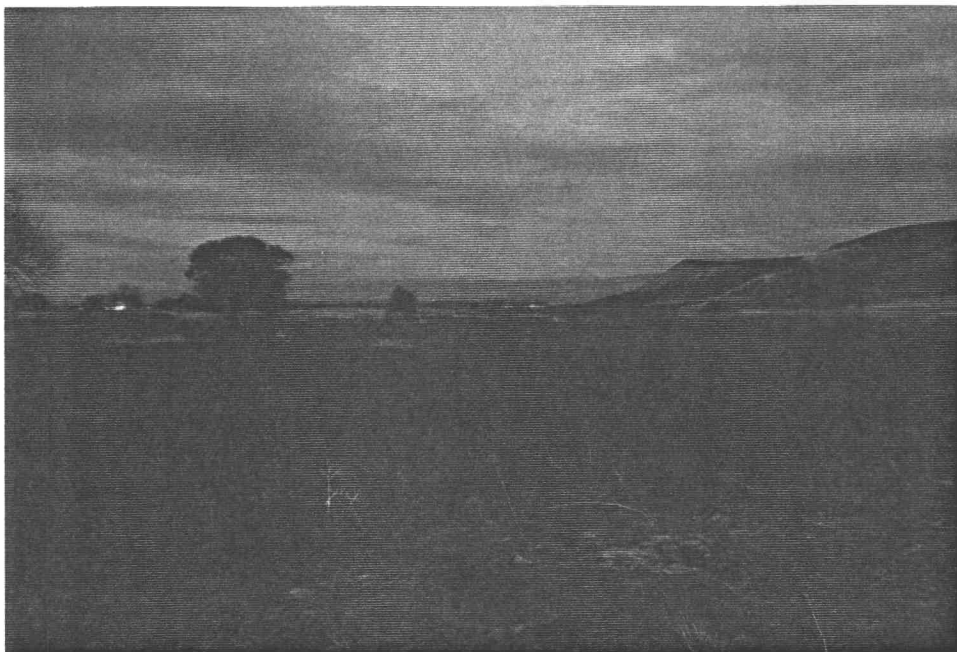


Figure 9. View of Unit D1 1 month after the March 19, 1985 burn. Canary grass is the dominant species.

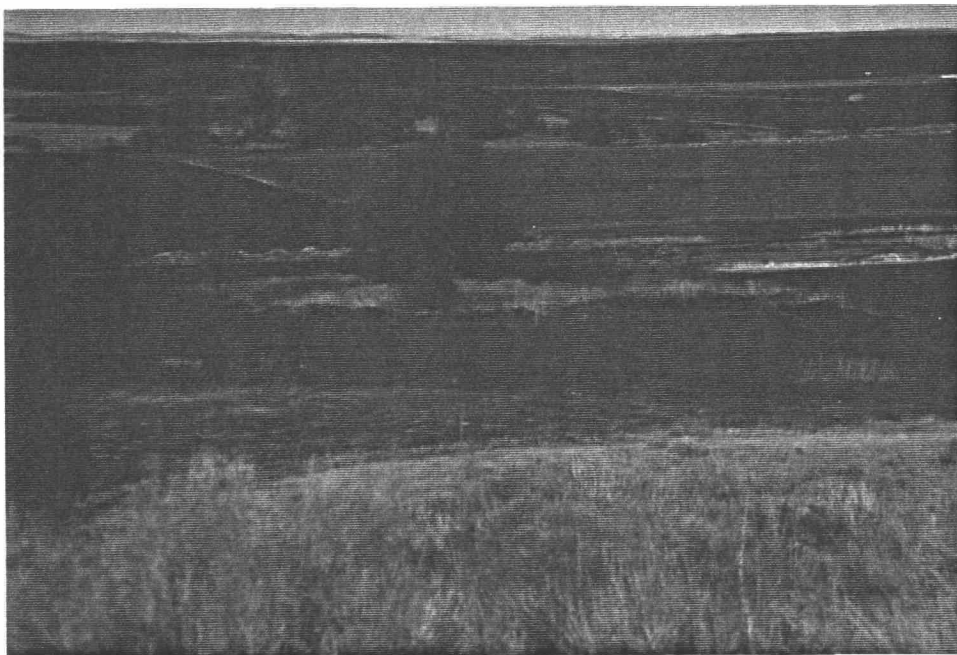


Figure 10. Subunits D1a and D1b from subunit C1 on March 19, 1985. Subunit C1 is in the foreground. Canary grass is the dominant species in D1a; teasel and poison hemlock are dominate in D1b.

SUBUNIT D1a

WEED CONTROL IN SUBUNIT D1a

A. Canada thistle--Canada thistle should be controlled with spot application of Roundup. Roundup must be applied yearly in the summer when plants are beginning to bloom and again in the fall before they enter dormancy. Care must be taken not to spray canary grass since it may also be killed by Roundup. If glean (Chlorsulfuron) is cleared for use on rangelands, it should be considered for use.

When Canada thistle is controlled, canary grass should spread into the area. Canarygrass can be burned on alternate years in the spring or grazed annually during late spring and early summer to maintain its vigor, enhance its spread, and suppress Canada thistle.

SUBUNIT D1b

WEED CONTROL IN SUBUNIT D1b

A. Poison hemlock--A combination of herbicides and mechanical control should be used for controlling poison hemlock. Application of Dicamba in the spring of 1985 should give good control, but any plants that survive the herbicide application should be cut off below ground level before they flower. Do not allow plants to flower and set seed.

B. Teasel--Teasel should be controlled with the combined use of herbicides and grubbing. Application of Dicamba should control the teasel. Any plants that survive the herbicide application should be cut off below ground level before they flower. Do not let plants develop seeds.

1. Fire--D1b was burned on March 19, 1985. Cheatgrass will probably increase when poison hemlock and teasel are controlled with the application of Dicamba. Cheatgrass must be controlled by burning D1b in spring or early summer of 1986 when cheatgrass is in the red stage.

SEEDBED PREPARATION

1. Mechanical--After burning D1b in the spring or early summer of 1986, the site should be disked. It should be disked again in the fall after rains are received (September or October) and cheatgrass has germinated.

SEEDING

1. Adapted species

Introduced species--Tall wheatgrass is adapted.

Native species--Magnar basin wildrye is adapted.

2. Seeding Methods--Magnar basin wildrye or tall wheatgrass are recommended for D1b. Do not seed these as a mixture. The area should be planted in the fall of 1986 after the site is disked. Seeds should be broadcast at 40 PLS per square foot and the site should be packed after seeding.

UNIT D2

Unit D2 lies south of subunit D1 and it is bordered on the south by a diversion ditch from the main irrigation ditch from Doane Creek (Figures 1 and 11). On the west D2 is bordered by the residential and utility area and Unit D3. Vegetation is a mix of cheatgrass, diffuse knapweed, yellow star thistle, and quackgrass. This area was cultivated in the past. Soils of this subunit are Umapine silt loam (Figure 2). Native vegetation on this area was probably a mix of basin wildrye and bluebunch wheatgrass.

WEED CONTROL AND SEEDBED PREPARATION

Because the vegetation of Unit D2 is a mix of annual, biennial, and perennial grasses and forbs, multiple strategies should be employed for reducing their densities. Fire, herbicides, and mechanical treatments should be used for seedbed preparation.

WEED CONTROL

1. Fire

A. This unit was burned on March 19, 1985 to remove the heavy litter buildup to improve the effectiveness of herbicides. At the time of burning, cheatgrass was green, therefore a clean burn was not achieved.

B. This unit will be burned when cheatgrass is in the red stage in late spring or early summer of 1986.

2. Herbicides--Tordon 22K was applied in the spring of 1985 to control yellow star thistle and diffuse knapweed. Tordon 22K was applied at 1/4 pound active ingredient per acre.

3. Mechanical--Subunit D2 should be disked after it is burned in 1986 and again in the fall (September or October) of 1986 after fall rains have been received and cheatgrass has germinated.

SEEDING

1. Adapted species

Introduced species--Tall wheatgrass, pubescent wheatgrass, Fairway crested wheatgrass, and Nordan crested wheatgrass are adapted.

Native species--Magnar basin wildrye, Whitmar bluebunch wheatgrass, and Secar bluebunch wheatgrass are adapted.

2. Seeding Methods--A mixture of Magnar basin wildrye and Secar bluebunch wheatgrass is recommended for this unit. Seeds can be broadcast seeded or drill seeded. Seeds should be planted in the fall of 1986 immediately after disking. Seeds should be planted approximately 1/4 to 1/2 inch deep.

A. Broadcast seeding--If broadcast seeding is selected, seeds should broadcast at 40 PLS per square foot (20 PLS Magnar basin wildrye plus 20 PLS Secar bluebunch wheatgrass per square foot). After broadcasting the soil should be packed with a cultipacker or brillion.

B. Drill seeding--If drill seeding is selected, seeds should be seeded at 20 PLS per square foot in the fall of 1986. Each species should be planted separately. That is, plant 1 species on the area and then plant the second species perpendicular to the first.



Figure 11. Unit D2 1 month after the March 19, 1985 burn. Subunit C1 is in the background. Cheatgrass, yellow star thistle, and diffuse knapweed are the dominant species in Unit D2.

UNIT D3

Unit D3 occupies approximately 10 acres in the southwestern portion of Unit D (Figures 1,12, and 13). Soils are Umapine silt loam, Hermiston silt loam, and Pedigo silt loam (Figure 2). Presently D3 support a dense stand of quackgrass and localized stands of cheatgrass and diffuse knapweed. The native vegetation of D3 was probably dominated by basin wildrye.

WEED CONTROL AND SEEDBED PREPARATION

1. Fire--This unit was burned on March 19,1985. The burn was very successful and it consumed nearly all the plant litter and standing dead plant material.

Unit D3 will be burned in early spring 1986, approximately 2 weeks after applying Roundup in the summer of 1986.

2. Herbicides

A. This unit was sprayed with Tordon 22K at a rate of 1/4 pound active ingredient per acre in the spring of 1985 to control broadleaf weeds.

B. Unit D3 will be sprayed with Roundup in 1985 and 1986 to control quackgrass. Roundup will be sprayed when quackgrass is in the boot stage or beginning to flower.

3. Mechanical treatment--Unit D3 must be disked after the unit is burned in 1986. The unit should be disked again in the fall (September or October) of 1986 after fall rains have been received and cheatgrass has germinated.

SEEDING

1. Adapted Species

Introduced species--Tall wheatgrass, intermediate wheatgrass, and pubescent wheatgrass are adapted.

Native species--Magnar basin wildrye is adapted.

2. Seeding methods--Magnar basin wildrye is recommended for this unit. Seeds can be broadcast or drill seeded. Seeds should be planted approximately 1/4 to 1/2 inch deep. Planting must be done in the fall of 1986 immediately after the site is disked.

A. Broadcast seeding--Seeds should be broadcast at 40 PLS per square foot. After seeding, the soil should be packed with a cultipacker or a brillion to insure coverage of seeds and firming of soil around seeds.

B. Drill seeding--If drill seeded, seeds should be planted at 20 PLS per square foot.

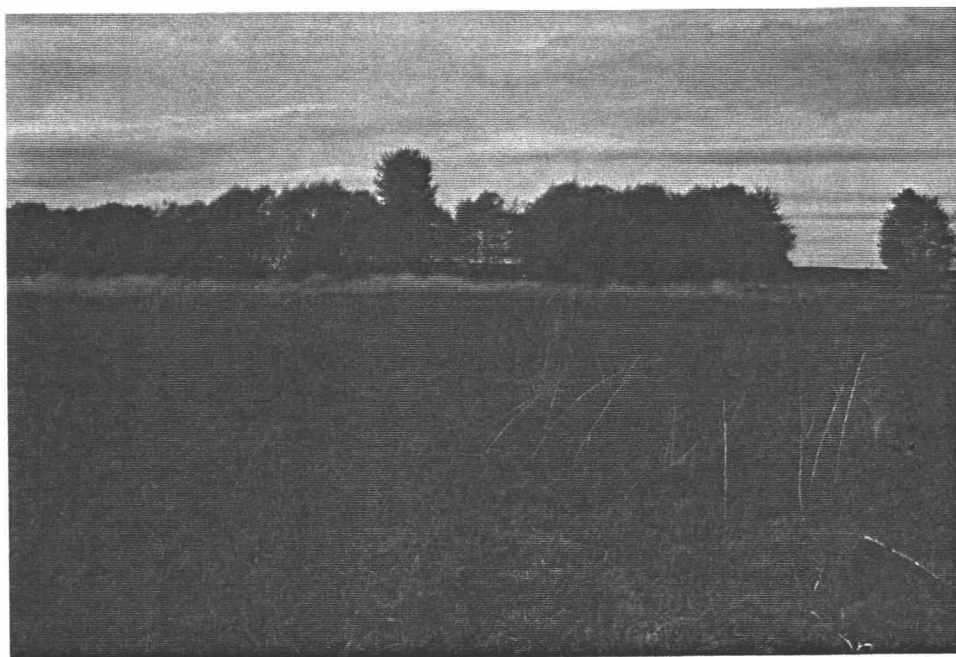


Figure 12. Unit D3 1 month after the March 19, 1985 burn. Unit D4 is in the background. Quackgrass is the dominant species in Unit D3.

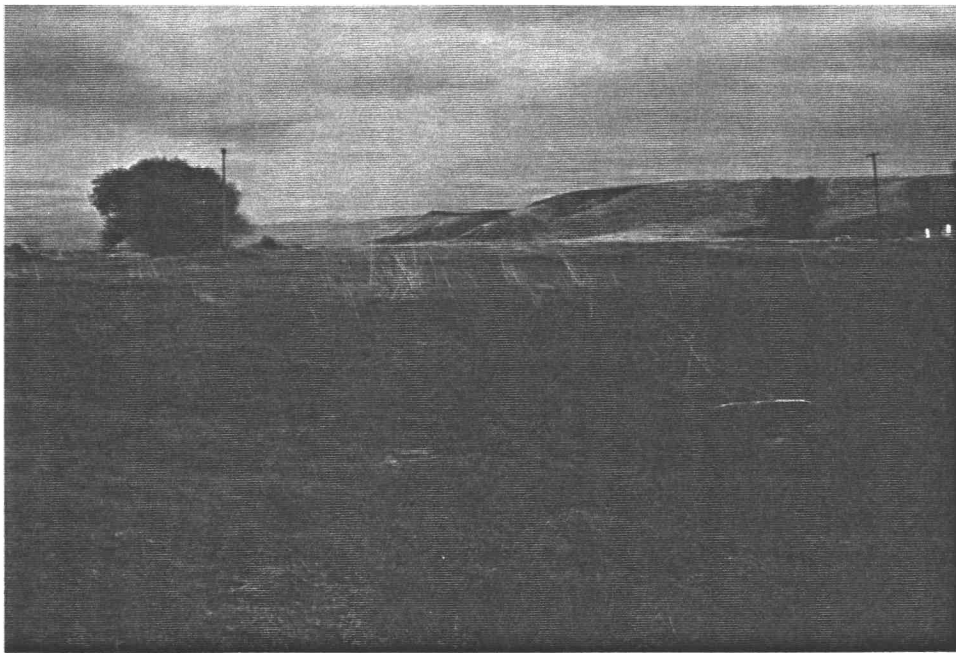


Figure 13. Unit D3 1 month after the March 19, 1985 burn. Subunits D1 and D2 are in the background.

UNIT D4

Unit D4 occupies approximately 4 1/2 acres in the extreme northwestern corner of the Mission (Figures 1, 14, and 15). Soils of this area are Catherine silt loam (Figure 2). This area has been severely disturbed in the past by stream bank stabilization. On the north side of Mill Creek, canary grass is abundant along the flood plain (D4a) (Figure 14). On the higher ground on the north side of the creek (D4b) (Figure 14), teasel and poison hemlock form a dense stand. Vegetation on the south side of Mill Creek (D4c) is composed of an overstory of cottonwood, willow, and smooth sumac (Figure 15); the understory is largely composed of teasel, poison hemlock, yellow star thistle and cheatgrass. Low spots in D4c are occupied by canary grass.

WEED CONTROL

1. Fire--Unit D4 was burned on March 19, 1985. The fire in D4a and D4b was very hot and it consumed nearly all herbaceous material. The burning of D4c was less successful because of the lack of fuel.

After perennial vegetation is well established on D4b, subunits D4a and D4b should be burned in the spring of alternate years.

2. Herbicides--Dicamba will be sprayed on D4b and D4c in the spring of 1985 to control poison hemlock and teasel. Any plants that survive herbicide application should be cut off below ground level before flowering.

SEEDBED PREPARATION

Seedbed preparation is recommended only for subunit D4b.

1. The area should be burned in early spring of 1986.

2. Mechanical--Subunit D4b should be scarified or disked in late summer of 1986 and again after fall rains are received.

SEEDING

SUBUNIT D4b

1. Adapted species

Introduced species--Tall wheatgrass is adapted.

Native species--Magnar basin wildrye is adapted.

2. Seeding Methods--Magnar basin wildrye or tall wheatgrass should be planted in subunit D4b in the fall of 1986 after the seedbed is scarified or disked. Broadcast seeding is recommended because D4b is small. Seeds should be broadcast at a rate of 40 PLS per square foot. After seeding, the area should be packed or the seeds should be raked into the soil.

SUBUNIT D4C

1. Planting containerized seedlings--Containerized seedlings of should be planted in D4c. Plant seedlings on 1 foot centers. The seedlings may be a very attractive food source for rodents in the winter, therefore seedlings should be planted in the spring of 1987. Approximate date of planting will be early March to early April. Subunit D4c is approximately 2 1/2 acres, thus approximately 110,000 seedlings will be required.

2. Subunit D4c can probably support shrubs and trees. Rooted stock of willow, dogwood, and cottonwood could be planted. However, observations in this area indicate that wooded areas are more susceptible to invasion by weedy species than areas devoid of a tree or shrub overstory.



Figure 14. Subunits D4a and D4b 1 month after the March 19, 1985 burn. Mill Creek is in the foreground. Canary grass is the dominant species in D4a; poison hemlock and teasel dominate in D4b.



Figure 15. View of Subunit D4c. Black cottonwood, willow, and smooth sumac are the overstory species; teasel, poison hemlock, yellow star thistle, and cheatgrass are the most common weeds.

UNIT E

Unit E lies between the residence area and the visitor center and is bordered on the south by Unit F (Figures 1 and 16). Soils of this 4 1/2 acre unit are Pedigo silt loam and Catherine silt loam (Figure 2). Presently the unit supports quackgrass, tall wheatgrass, and tall fescue. These perennial grasses are effectively suppressing annual weeds. Revegetating the area with perennial grasses may not be necessary on this unit. However, efforts must be made to maintain or increase the vigor of the perennial grasses. If revegetation of this unit is deemed appropriate, the following methods can be used.

WEED CONTROL AND SEEDBED PREPARATION

1. Fire--Fire can be used as an effective tool for maintaining or increasing the vigor of perennial grasses in this unit. This unit should be burned in the spring of alternate years to reduce litter and release nutrients.

2. Herbicides

- A. If this site is revegetated, it should be burned in spring of the first year of implementing the revegetation plan. The site should be sprayed with Roundup in the first and second year of the revegetation plan to kill quackgrass. Quackgrass should be sprayed with Roundup when it is in the boot or early flowering.

3. Mechanical treatments--During the second year of preparation, the site should be disked approximately 2 weeks after applying Roundup and again after rains are received in the fall.

SEEDING

1. Adapted Species

Introduced species--Fairway crested wheatgrass, Nordan crested wheatgrass, pubescent wheatgrass, tall wheatgrass, streambank wheatgrass, hard fescue, and sheep fescue are adapted.

Native species--Magnar basin wildrye, Secar bluebunch wheatgrass, and Whitmar bluebunch wheatgrass are adapted.

2. Seeding Methods--Magnar basin wildrye is recommended for this Unit. The area should be seeded in the fall immediately after the fall disking. Seeds can be broadcast or drill seeded. If seeds are drill seeded, seed at approximately 20 PLS per square foot. If broadcast seeded, 40 PLS per square foot should be planted. After broadcast seeding the site should be packed with a cultipacker or brillion.

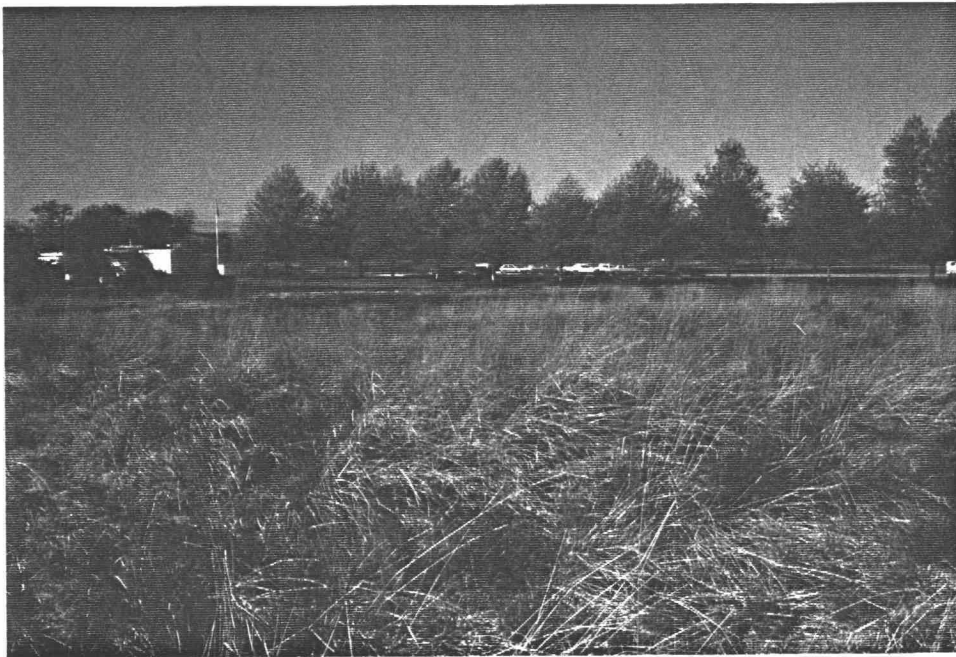


Figure 16. View of Unit F from the southwest corner of Unit D2. Dominant species are quackgrass, tall wheatgrass, tall fescue, and basin wildrye.

UNIT F

Unit F includes approximately 16 3/4 acres in the south and north unit of the Park (Figures 1 and 17). Unit F has been subdivided into 2 subunits. Subunit F1 includes the area east and south of the visitor center, to the base of Shaft Hill, and south to the Oregon Trail (Figures 1 and 17). Subunit F2 includes mill pond and the visitor use area south of the Oregon Trail (Figures 1 and 18).

SUBUNIT F1

Vegetation and soils of subunit F1 are similar to Unit E. Because of the proximity to Unit E, Subunit F1 can be easily managed with Unit E and prepared for seeding at the same time as Unit E by using the same methods. Soils of Subunit F1 are Pedigo silt loam (Figure 2). Presently the vegetation of F1 is dominated by quackgrass, tall wheatgrass, and basin wildrye. Teasel is locally abundant on low wet sites. Subunit F1 is large enough to accomodate equipment for seedbed preparation and seeding.

VEGETATION MANAGEMENT

Perennial grasses in this unit are competing with and suppressing weedy species. A prescribed fire management plan should be implemented on unit F1 to maintain the vigor of perennial grasses. Unit F1 should be burned in early spring of alternate years.

REVEGETATION RECOMMENDATIONS

WEED CONTROL AND SEEDBED PREPARATION

1. Fire--In the first year of implementing the revegetation plan, the site should be burned in the spring to reduce litter accumulations to improve efficacy of herbicides.

2. Herbicides--In the first year of implementing the revegetation plan, the site should be sprayed with Roundup to kill quackgrass. Spray when quackgrass is in the boot stage or beginning to flower. The unit should be sprayed again in the second year at the same stage of development in quackgrass.

3. Mechanical treatment--In the second year of preparation, the subunit should be disked approximately 2 weeks after spraying with Roundup and again in the fall after rains are received.

SEEDING

1. Adapted Species

Introduced species--Pubescent wheatgrass, orchardgrass, and tall wheatgrass are adapted.

Native species--Magnar basin wildrye, streambank wheatgrass, and big bluegrass are adapted.

2. Seeding Methods--This subunit must be seeded in the fall of the second year of implementing the revegetation plan. Seed immediately after disking in the fall. Seeds can be broadcast seeded or drill seeded. If broadcast seeded, seeds should be sown at 40 PLS per square foot, followed by packing with a cultipacker or a brillion. If drill seeded, seed at 20 PLS per square foot.

SUBUNIT F2

Subunit F2 includes the Mission site, Mill Pond, and the oxbow (Figure 18). No revegetation is planned for the intensively managed turf. Consult landscape architects for recommendations on managing the vegetation of this unit.

Spikeweed forms a dense stand on the east side of mill pond. In the summer of 1985 and 1986, the spikeweed should be cut off at ground level before plants flower. In the fall of 1986, Magnar basin wildrye or tall wheatgrass should be broadcast over the area formerly supporting spikeweed. Seeds should be broadcast at 40 PLS per square foot and the seeds should be raked into the soil.

The area in subunit F2 that is not managed as lawn should be burned in the spring of alternate years after grasses are well established in the area previously occupied by spikeweed.



Figure 17. View of subunit F1. Dominant species in this subunit are quackgrass, tall fescue, tall wheatgrass, and basin wildrye.

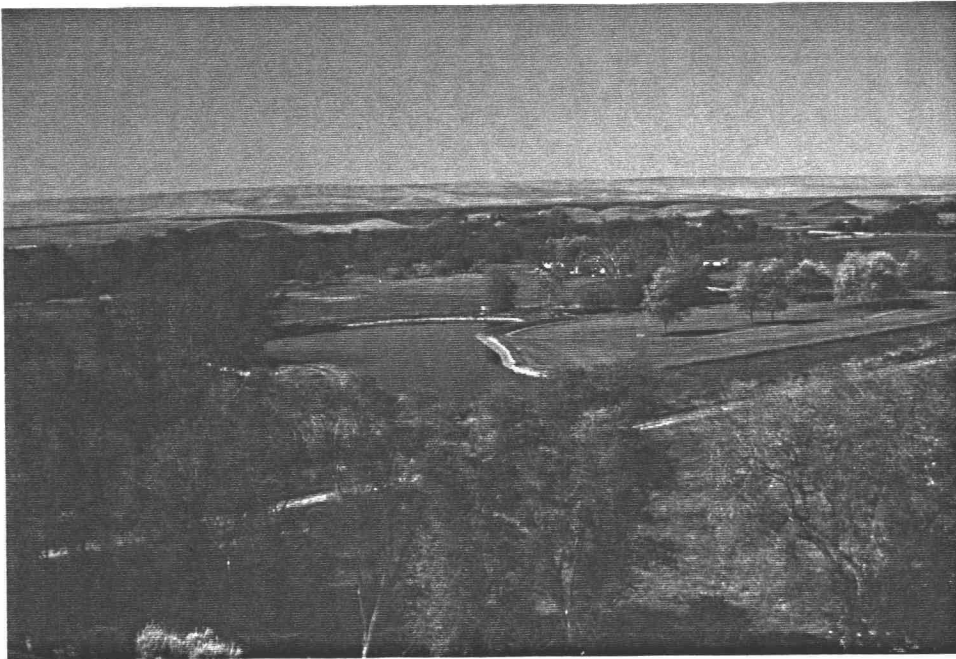


Figure 18. View of subunit F2 from subunit C1. Subunit F2 contains the visitor use area, mill pond, and the oxbow.

UNIT V

Unit V includes the visitor center, parking lot, and picnic area. We are not recommending plans for revegetation. The Park should contact turf management specialists and landscape architects for recommendations for specific problems.

EVALUATION OF REVEGETATION EFFORTS

The seeded areas should be evaluated to determine success and monitor changes in vegetation. Evaluations should be made at least each year for the first 3 years after seeding; monitoring should be continued on alternate years after third year. Evaluation the first and second year is critical because it will give a good indication of the success of the revegetation effort, and it will guide us in determining whether remedial action should be taken. Recording the number of individuals for weed species in plots will provide information that is useful for evaluating the effectiveness of each native species in suppressing weeds. The information generated from these evaluations can also be used for modifying future revegetation prescriptions at WMNHS and other Parks in the region.

Seedlings should be evaluated in spring. Seedlings can be evaluated by establishing several transects through the revegetated area and counting the number of plants of seeded species and the most common weedy species in 1 square foot quadrats. The number of plots required will be dependent on the variability between plots. The number of plots should be adequate to provide 95% accuracy. A successful seeding at WMNHS will be one in which the average number of seeded species exceeds 1 per square foot.

After data are collected, determine the mean and variance for the number of seedlings of seeded species counted in plots. Use the variance and compute 95% confidence limits for the mean. The upper confidence limit is not as important as the lower limit. If the lower limit of the confidence interval is greater than 1, the stand can be rated successful. If the mean number of seedlings for seeded species is less than 1 per square foot, and the lower confidence limit is less than 1, it may be necessary to reseed the area.

TABLE 1. COMMON AND SCIENTIFIC NAMES OF GRASSES, FORBS, TREES, AND SHRUBS AT WHITMAN MISSION NATIONAL HISTRIC SITE.

GRASSES

bluebunch wheatgrass--*Agropyron spicatum*
 basin wildrye--*Elymus cinereus*
 saltgrass--*Distichlis stricta*
 native bluegrass--*Poa sandbergii* or *P. secunda*
 quackgrass--*Agropyron repens*
 ripgut brome--*Bromus rigidus*
 cheatgrass--*Bromus tectorum*
 Kentucky bluegrass--*Poa pratensis*
 orchardgrass--*Dactylis glomerata*
 red threeawn--*Aristida longiseta*
 canarygrass--*Phalaris arundinacea*
 sand dropseed--*Sporobolus cryptandrus*
 tall wheatgrass--*Agropyron elongatum*
 tall fescue--*Festuca arundinacea*

FORBS

diffuse knapweed--*Centaurea diffusa*
 yellow star thistle--*Centaurea solstitialis*
 poison hemlock--*Conium maculatum*
 Canada thistle--*Cirsium arvense*
 teasel--*Dipsacus sylvestris*
 Scotch thistle--*Onopordum acanthium*
 lupine--*Lupinus* sp.
 balsamroot--*Balsamorhiza sagittata*
 blue flax--*Linum perenne*
 yellowbell--*Fritillaria pudica*
 shooting star--*Dodecatheon* sp.
 horseweed--*Conyza canadensis*
 spikeweed--*Hemizonia pungens*

SHRUBS AND TREES

snow buckwheat--*Eriogonum niveum*
 green rabbitbrush--*Chrysothamnus viscidiflorus*
 grey rabbitbrush--*Chrysothamnus nauseosus*
 cottonwood--*Populus trichocarpa*
 willow--*Salix* sp.
 smooth sumac--*Rhus glabra*

TABLE 2. SEED CHARACTERISTICS OF ADAPTED SPECIES FOR USE AT WHITMAN MISSION NATIONAL HISTORIC SITE.

SPECIES	APPROXIMATE NUMBER OF SEEDS PER POUND	POUNDS OF PURE LIVE SEED (PLS) REQUIRED FOR SEEDING 1 ACRE *	
		20 PLS SQUARE FOOT	40 PLS SQUARE FOOT
Reed canarygrass (<u>Phalaris arundinacea</u>)	506,000	3.50	7.00
tall fescue (<u>Festuca arundinacea</u>)			
var. Alta**	230,000	3.75	7.50
var. Fawn	181,000	4.00	8.00
bluebunch wheatgrass (<u>Agropyron spicatum</u>)			
var. Secar	140,000	6.25	12.50
var. Whitmar	130,000	6.75	13.50
crested wheatgrass (<u>Agropyron cristatum</u>)			
var. Fairway	200,000	4.50	8.75
crested wheatgrass (<u>Agropyron desertorum</u>)			
var. Nordan	175,000	5.0	10.00
streambank wheatgrass (<u>Agropyron riparium</u>)			
var. Sodar	170,000	4.00	8.00
pubescent wheatgrass (<u>Agropyron tricophorum</u>)			
var. Topar	90,000	9.75	19.50
var. Luna	90,000	9.75	19.50
var. Greenleaf	90,000	9.75	19.50
tall wheatgrass (<u>Agropyron elongatum</u>)			
var. Alkar	79,000	11.0	22.0
var. Jose	79,000	11.0	22.0
basin wildrye (<u>Elymus cinereus</u>)			
var. Magnar	165,000	5.25	10.5
hard fescue (<u>Festuca ovina</u> var. <u>duriscula</u>)			
var. Durar	565,000	1.50	3.00
var. Common	565,000	1.50	3.00
sheep fescue (<u>Festuca ovina</u>)			
var. Covar	680,000	1.25	3.00

TABLE 2 CONTINUED.

orchardgrass (<u>Dactylis glomerata</u>)			
var. Latar	500,000	1.75	3.50
var. Paiute	500,000	1.75	3.50
var. Potomac	500,000	1.75	3.50
big bluegrass (<u>Poa ampla</u>)			
var. Sherman	917,000	1.00	2.00
intermediate wheatgrass (<u>Agropyron intermedium</u>)			
var. Greenar	110,000	8.75	15.50
var. Oahe	110,000	8.75	15.50

*PLS (Pure live seed)= Seed Purity X Percent Germination

Example: Purity=80%=.80
 Germination=50%=.50
 PLS=(.80 X .50)=.40=40%

1/PLS=Pounds of bulk seed required to equal 1 pound PLS:
 1/.40= 2.50 pounds of bulk seed required for 1 pound of PLS.

**var. is variety

TABLE 3. MORPHOLOGICAL AND ECOLOGICAL CHARACTERISTICS OF GRASS SPECIES
ADAPTED TO WHITMAN MISSION NATIONAL HISTORIC SITE.

Crested wheatgrass--Introduced, long-lived, erect bunchgrass, very drought resistant, grows well on well drained soils, does not tolerate flooding, early spring growth, dormant during summer months, tolerates heavy grazing. Either Nordan or Fairway crested wheatgrass should be adapted for use at WMNHS. Grows 1 1/2 to 3 feet tall.

Pubescent wheatgrass--Introduced, long-lived, sod-forming, moderately drought tolerant, grows well on soils with low fertility, growth in early spring and fall, grows 3 to 5 feet tall.

Tall wheatgrass--Introduced, long-lived bunchgrass, low drought tolerance, very salt tolerant, tolerates saturated soils, late maturing, grows 4 to 6 feet tall. Jose is more drought tolerant and salt tolerant than Alkar.

Streambank wheatgrass--Native, long-lived, sod forming, semierect, drought resistant, grows well on a wide variety of soils, early season growth. Sodar is the only variety commercially available. Grows 1/2 to 1 foot tall.

Whitmar beardless bluebunch wheatgrass--Native, long-lived, erect bunchgrass, awnless, drought resistant, grows well on well drained soils, grows in spring and matures during summer. Less drought resistant than Secar bluebunch wheatgrass. Grows 2 to 3 feet tall.

Secar bluebunch wheatgrass--Native, long-lived, erect bunchgrass, awned form, drought tolerant, does best on well drained soils, early spring growth, matures in early summer. Secar bluebunch wheatgrass is more drought resistant than Whitmar, and morphologically it more closely represents the native bluebunch wheatgrass at WMNHS. Grows 2 to 3 feet tall.

Big bluegrass--Native, long-lived, erect bunchgrass, moderately drought tolerant, early spring growth, matures in summer. Sherman big bluegrass is the only variety commercially available. Big bluegrass is difficult to establish. Grows 2 to 3 feet tall.

Tall fescue--Introduced, long-lived, erect bunchgrass, moderately drought resistant, survives flooding in the winter, remains green throughout the summer, tolerant of grazing. Fawn tall fescue is the variety commonly used in eastern Washington. Grows 2 to 5 feet tall.

Hard fescue-- Introduced, long-lived, densely tufted, semierect bunchgrass, grows on a wide variety of well drained soils, excellent for erosion control, spring growth, matures in summer, grows 1/2 to 1 1/2 feet tall.

Orchardgrass--Introduced, long-lived, erect bunchgrass, moderate drought tolerance, does best on medium to well drained soils, spring to early summer growth, matures in summer. Paiute orchardgrass is more drought tolerant than Latar and Potomac. The former can be used under dryland conditions and the later varieties do best under irrigation. Grows 2 to 4 feet tall.

TABLE 3 CONTINUED.

Reed canary grass--Native, long-lived, erect, rhizomatous species, grows well on poorly drained soils, very competitive with weedy species, matures in late summer. Difficult to establish from seed, but once established it spreads well by rhizomes. Grows to 8 feet tall.

Basin wildrye--Native, long-lived, erect, bunchgrass, drought tolerant, grows on well drained to moderately well drained soils, early spring growth, matures in mid summer. Magnar is the only commercially available variety of basin wildrye. Grows 6 to 8 feet tall.

Sheep fescue--Introduced, drought tolerant, long-lived perennial, semierect to spreading, grows on a wide variety of soils, early spring growth, matures in early summer, grows 1/2 to 1 foot tall.

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