Impacts of broom (*Cytisus scoparius*) in western North America

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Summary

There are many economic and ecological consequences of the success of the introduced weed, broom (*Cytisus scoparius*), in western North America. Results of a survey of landowners and managers involved in forest regeneration and with roadside vegetation management are presented, and some ecological impacts are described and their extent is discussed. While there are some positive economic impacts, the negative effects of broom are considerable and conservatively amount to more than US $11 million ($A16.5 million) in western North America. Many of the ecological impacts of broom invasion are not known, or are poorly understood, but its role in stabilizing dunes along the western coastline of North America is substantial.

Introduction

Distribution of broom

Broom (*Cytisus scoparius* (L.) Link) has been introduced into and established in Australia, eastern and western Canada, Chile, India, New Zealand, Japan, South Africa and eastern and western regions of the United States (Holm *et al.* 1979, Hosking *et al.* 1996, Luken and Thieret 1997). Its native range extends from Sweden in the north to southern Spain and the Azores, and from Ireland in the west to west central Ukraine (Tutin *et al.* 1968). It is known in Canada from the provinces of British Columbia, Nova Scotia and Prince Edward Island, and in the United States from the states of Alaska, California, Connecticut, Delaware, Georgia, Hawaii, Maryland, Maine, Montana, North Carolina, New Jersey, New York, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, Utah, Virginia, Washington and West Virginia (Luken and Thieret 1997). Its range in the western United States is expanding, and densities of broom within its established range there are also increasing. Formerly regarded as a species best adapted to coastal climates, broom has established in areas within the continental climate of the Great Basin of the western United States, growing to maturity in five eastern Oregon counties, in eastern Washington (Lantz 1996), and in Idaho (Callihan and Miller 1994). Broom was introduced into western Canada in 1850 (Pojar and MacKinnon 1994), and it now occurs on southern Vancouver Island, north along the mainland coast several hundred kilometres, and eastward from Vancouver about 120 km, with scattered occurrences in eastern British Columbia (Dorworth *et al.* 1996).

The first records of broom in Oregon are from the late 1880s, and broom has steadily increased its range since then to the present (see Figure 1). The current extent of broom in western United States is illustrated in Figure 2.

Status of broom as a pest

In the western United States, broom is now regarded as a pest and is listed on noxious weed lists for California, Washington and Oregon. It is also generally regarded as a pest in British Columbia although it is not listed there as a noxious weed (Dorworth *et al.* 1996). It is listed on the All States' Noxious Weed Seed List maintained by the United States Department of Agriculture (USDA) Agricultural Marketing Service's Seed Regulatory and Testing Branch (Anon. 1998). It is regarded as a common weed in Hawaii and Iran, and as a principle pest in New Zealand (Holm *et al.* 1979) and as a noxious weed in parts of Australia (Parsons and Cuthbertson 1992).

General comments on impacts of broom

There are different perspectives on impacts of broom in western United States. For example, the main concern of foresters is broom's interference with regeneration of Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) plantations; road maintenance personnel are concerned with the influence of broom and other brushy species on sight safety distance and erosion near roadsides; and natural area managers are concerned with broom's interaction with both physical and biotic characteristics of the landscape. In the forestry setting, actions are often taken which directly target broom. In many settings

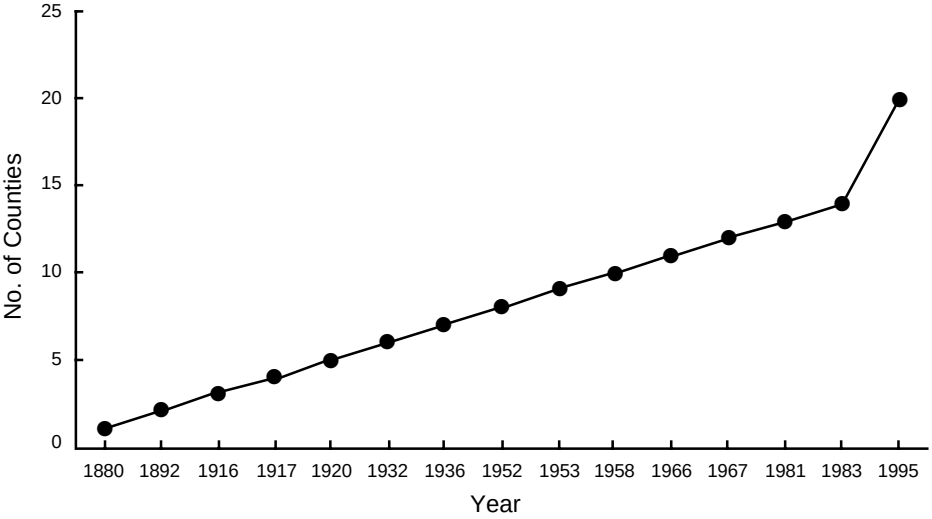

Figure 1. Extent of broom (*Cytisus scoparius*) in Oregon.

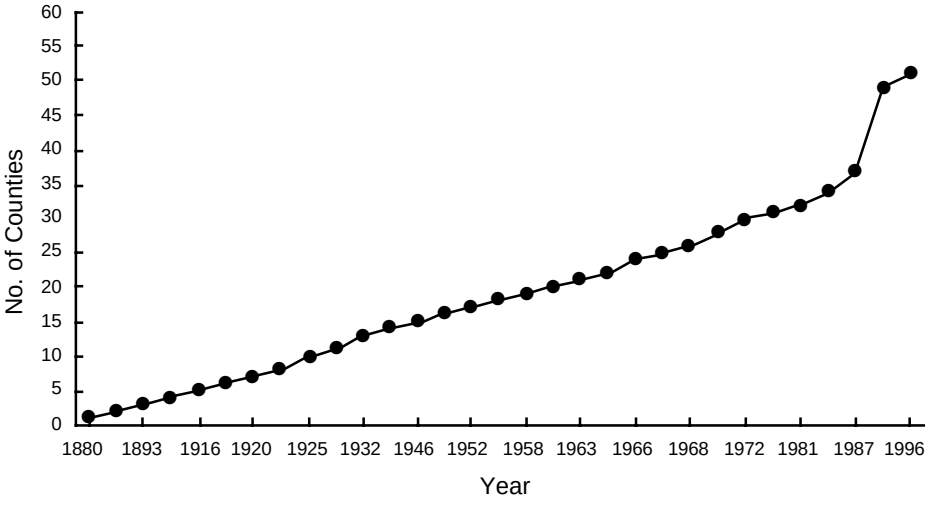

Figure 2. Extent of broom (*Cytisus scoparius*) in the Pacific Northwest of the United States of America.

along roads, broom is but one of the plants that cause problems with sight safety or erosion, and there are fewer instances of actions being taken that directly target broom. In the case of landscape change, broom interacts with other species to alter successional change and physical features of the landscape. Evaluating impacts of broom from such differing perspectives presents a challenge; we would like to have a common measure of utility that would neatly summarize the importance of broom, but we do not.

In this overview, I take two different approaches to evaluating broom's importance. First, I outline some important economic impacts of broom in three different areas; forestry, roadside treatments and nursery production. Secondly, I describe broom's role in one particular landscape setting, that of oceanside dunes, to show the extent and complexity of changes broom may cause.

Economic impacts of broom

There are two recent surveys of the economic impacts of broom. From one, I developed several estimates that summarize: (i) the extent of broom in western Oregon on industrial forest lands and on federal forest lands administered by the United States Department of the Interior's Bureau of Land Management (BLM), (ii) the extent of broom infestations along western Oregon public and private roads, (iii) treatment costs in forest and roadside settings. In the other, I assessed the benefits to the nursery industry in Oregon of brooms.

Economic costs of broom in forest regeneration and road maintenance

Dense stands of broom prevent establishment of native and desirable plant species. This is particularly true in forest settings, where broom interferes with reforestation efforts (Balneaves 1992). Dense stands of broom also cause safety problems. Broom often grows along roadways, and can reach two to three metres or more in height, and this can create sight-safety hazards, particularly at intersections, driveways and around bends. It is also a fire hazard (Goeden 1978), of concern in both forest and roadside settings, and, like gorse (*Ulex europaeus* L.), can be a fuel source for quick-burning fires.

In 1998, Decker (1998) completed a survey of foresters and road maintenance managers in an attempt to quantify some broom impacts in forests and along roadsides in western Oregon. She sent surveys to 48 private industrial forestry firms, 15 BLM forest management units, and 60 private and public organizations with road maintenance responsibilities. Responses were returned from 32 of the 48 forestry firms, representing management and/or ownership of 1.3 million ha, and 12 of the 15 BLM units representing 0.5 million ha of publicly held lands in forest production. There were 42 road maintenance responses, representing nearly 32 350 km of roads.

(a) Forest regeneration. Broom was reported as a significant or dominant plant on 46 000 ha of privately held forest land, and broom was reported as present on about 84% of units undergoing regeneration. Broom was regarded as more difficult to control than other weedy species by 84% of respondees, and only three respondees did not consider that broom increased yearly production and maintenance costs within their operations. Private foresters reported manual and/or chemical treatments on more than 2670 ha of broom annually. These foresters also reported annual treatments on 22 250 ha for brush control where broom was a component of the target vegetation, but where it was not dominant. Annual treatment costs targeting broom averaged $US424 000 ($A636 000) over the previous three years at $US158 ($A237) ha^{-1}. Manual costs for broom treatments were more costly at $US238 ($A357) ha^{-1}, but few areas were so treated.

BLM personnel reported broom as significant or dominant on 49 000 ha in publicly-held forest production. There were no chemical treatments on BLM lands, due to herbicide use restrictions, and one unit initiated a five-year manual treatment program on 32 ha. Infestation and control data for forestry settings are summarized in Table 1.

(b) Road maintenance. Private road managers maintaining 15 050 km of road reported broom on 805 km of their roadsides. Of these, 355 km were seriously affected by broom, and they expended $US40 250 ($A60 375) annually for treatment. Non-federal public road managers maintained 19 950 km of road, 3780 of which were reported with broom. Average costs for vegetation management on these roads were $US1163 ($A1745) km^{-1}, but there were few treatments that targeted only broom. BLM road managers reported maintaining 13 440 km of roads, 915 of which had broom as a significant or dominant component, with treatment costs of $US786 ($A1179) km^{-1}. Infestation and control data along roadsides are summarized in Table 2.

Table 1. Broom control in western Oregon forests (based on Decker 1998).

Forest ownership	Managed area (ha)	Area requiring and/or monitoring treatment (ha)	Area requiring and/or monitoring treatment (%)	1997 treatment costs ($US)	1997 treatment area (ha)
Private industrial forestry firms[A]	1 300 000	46 000	3.56	424 000	2 670[D]
US Department of Interior, Bureau of Land Management[B]	500 000	49 000	8.13	8 000[C]	32[CD]

[A] 32 responses from 48 surveys. [B] 12 responses from 15 surveys. [C] Not from Decker (1998).
[D] Treatment specifically for broom, not general brush control.

Table 2. Broom control along western Oregon roadsides (based on Decker 1998).

Road owners/managers	Road maintained (km)	Infested with broom (km)	km broom (%)	Broom treatment (km)	Broom treatment costs ($US)
Private industrial forestry firms	15 050	805	5.3	355	40 250[C]
Non -federal public	19 950	3 780	19.0	–[B]	
US Department of Interior, Bureau of Land Management	13 440	8 940[A]	66.7[A]	915	181 250[C]

[A] From % categories reported for 9 of 15 surveyed units, these figures contain a bias towards over-estimation. [B] No reports of treatments specifically for broom. [C] Treatments by forestry firms mainly chemical treatments; Bureau of Land Management treatments are manual/physical and often directed at maintaining right-of-way rather than of a specific target weed infestation.

Benefits of broom production to Oregon nurseries

Broom is valued for its showy flowers, for its capacity to serve as a visual screen, and for its ability to persist in settings with a minimum of maintenance where other plants do poorly. Because of these attributes, broom and derived cultivars have been produced by nurseries in California and Washington for several decades. Broom has also been imported from other countries for resale. Relative to the industry as a whole, production and demand for these products has declined, and only a few Oregon nurseries are still producing and selling broom products, but production is a significant source of income for a small number of nurseries.

The Oregon Association of Nurserymen annually publishes a directory of its 1400-odd members, which includes production and sales figures volunteered by participating nurseries. Directories from 1991, 1995 and 1997 (Oregon Association of Nurserymen 1997) were reviewed and data extracted on numbers of nurseries handling broom and the volume of broom they processed.

Twenty-five Oregon nurseries reported handling broom or related cultivars in 1997. Ten reported producing or importing seedlings, and 23 reported producing container and/or bareroot plants. Of the 10 nurseries reporting handling of seedlings, nine reported the quantity they handled, and 18 of the 23 nurseries producing containers/bareroot plants reported quantities of production.

Reported production of broom and derived cultivars in 1996 totalled 183 500 plants, up from reported production in 1990 and 1994. The value of 1996 production, at wholesale values of $US0.30 ($A0.45) for seedlings and $US1.25 ($A1.88) for containers and bareroot stock, was $US176 250 ($A264 375), an increase in value of more than 45% over earlier reports.

Washington weed laws prohibit the sale of broom plants and seeds, and the Oregon Department has proposed an administrative rule change, which would likewise prohibit sales of plants and seeds in Oregon. Production and sales of broom products in California and British Columbia are unknown, but certainly would be much less than those in Oregon.

Discussion of economic impacts of broom

Decker's (1998) survey captured data from important major sources, but there are notable omissions. In forestry, neither the holdings of the USDA Forest Service (USFS) nor those of small woodlot owners are represented. In western Oregon USFS holdings would be roughly equal to those of the BLM, and those of small woodlot owners would nearly be so. In designing the survey, Decker determined that the number and diversity of small woodlot owners would complicate the survey beyond her intended scope. While the dispersion of BLM and USFS lands are quite different, with the USFS lands being more 'blocked up' and less dispersed, their management, particularly with respect to the restrictions of the use of herbicides, is similar.

Also, while the return rates for Decker's survey were quite respectable, there were segments of each of the target categories that did not respond. Data summarized from returned surveys thus result in underestimates, and correcting for underreporting may give more accurate estimates.

Decker's survey targeted Oregon land owners and managers exclusively. If economic impacts for broom are to be representative for the western United States, we must make some assumptions about impacts in Washington and California. Based on the distribution of broom shown in Figure 2, the extent of broom within each of the states is comparable, and we have no other data. British Columbia could also be said to have about the same amount of broom as any of the states mentioned (Dorworth *et al.* 1996). Rough estimates for adverse economic impacts for the western North America then could be about four times those for Oregon.

Assuming that production and sales of broom products in British Columbia and California together equal those of Oregon, current direct economic benefits of broom are on the order of $US350 000 ($A525 000) annually. Oregon will likely prohibit production and sales after 1999, and this figure might then be halved. Decker's study provides us with the perspective to make reasonable and conservative assumptions about treatment and opportunity costs of broom in forest regeneration and along roadsides, and if we assume that British Columbia and the other states invest comparable amounts in broom management, we have justification for saying that more than $US11 million ($A16.5 million) annually is directed to broom efforts. This figure would not include several other important economic cost categories, for example, losses and treatment costs in livestock production.

Broom in oceanside dune areas

Oregon's coastline measures over 485 km north and south. Coastal physiography tends to alternate within this reach between rocky headlands and sandy dunes and spits. The sand-based features of Oregon's coast tend to be dynamic and ephemeral under natural conditions, but there have been a number of human efforts to stabilize these areas to allow their use and to permit transit over them.

A north-south federal road was not completed along Oregon's coast until 1936, and both the rocky headlands and the sandy areas represented challenges to the completion of this road, US Highway 101. After the road was completed, sand movement onto and over the road caused closures and was a major maintenance concern. An effort was mounted to stabilize active dune areas, much of it utilizing combined plantings of marram grass (*Ammophila arenaria* (L.) Link) and broom. This reduced velocity of sand-moving winds and allowed establishment of other vegetation. By 1955, 3992 ha of dunes had been planted on USFS, state, county and private lands along 77 km of coastline between Florence and Coos Bay at a cost of $US618 ($A927) ha^{-1}. The BLM planted another 506 ha (Parker 1958).

In terms of the original rationale for planting broom, these early efforts have been remarkably successful. Sand encroachment on roads is now a minor concern, stabilized sandy areas have been developed as residential and commercial areas, and productive coniferous forests have established over much of the remaining area.

Much of what was, however, termed a 'dune problem area' is now managed by the USFS as the Oregon Dunes National Recreation Area (NRA) and considered a valuable natural resource. Broom and other introduced plants interfere with current management objectives. The protection of snowy plover (*Charadrius alexandrinus* Linnaeus) habitat is an example. Windswept open beaches, the nesting habitat for the plover, decreased with sand stabilization, and the succession of vegetation to spruce (*Picea sitchensis* (Bong.) Carr.) and coast pine (*Pinus contorta* Dougl.) forest provided cover for predators of plovers and their eggs, such as crows, ravens, and skunks. Beach areas suitable for nesting are closed to public use, and large and expensive projects are now underway to remove vegetation from many areas, and broom is one of the main target plants.

Dilemmas like these are not limited to the Dunes NRA. Broom has been planted along much of the west coast of the United States, and there are benefits and costs derived from broom's role in altering patterns of succession in coastal areas. Throughout the area where broom is now established, it is a direct competitor with native legumes, and this is especially troublesome in the case of the threatened *Lupinus sulphureus* Dougl. var. *kincaidii* (Smith) Hitch., which is the exclusive host of another threatened species, Fender's blue butterfly (*Icaricia icarioides* Boisduval).

Broom is a more successful functional analog of lupins in many ecological settings, and in this case is encroaching into the natural meadows, which are habitat for this lupin.

Discussion of broom impacts

One of our main interests in understanding impacts of broom is in having the information needed to support decisions as to whether to, or how much, we should invest in efforts to manage it. In site-based settings, private industrial foresters clearly believe that control is necessary, although the documented amount of their annual investment in such control is modest. Federal land managers are also investing in site-specific control in conservation efforts other than for forest regeneration, and we can observe other examples of site-based attempts at controlling broom. Coordination of large-scale management of broom is, however, lacking. Individuals and organizations make local decisions on broom control, but rarely do they cooperate on management projects even though there is consensus that problems associated with its spread are increasing.

While there is evidence that there is justification for a coordinated project targeting broom, one deterrent is that, in relation to other issues and problems, broom is not a priority with most landowners and managers. Even limiting discussion simply to weed issues, broom would not have highest priority, as other species, particularly European blackberries (*Rubus* spp.), generate more interest and concern.

The one opportunity for coordinated efforts directed at broom control that seems practicable at the present time is biological control. Throughout western North America, successful control of tansy ragwort has put biological control in favour, and there is general support for organizing and sustaining a biological control project aimed at broom. Both public and private interests have supported research to date through modest contributions to a control fund, and prospects for continued support are encouraging.

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Status of broom in New Zealand

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Summary

Broom (*Cytisus scoparius* (L.) Link) is the only broom species that is a declared noxious weed in New Zealand. It was first recorded in the wild in 1872 and is now widespread and abundant on a range of soils (esp. of alluvial or colluvial origin), particularly the drier eastern side of the South Island and in central North Island. The range expansion of broom has been most dramatic over the last 50 years, but it continues to invade new areas. Broom grows more vigorously in many parts of New Zealand than in its native range, obtaining a greater maximum age and a larger size. It occupies open habitats, from sea level to 1200 m, invading native tussock grassland, introduced pasture, riverbed and wasteland throughout productive and conservation areas. Broom causes economic losses to agricultural and forestry operations, and detracts from conservation values. Establishment costs of exotic pine forests are increased by the need to clear broom from plantation sites, and reinvasion by the weed reduces the rate of pine growth. Broom is a serious invader of pastoral land, particularly in drier hill country areas, where substantial losses to agricultural production may result. In the South Island it has been estimated to occupy 0.92% of farmable land. In some situations grazing management can contain broom, and where further control is necessary, herbicides, although expensive are effective. Cutting and burning have also been recommended in certain situations. Habitat of nesting native birds on open riverbeds is threatened when broom and other scrub species invade and provide cover for predators. On the positive side, broom is regarded as a useful pollen source by New Zealand beekeepers. In some environments it can play a role in encouraging succession to native bush, and in some areas it may provide an important spring food source for the native pigeon. However, its negative environmental effects are much greater than its positive effects, and a recent update of the cost-benefit analysis for biological control of broom in New Zealand showed a clear net benefit from its control.