ELEMENT STEWARDSHIP ABSTRACT
for

Spartium junceum

Spanish Broom, Weaver's Broom

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The Nature Conservancy
Element Stewardship Abstract
For *Spartium junceum*

I. IDENTIFIERS

Common Name: spanish broom, Weaver's broom

General Description:
The following description of Spartium junceum is adapted from Munz and Keck (1973).

Spartium junceum is a perennial shrub, up to 3 m high, with long, slender, leafless or few-leaved, green, rushlike branchlets. The shrub is virgately branched and contains no spines, unlike gorse (Ulex europaeus). The alternate leaves are simple, entire and more or less strigose, having short petioles. The oblance-oblong or narrower leaves are 1-3 cm long.

The fragrant yellow flowers are borne in loose terminal racemes, unlike those of Cytisus scoparius which are usually solitary in the axils. Individual flowers are 2-2.5 cm long. The banner and keel are longer than the wings, and the keel is pubescent along its lower edge. The calyx is split above, hence one-lipped, with 5 minute teeth. This may be contrasted with the two-lipped calyx of Cytisus monspessulanus. The stamens are monadelphous (united by their filaments forming a tube around the gynoecium).

The linear pods are 5-10 cm long, more or less strigose, compressed, and many seeded. Each seed has a basal strophiole (appendage at the hilum).

II. STEWARDSHIP SUMMARY

III. NATURAL HISTORY

Habitat:
Spanish broom is native to the Mediterranean region and the Canary Islands. It was the first broom to arrive in California, being offered in San Francisco nurseries in 1858 (McClintock 1979). Beginning in the late 1930s Spanish broom was being planted along mountain highways in southern California (Hellmers and Ashby 1958). Mobley (1954) described the plant as having escaped cultivation and become naturalized in El Dorado County.

Of the three brooms that have naturalized in California, Spanish broom is the least widespread and is considered less of a problem than the other two, Scotch and French. It is known from fourteen counties in scattered localities throughout coastal California, where it spreads aggressively in waste places and along roadsides (McClintock 1985). No information was available describing the optimal physical environment for Spanish broom, but it may be similar to Scotch broom.

Reproduction:
Spanish broom may reproduce by seeds or by stump sprouting (Mountjoy 1979). Seeds germinate readily without any pretreatment (Hellmers and Ashby 1958), but scarification gives greater germination results (Cabral 1954). Beyond vague statements about the copious production of hard coated seeds which may remain viable for many years, there is almost no information available about seed production, dispersal, viability, germination, or seedling establishment.

IV. CONDITION

V. MANAGEMENT/MONITORING

Management Requirements:
Spanish broom is the least widespread broom in California and has not significantly invaded native vegetation (McClintock 1985). This weed was nominated as a subject for an Element Stewardship Abstract by the preserve manager from Santa Cruz Island.

With proper management, areas infested with the weedy brooms may be restored to more desirable vegetation. Soil disturbance should be kept to a minimum as it provides bare soil which is very conducive to broom seedling establishment. Improper use of broadcast burning may contribute to a re-invasion of broom. Research by Williams (1983) suggests that broom stands are early successional in nature and can be replaced by later seral stages if left undisturbed. Planting of tall growing shrubs or trees in or near broom stands may aid in reducing photosynthesis in broom plants and possibly lead to their demise. Goats are also effective in controlling re-establishment of broom.

Weed control involves three fundamental objectives: prevention, eradication and control.

From a practical viewpoint, methods of weed management are commonly categorized as follows: physical, thermal, managerial, biological, and chemical (Watson 1977). Physical methods include both manual and mechanical methods. Thermal methods include both broadcast burning or spot treatment with a flame thrower. Managerial methods include the encouragement of competitive displacement by native plants and prescribed grazing. Biological control is usually interpreted as the introduction of insects or pathogens which are highly selective for a particular weed species. Chemical control includes both broadcast and spot application.

The most desirable approach for controlling weeds is that of an integrated pest management plan. This involves the optimum use of all control strategies. This approach is generally accepted as the most effective, economical and environmentally sound, long-term pest control strategy (Watson 1977). In cases where more than one control technique is used, the various techniques should be compatible with one another. Broadcast herbicide application, for example, may not work well with certain managerial techniques (i.e., plant competition).

PHYSICAL CONTROL
The physical control methods discussed below (manual and mechanical) produce slash that can be disposed of by several techniques. If the vegetation is cut before seeds are produced, the debris may be piled and left for enhancement of wildlife habitat (i.e., cover for small mammals). Debris may be fed through a mechanical chipper and used as mulch during revegetation procedures. Care should be taken to prevent vegetative reproduction from cuttings. Burning the slash piles is also effective in disposing of slash.

MANUAL CONTROL
Manual methods use hand labor to remove undesirable vegetation. These methods are highly selective and permit weeds to be removed without damage to surrounding native vegetation. The Bradley Method is one sensible approach to manual control of weeds (Fuller and Barbe 1985). This method consists of hand weeding selected small areas of infestation in a specific sequence, starting with the best stands of native vegetation (those with the least extent of weed infestation) and working towards those stands with the worst weed infestation. Initially, weeds that occur singly or in small groups should be eliminated from the extreme edges of the infestation. The next areas to work on are those with a mixture of at least two natives to every weed. As the native plant stabilizes in each cleared area, work deeper into the center of the most dense weed patches. This method has great promise on nature reserves with low budgets and with sensitive plant populations. More detailed information is contained in Fuller and Barbe (1985).

Since manual removal is labor intensive, a ready supply of cheap labor is the first obstacle to overcome for manual control programs. The Marin Chapter of the California Native Plant Society has been successful in getting volunteers on weekend days to form broom pulling parties (Bravo 1985). Youth groups and civic organizations might also be willing to form work parties (Mountjoy 1979). More work is

accomplished proportionately in a short period, such as from 10 a.m. to 1 p.m., than in a long period with a lunch break. In addition to being short, the 10 a.m. to 1 p.m. work period also allows volunteers to hike in the afternoon, a factor that results in increased participation.

Hand Pulling: This method may be used to destroy seedlings or plants up to 1.5 m tall. Hand pulling is best done after a rain when the soil is loose. This facilitates removal of the rooting system, which may resprout if left in the ground. Plants should be pulled as soon as they are large enough to grasp but before they produce seeds.

Hand Hoeing: Plants can be destroyed readily while they are still small by hand hoeing, either by cutting off their tops or by stirring the surface soil so as to expose the seedlings to the drying action of the sun. The object of hoeing is to cut off weeds without going too deeply into the ground and doing damage to the roots of desirable vegetation.

Plants with a large tap root may not be completely removed by hoeing and may resprout afterwards. For plants up to 4 m tall a claw mattock is effective. The dirt around the root is loosened by the claw and the plant is then pulled out in the same way a claw hammer is used to pull out nails.

Cutting: Manually operated tools such as brush cutters, power saws, axes, machetes, loppers and clippers can be used to cut Spanish broom. This is an important step before many other methods are tried, as it removes the above-ground portion of the plant. For thickly growing, multi-stemmed shrubs such as Spanish broom, access to the base of the shrub may not only be difficult but dangerous where footing is uncertain. Cutting the aboveground portion and leaving the root intact is only partially successful; about half the remaining roots will resprout. Bravo (1985) suggests cutting plants before the seeds are set. This prevents seed production and dispersal for that plant. Hand Digging: The removal of rootstocks by hand digging is a slow but sure way of destroying weeds which resprout from their roots. The work must be thorough to be effective. Every piece of root that breaks off and remains in the soil may produce a new plant. Such a technique is only suitable for small infestations or around trees and shrubs where other methods are not practical.

Use of the manual methods discussed above to control broom in Marin County has allowed at least some of the native plants to return (Bravo 1985). Success may be somewhat limited, as these techniques do not totally eradicate broom. The resurgence of broom seedlings with time suggests that manual removal must be regularly repeated. One suggestion may be to re-seed the area with fast growing, non-weedy natives in hopes of reducing broom seedling survivorship.

MECHANICAL CONTROL

Mechanical methods use mechanized equipment to remove above-ground vegetation. These methods are often non-selective in that all vegetation on a treated site is affected. Mechanical control is highly effective at controlling woody vegetation on gentle topography with few site obstacles such as rocks, stumps or logs. Most mechanical equipment is not safe to operate on slopes over 30 percent. It is also of limited use where soils are highly susceptible to compaction or erosion or where excessive soil moisture is present.

Chopping, Cutting or Mowing: Spanish broom may be trimmed back by tractor-mounted mowers on even ground or by scythes on rough or stony ground. Unwanted vegetation can be removed faster and more economically in these ways than by manual means and with less soil disturbance than with scarification. However, these methods are non-selective weed eradication techniques and cut plant species which do not need control. They reduce potential for biological control through plant competition and open up new niches for undesirable vegetation. In addition, wildlife forage is eliminated. Broom plants usually require several cuttings before the underground parts exhaust their reserve food supply. If only a single cutting can be made, the best time is when the plants begin to flower. At this stage the reserve food supply in the roots has been nearly exhausted, and new seeds have not yet been produced. After cutting or chopping

with mechanical equipment, broom may resprout from root crowns in greater density if not treated with herbicides (Amme 1983).

PRESCRIBED BURNING

Flame Thrower: A flame thrower or weed burner device can be used as a spot treatment to heat-girdle the lower stems of shrubs. This technique has the advantages of being less costly than basal and stem herbicide treatments and of being suitable for use during wet weather and snow cover; it cannot be used during periods of wildfire hazard. Its effectiveness is comparable to manual cutting. Timing of treatment may affect resprouting behavior in some plant species (Jones and Stokes Associates 1984).

Although burning will remove the shoot portions of broom plants, it probably stimulates broom seed germination. A few years after hot fires in El Dorado County there is a noticeable solid stand of broom in burned areas (Mobley 1954). In New Zealand lowland scrub areas which are periodically burned contain both broom and gorse (Johnson 1982).

Broadcast Burning: Large areas of weed infestation may be burned in order to remove the standing mature plants. This may be accomplished with a prespray of herbicides to kill and desiccate plants, or without such spraying for notably flammable species. Used alone, this method will not prevent resprouting from root crowns. Burning is best followed by (1) herbicide treatment of stumps, (2) subsequent burning to exhaust soil seed bank and underground food reserves, and/or (3) revegetation with fast growing native species. Other considerations for the use of prescribed burning include the time and cost of coordinating a burn, and the soil disturbance resulting from firebreak šconstruction.

MANAGERIAL CONTROL

Biological Competition: Sowing native plant species which have the potential to outcompete weedy exotics for important resources is usually a preventive method of weed control. In some cases later successional plants may be encouraged to take root among the unwanted vegetation. Williams (1983) suggested that broom stands provide good environment for the establishment of other broad-leaved shrubs or trees. Such seedlings should be looked for in broom stands and encouraged. In addition, seeds of taller growing plants should be sown among the broom. These may establish sufficiently to eventually shade out the broom (Williams 1983). Such an approach is recommended in shrub- or tree-covered areas in national parks in New Zealand (Green 1976).

In most cases broom prevents the establishment of other native plants and must be initially removed. Following removal of mature plants, root crowns must be treated to prevent šresprouting. Seedlings of native plant species usually cannot establish fast enough to compete with sprout growth from šuntreated stumps.

Some plant species inhibit the establishment or growth of other plants through the effects of allelopathy (i.e., biochemical interference by metabolic products). Native species with such properties may be propagated in treated areas to control re- establishment of broom. Allelopathic noxious weeds should, of course, be avoided.

Prescribed Grazing: The continued removal of the tops of seedlings and resprouts by grazing animals prevents plant development and seed formation and also gradually weakens the underground parts. Grazing must be continued until the seed bank is eliminated, as the suppressed plants return quickly after livestock are removed.

In many areas of California the use of Angora and Spanish goats is showing promise as an effective control for broom (Daar 1983). In the Cleveland National Forest goats are herded for firebreak management of brush species on over 79,000 acres of land. Goats are less costly to utilize than mechanical and chemical control methods. They can negotiate slopes too steep to manage with machines and do not pose the environmental dangers inherent with herbicides (Andres 1979a). The pioneer in the use of goats for weed control in urban settings is Richard Otterstad, owner of Otterstad's Brush Clearing

Service (718 Adams St., Albany, CA 94706, 415/524-4063). The primary weed control "tools" utilized by Otterstad's company are Angora goats and light-weight flexible fencing reinforced with electrified wire. Angoras are preferred over Spanish goats because their smaller size makes them easier to transport (Otterstad uses a pickup truck). Dairy goats were abandoned when Otterstad found them to be "goof-offs" when it came to eating (Daar 1983). Goats prefer woody vegetation over most grasses or forbs, although Angoras have a higher tolerance for non-woody species. Since goats will trample or browse virtually any vegetation within a fenced area, any desirable trees or shrubs must be protected. Experience has shown that goats are most cost-effective when used to clear or suppress one- to four-year-old regrowth of brush rather than to do initial clearing of dense, tall, mature stands of vegetation. When faced with mature brush, goats will defoliate twigs and strip off bark, but will leave standing the plant's main superstructure which is too old and tough to tempt them.

Sheep are more selective than goats in their food choices but function well in grazing down a variety of plants. Thus sheep grazing may be a practical alternative to mowing. It is important to properly manage sheep grazing to prevent soil compaction problems which may occur when sheep are allowed to graze an overly damp area. Sheep are valuable not only for weed control but also for additional income from the sale of their wool and their contribution of fertilizer to the soil. However, it is possible that seed re-introduction may occur from the sheep droppings.

Spanish broom may contain alkaloids or other toxins similar to Scotch broom (Smith 1966), and grazing may not be an effective control measure. Scotch broom is slightly toxic and is avoided by livestock (Long 1938, Mobley 1954). An attempt at controlling Scotch broom in New Zealand by sheep grazing failed, even though grazing commenced when broom plants were only a few inches high (Allo 1960).

Chickens, surprisingly enough, are known to effectively digest (and destroy) all weed seeds passing through their crops. They can thoroughly graze back vegetation in areas up to one acre in size. Releasing chickens into an area after the mature plants are removed allows them to scratch and peck out weed seeds and potentially reduce the weed seed bank in the soil (Andres 1979a).

BIOLOGICAL CONTROL

The term "biological control" is used here to refer to the use of insects or pathogens to control weeds. The introduction of exotic natural enemies to control plants is a complex process and must be thoroughly researched before implementation to prevent biological disasters. Such tools are not normally suitable for preserve managers to implement.

The introduced twig-mining moth (Leucoptera spartifoliella) and the seed weevil (Apion fuscirostre) are specific to Cytisus scoparius and will not feed or develop on Spanish broom (Andres 1979a). Eriophyes spartii (Acarina: Eriophoidea) has been noted to live exclusively on Spartium junceum in Italy (Castagnoli 1978). The attack begins on the young apical shoot and causes excessive hairiness, thickening of the axis, and shortening of the inter¬nodes. The heavily infested plants go through a process of withering and may die in a few years. The broom aphid (Aphis cytisorum) also feeds on S. junceum (Tkachuk 1981).

Please notify the California Field Office of The Nature Conservancy of any field observations in which a native insect or pathogen is seen to have detrimental effects on Spanish broom. These reports will be used to update this Element Stewardship Abstract. Management techniques which encourage the spread of such species-specific agents may be desirable in controlling broom.

CHEMICAL CONTROL

Detailed information on herbicides are available in such publications as Weed Science Society of America (1983) or USDA (1984) and will not be comprehensively presented here. The Weed Science Society publication gives specific information on nomenclature, chemical and physical properties of the pure chemical, use recommendations and precautions, physiological and biochemical behavior, behavior in or on soils, and toxological properties for several hundred chemicals.

Herbicides may be applied non-selectively (i.e., broadcast treatments) or selectively (i.e., spot treatments). Both types of treatments have advantages and disadvantages and will be discussed separately.

Broadcast Herbicide Application: Broadcast application of herbicides has become the mainstay of most weed control efforts today. This may be due to the illusion that it is a "quick fix" method of eradicating undesirable vegetation. Most herbicides so applied are non-selective and will kill most, if not all, of the vegetation sprayed. Those species which survive the treatment may, after repeated sprayings, form an herbicide-resistant vegetation cover, thus creating a more difficult problem to deal with. Such broadcast spraying may also kill off native plants which have the ability to outcompete exotic weeds.

Broadcast herbicide application may be most effective where the weed infestation is very dense and needs to be killed and desiccated prior to burning. It may also be useful following the removal of mature plants so as to reduce the soil seed bank.

The most commonly mentioned herbicides for broom are 2,4-D alone or with additives. These additives include diquat, picloram, dicamba, and sodium chlorate (Allo 1960, Elliot 1976, Watt and Tustin 1976, Balneaves 1981).

Broom proved to be very susceptible to picloram, regardless of the form of picloram (Moffat 1965, Upritchard 1969). The 0.5 lb/acre ester formulation gave control equal to the 0.751 lb/acre amine formulation, both rates being clearly superior to the 0.5 lb/acre amine formulation. Moffat (1966) recommends rates twice this amount. Such a rate resulted in complete death of plants 2-3 m high within nine months (Patterson 1964).

Broom has been eliminated using 8 lbs of sodium chlorate in 80 gallons of water per acre (Anonymous 1934). McCavish (1980) concluded that triclopyr ester was particularly effective in controlling broom, superior to glyphosate and fosamine ammonium. Triclopyr amine or triclopyr ester also controls broom (McCavish 1979, Gilchrist 1980).

Paraquat and diquat result in only short-term (3-6 weeks) control of stump sprouting and seedlings(Balneaves 1981). Hexazinone (Issaly 1980) or atrazine may provide control of germinating and very young broom seedlings but are generally ineffective against established plants and resprout material. Also, other competing vegetation would be eliminated, allowing ideal conditions for re-infestation (Balneaves 1981).
Glyphosate did not satisfactorily control broom (McCavish 1980). The reader is referred to those papers for details on application procedures.

The potential for herbicide damage to native plants must be considered when deciding which herbicide to use. Pines are sensitive to triclopyr, spruces and firs are damaged by glyphosate. The growth of Douglas fir and western hemlock was stunted by fosamine ammonium. Herbicides cause less damage to conifers if applied in July and August, after they have laid down a waxy cuticle on their needles (McCavish 1980).

Spartium junceum may react in the same way as Cytisus scoparius to hormone weed killers. Cytisus scoparius plants in the seed-leaf stage are resistant. When 4 to 6 inches high they are quite susceptible to emulsifiable esters of 2,4-D at 1 lb acid equivalent per acre (Matthews 1960).

In general, when using the broadcast application method, plants should be sprayed only in full leaf. Results are poor if plants are sprayed when the leaves are developing and when plants are in full flower before leaf development. The best results have been obtained when plants are in the seed head stage in late summer and early autumn (Matthews 1960).

Spot Chemical Methods: Spot chemical methods consist of various techniques for manually applying herbicides to individual plants or small clumps of plants (such as stump resprouts). These methods are highly selective as only specific plants are treated. They are most efficient when the density of stems to be

treated is low. In applying herbicides it is recommended that a dye be used in the chemical mixture to mark the treated plants and thus minimize waste.

Jones and Stokes Associates (1984) reviewed a variety of spot chemical techniques. The following is an excerpt from this report, listing techniques in order of increasing possibility of herbicide exposure to the environment or to humans in the vicinity of treated plants.

1) Stem injection: Herbicides are injected into wounds or cuts in the stems or trunks of plants to be killed. The herbicide must penetrate to the cambial tissue and be water-soluble to be effective. The chemical is then translocated throughout the tree and can provide good root kill, which is important in order to prevent resprouting.

2) Cut stump treatment: Herbicides are directly applied to the cambial area around the edges of freshly cut stump. They must be applied within 5-20 minutes of cutting to ensure effectiveness. McHenry (1985) suggests late spring as the best season to do this. In early spring sap may flow to the surface of the cut and rinse the chemical off. At other times of the year translocation is too poor to adequately distribute the chemical. Applications may be made with backpack sprayers, sprinkling cans, brush and pail, or squeeze bottles. Picloram should not be used for this technique as it is known to "flashback" through root grafts between treated and untreated plants and may damage the untreated individuals.

3) Basal/Stem sprays: This technique involves applying, with the use of backpack sprayers, high concentrations of herbicides in oil or other penetrating carriers to the basal portion of stems to be killed. The oil carrier is necessary for the mixture to penetrate bark and enter the vascular system. This method gives good root kill, especially in the fall when vascular fluids are moving toward the roots. This method may be easier to use with small diameter stems than the two previous techniques.

4) Herbicide pellets: Pelletized or granular herbicides are scattered at the bases of unwanted plants. Subsequent rainfall dissolves the pellets and leaches the herbicide down to the root system. Optimal time for treatment is towards the end of the rainy season to prevent leaching beyond the root zone. Large broom clumps have been successfully treated by hand applied granules of picloram (Green 1976).

The California Dept. of Parks and Recreation is attempting to control broom in several of their parks (Ryburn 1985). The topographic relief in Mt. Tamalpais State Park is severely limiting the success of weed control at any great distance from roadways. Roadway spraying of broom with Roundup may be the most feasible method. Broom control is more manageable in areas with less rugged terrain.

Mechanical removal and use of picloram (Tordon) over the last five years on Angel Island have been ineffective. Picloram was sprayed on the broom plants but "flashed-back" into surrounding vegetation, creating undesired damage. However, a pilot study using Roundup has produced good results on Angel Island. Use of Roundup at Sinkyone Wilderness State Park has also been effective. At Sinkyone the herbicide sprayer is mounted on a horse to reach distant infestations.

Broom control at Jughandle State Reserve is conducted simultaneously with gorse control. Thickets are sprayed with Roundup to desiccate the plants and then burned. There is a small amount of resprouting which can be subsequently controlled with more Roundup.

Contact: Marla Ryburn or David Boyd
State Park Resource Ecologist
California Dept. of Parks and Recreation
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Santa Rosa, CA 95403©2183
(707) 576-2185 or 576-2310

Thomas Reid Associates, working with the County of San Mateo, is managing both broom and gorse on San Bruno Mountain (Reid 1985). Thickets are mechanically disked and then burned. This promotes seed germination and exhausts the seed bank. Seedlings and resprouts are spot treated with two applications of Roundup. All phases and tools of the program are working well, and native species are returning. Ninety percent restoration of the habitat is expected within ten years, but management should be continued long beyond that.

Contact: Thomas Reid or Victoria Harris
Thomas Reid Associates
P.O. Box 872
Palo Alto, CA 94302

The California Native Plant Society encourages volunteers to participate in "broom-bashing" parties (Nackley 1985). These control efforts rely on manual removal of plants and use no herbicides. No quantitative evidence was available to determine the effectiveness of these efforts.

Contact: Bonnie Nackley
California Native Plant Society
Marin Chapter
P.O. Box 146
Lagunitas, CA 94938
(415) 488-9638

Manual removal of broom is being done at TNC's Northern California Coast Range Preserve, and repeated treatments may eliminate it there (Barrows 1985).

Contact: Peter Steel
Northern California Coast Range Preserve
42101 Wilderness Road
Branscomb, CA 95417
(707) 984-6653

Nona Dennis of ESA-Madrone has written a management plan for a coastal resort near Fort Bragg, Mendocino County, which includes suggestions for monitoring and controlling broom. No results are yet available.

Contact: Nona Dennis
Vice President
ESA-Madrone
23 Pamaron Way
Novato, CA 94947
(415) 883-0484

The El Dorado County government is managing broom throughout the county. Foliage spraying with 2,4-D or Roundup is used but must be repeated from year to year. Mechanical means are avoided as they are believed to disturb the soil and create an excellent seed bed for broom seedlings (Delfino 1985).

Other people to contact regarding broom management programs in California include Bob Hubbell (916/644-2345) of the Mt. Danaher Research Station, Jackson State Forest (located in the northern Coast Range), who is presently engaged in a broom removal project; Gary Strachen (408/649-2862) of the Monterey Central Coast Region of California Parks and Recreation Department who is in charge of managing Scotch broom in Mt. Diablo State Park; and Ralph Carhart who works for CalTrans and has been instrumental in assuring that CalTrans no longer plants broom along rights of way.

Spanish broom is the least widespread broom in California and is considered less of a problem than Cytisus. Little quantitative information is available on its biology and ecology. Parallels may exist with the related Cytisus scoparius. Control of adult plants should begin with removal of at least the above-ground portion either by hand, machine or fire. As broom stumps may resprout, it is best to remove a majority of the root system. Stumps may be treated chemically if root removal is not pos¬sible. Seeding with native species in areas where broom has been removed may lessen the chances of survivorship of subsequent broom seedlings. Biological control of Spanish broom has been poorly explored.

VI. RESEARCH

Management Research Programs:
Monitoring is needed to determine the effectiveness of management practices.

Detailed observations focused on the vegetational change of the affected area over time will help to determine what method of control would be most efficient.

No quantitative monitoring studies of Spanish broom were discovered in this research. In California qualitative monitoring of control efforts for other weedy brooms are being conducted along with management programs at San Bruno Mountain, TNC's Northern California Coast Range Preserve, Mt. Tamalpais State Park, Angel Island State Park, Siskiyou Wilderness State Park, Jughandle State Reserve, and in El Dorado County

It would be useful to more thoroughly document the conditions under which broom initially establishes itself. If it is true that broom is shade intolerant and can be displaced by taller growing species, why has broom spread so quickly throughout California? Is initial establishment due to soil disturbance, overgrazing, improper fire management, or some other factor? Broom seeds buried more than 10 cm do not germinate. Is it possible to burn a broom stand and then disk the debris in an attempt to bury all broom seeds? The seeds would still be viable and ready to grow rapidly with future soil disturbance, but the rapid establishment of a dense native vegetative cover may adequately prevent seedling emergence.

John Cliezewitz, Dept. of Pathology, University of California, Davis (916/752-0309), is studying a fungus which may prove to be pathogenic to Scotch broom. His findings may prove relevant to the control of Spanish broom. As of May 1985 he was still waiting for his plants to size up to begin his experiments.

Rosemary Lien is just beginning research at the University of California, Berkeley, to study native lupine moths to determine whether or not they would be useful in controlling broom (Nackley 1985).

VII. ADDITIONAL TOPICS

VIII. INFORMATION SOURCES

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