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Management and Control of Gorse and Scotch Broom in British Columbia

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The Problem

Scotch broom (*Cytisus scoparius*) and gorse (*Ulex europaeus*) are two exotic weeds that were introduced to Vancouver Island in the last 150 years. They are very aggressive and invasive and have come to dominate many landscapes, often replacing native species. Roughly ten percent of Vancouver Island is infested with these species and this area is increasing each year. Of particular concern is their threat to the unique and endangered Garry oak (*Quercus garryana* Dougl.) ecosystems on southeastern Vancouver Island and the southern Gulf Islands of British Columbia. They quickly form dense thickets that can effectively shade out native vegetation and reduce biodiversity. On forested lands these weeds interfere with fibre production by limiting the growth of commercially important conifer seedlings (Prasad 2000). They are nuisance species as they occupy desirable land and limit agriculture, grazing, recreation and other activities. Furthermore, gorse has a high concentration of volatile oils in its branches and produces considerable biomass which creates a fire hazard.

Invasive weeds, like Scotch broom and gorse, are a threat to native ecosystems, like the endangered Garry oak woodlands.

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Range

Both plants, although most prevalent on the drier, southern portion of Vancouver Island where they were initially introduced, have expanded their ranges along the coast of British Columbia. Pockets of infestations extend to the Queen Charlotte Islands, the nearby Gulf Islands, and to some areas of the mainland. Isolated patches of broom have been reported along Kootenay Lake and Castlegar in the interior of the province. Scotch broom also exists along the coast in Atlantic Canada (Peterson and Prasad 1998).

Characteristics

Scotch broom and gorse have numerous characteristics that promote their invasiveness and displacement of native plant species:

- capability of forming dense, one-species stands and thickets;
- rapid vertical growth and intense spatial competition;
- adaptability to varying ecological niches;
- profuse seed production (a mature plant of three to eight years can produce 6000-18,000 seeds per year);
- longevity of seed banks (seeds can remain viable in the soil for more than 30 years with up to 20 000 seeds/m^2 in the top 6 cm of soil);
- long life span (plants can live up to 30 years);
- nitrogen fixation capability;
- deep roots;
- reduced leaves and active stem photosynthesis during unfavorable (winter) periods;
- tolerant to drought and cold; and
- lack of natural enemies (parasite-predator complexes).

Broom is an aggressive colonizer of disturbed sites. Rapid development of both roots and foliage enables it to invade and persist in new habitats. In comparison to Scotch broom, gorse generally invades drier areas, and more gradually. However, it is often able to persist longer at a given site and, once established, is more difficult to control (Clements et al. 2001). In general, both broom and gorse eventually form a major component of the disturbed areas they occupy. They are highly competitive with native forest vegetation for space, light, nutrients and water (Prasad 2000). A stand of gorse or broom can perpetuate itself for many years, effectively excluding most of its competitors. Gorse and broom are difficult plants to control. They multiply, proliferate and invade largely by production of enormous amounts of seed, 6000 to 18 000 per plant per year. Half of these remain viable for 30 to 40 years. The resulting vast seed bank is capable of producing seedlings for a long time.

Gorse is highly competitive with native vegetation for space, light, nutrients and water, and interferes with seedling growth and fibre production on commercial forest land.

Investigation in Control Methods

In 1999, a project was initiated to investigate eradication and control methods and develop a management strategy for broom and gorse on Department of National Defense (DND) properties on Vancouver Island, British Columbia. Existing control methods, cited in the literature and in operational use, were reviewed. From this review, it was determined that control protocols for broom did exist, however, no control method for gorse, appropriate for use on DND property, was found. Operational trials and research plots were established based on this information.

Broom Control

From the review, it was determined that the best control method available for broom was to cut mature plants at the start of the drought season to reduce resprouting and then, each year, pull any seedlings that reach 0.5 m in height. Operational removal of Scotch broom, by manual cutting and chipping, began in 1999 on a number of DND sites. Long-term monitoring plots were set up to study the re-establishment of Scotch broom and the succession of other species on these sites.

The invasion of Scotch broom (yellow plants) and gorse (brown plants) on this DND property at Rocky Point, BC makes training sites inhospitable and compromises the native biodiversity of the area.

Results showed that the incidence of sprouting of the cut broom stems was minimal, confirming that cutting, at certain times, is an effective control strategy for broom. The number of species increased on the sites after the broom plants were removed, thus increasing the biodiversity. However, removal of the adult plants promoted the emergence of numerous broom seedlings from the enormous seed bank in the soil. It is imperative that the ground cover and soil not be disturbed more than is absolutely necessary. Disturbance creates good seedbed conditions for broom seedlings and other invasive species, such as grasses.

To study the effectiveness of other control methods on Scotch broom, an experiment similar to the gorse study, described below, was established in 2002 at Rocky Point. The sites will be monitored for three years and control recommendations amended as results become available.

Gorse Control

In 1999 a field experiment was set up on three sites at the Rocky Point DND property near Victoria, British Columbia to test the effectiveness of four control methods on the resprouting behaviour of gorse – a bioherbicide agent (*Chondrostereum purpureum*, Cp), a triclopyr herbicide (Release®), plastic mulch, and manual cutting (for details of the experimental design see Prasad and Kushwaha [2001b] and Prasad [2002]). For all treatments, adult plants were cut to a stump height of less than 10 cm. The herbicide was applied with a squeeze bottle at the rate of 3 ml/stem to the cut ends, within one minute of being cut. In the mulching treatment, adult plants were cut and a black plastic mulching (landscaping) cloth was secured to the ground to cover the stumps. The control treatment used a blank carrier solution (no bioherbicide) to isolate the effect of the fungus. The study sites were monitored over a three-year period. The herbicide (Release®; active ingredient triclopyr, 480 g/L) is fully registered for forestry use in Canada.

Chondrostereum purpureum (Cp) is a bioherbicide which has been found to be as effective as the herbicide Release® at preventing resprouting of 2- year-old Scotch broom plants in greenhouse trials (Prasad and Kushwaha 2001a; Prasad and Naurais 1999). It was included in the trials at Rocky Point to test its effectiveness in field conditions on gorse. Although it has been researched and patented, it is still considered to be experimental as it is not yet registered for use in British Columbia nor readily available in the market.

Gorse Control Results

The results of the field trials demonstrated that applying a herbicide to the stumps immediately after cutting, appears to be the fastest, most effective way of killing gorse. However, in the long run, both the mulching and herbicide treatments were effective and completely suppressed resprouting. The triclopyr herbicide (Release®) was found to be highly efficacious; there was 100% inhibition of resprouting in these plots and no regrowth occurred. The herbicide acted quickly and killed the roots, whereas mulching treatments were slow acting initially, but after two years they also proved to be highly effective (100%). Mulching with plastic ground cover suppressed resprouting, but underneath the mulch some resprouting occurred which eventually died under the mulch in the subsequent year. Of greatest interest was the total suppression of emergence of new seedlings under the mulch: there was no recruitment of new seedlings under the mulch.

Results varied in the plots treated with the biocontrol agent Cp. In some treated stems, slow, diseased or deformed regrowth occurred. In others, many cut stems resprouted, but they were stunted. The bioherbicide killed about half of the resprouts after two years. It acted more slowly than the herbicide since its' mycelia require time to penetrate, establish and infect the host.

It was also found that cutting gorse without any treatment does not work under these conditions. If an adult plant is cut off, there is prolific resprouting on the stem from anywhere slightly below the root collar and upwards. There was profuse resprouting in the untreated control and the control treated with the blank formulation. Resprouting can occur on the stump as early as three weeks after cutting. Sprouts may appear on the lower part of the stem of adult plants if the stem is exposed to sunlight. This confirms that cutting stems at or above ground level does not kill the plant.

An investigation into the regeneration potential of gorse roots in both field and greenhouse conditions (Prasad and Robinson, 2002) found that gorse does not appear to regenerate from the roots. The adult plant can effectively be killed by pulling it out by the roots, cutting off live stems 5 cm *below* ground level, or treating the stump with a herbicide, or mulching cover.

However, most types of control, no matter how successful initially, will likely fail unless there is follow-up treatment. The initial effectiveness of the treatment, i.e., the killing of the adult plants, is often negated in the long term by the emergence of numerous seedlings from the enormous seed bank under and around the adult plants. Mulching was the only treatment which had any effect on controlling the emergence of new seedlings.

A single, mature gorse plant can produce 6000 - 18 000 seeds per year.
Control efforts must consider the vast resulting seed bank which is capable of producing seedlings for a long time.

Management Strategies

The following control strategies for broom and gorse are recommended based on information and experience gained from the literature, operational trials and research.

Recommendations for Controlling Gorse

- Remove the entire adult plant:
    - Since gorse is capable of resprouting from cut stems, ideally the entire adult plant should be removed, roots and all. Where practical, adult plants should be uprooted, by pulling or with a brush rake, with the roots left to dry.
    - This method is not appropriate for sensitive sites or sites with species at risk.
    - This should only be done on heavily disturbed sites, as much soil will be exposed and gorse seeds in the soil will grow as a result.
    - Due to the high level of ground disturbance, a large number of gorse seedlings can be expected to emerge and should be pulled out before they become too large.

- Cut the plant below ground level:
    - Since adult gorse plants do not tend to resprout from roots, the plant can be killed if the stem is cut *at least 5 cm* below ground level. However, care must be taken because prolific resprouting will result if the stem is cut anywhere above the root. This method is most applicable to small areas because it is extremely difficult and labour intensive.

- Cut the plant and treat the stump:
    - Cutting the adult plants and painting the stumps with a herbicide (Release®) immediately after cutting appears to be the most effective way of killing gorse on most sites.

- Mulching:
    - Mulching a large area with uneven terrain is not economical, but mulching may have some limited application on small, selected areas where other methods cannot be employed.

- The uprooted or cut plant material should be disposed of by chipping or removed from the site to avoid creating a fire hazard. Burning gorse may not be desirable due to the high content of volatile oils in the branches which creates an oily, black smoke.

- Follow-up treatments will be necessary to control the seedlings that emerge from the seed bank. The seedlings should be pulled out by hand before they reach 0.5 m in height, and not cut as cutting promotes sprouting. Since gorse seedlings are fairly slow growing, this follow-up treatment will likely not be required until the second year after the initial treatment. It should be repeated every few years until the gorse plants are totally eradicated from the site.

- The initial treatment will be the most expensive due to the size of the adult plants, but follow-up treatments will be considerably less costly and will become less expensive for each successive treatment.

- New infestations of gorse should be treated before older infestations. Younger plants are smaller and therefore easier and less costly to remove. Early eradication also prevents the build up of a large seed bank on the site.

- Priority should be given to removal of gorse within 10 m of roads to prevent spread of seeds by vehicles. Roads should be surveyed once a year for new gorse infestations. These infestations should be removed by pulling the plants before they seed and create a seed bank.

Recommendations for Controlling Scotch Broom

- Cutting:
    - If the adult plants have stems larger than 2 cm in diameter they should be cut off low to the ground. If the plants are cut when the carbohydrate food reserves are lowest in the root (after flowering) or at the start of the drought season, the incidence of resprouting should be low. Any sprouts that occur may not survive the drought period in the summer.
    - If the stems are less than 2 cm in diameter they should be pulled out, either by hand or with a broom puller, and not cut. Seedlings and smaller plants have a greater tendency to sprout after cutting than adults plants.
    - The initial treatment, including chipping, may cost about $1000/ha; the first follow-up treatment will cost about $300/ha; the cost of subsequent follow-up treatments will continue to decline.

- Cut the plant and treat the stump:
    - Cutting the adult plants and treating the stumps with a herbicide (Release®) immediately after cutting appears to be an effective way of killing broom (Prasad and Kushwaha 2001a).
    - The cut plant material should be disposed of by burning, chipping or removed from the site, to avoid creating a fire hazard.
    - A follow-up treatment should be carried out to control emerging seedlings before they reach 0.5 m in height. Since broom seedlings grow much faster than gorse, this follow-up treatment may be needed before the second year after the initial treatment, and repeated every few years until the broom plants are totally eradicated from the site. The seedlings should be pulled out by hand and not cut, as cutting promotes sprouting.

The broom experiment plots installed at Rocky Point in 2002 will be remeasured for three subsequent years to determine the long-term effects of the control treatments. Control strategies for broom may be amended as results from this project become available.

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