

Annotated Bibliography on the Ecology and Management of Invasive Species:

Gorse (*Ulex europaeus*)

**Prepared by Judith Cullington & Associates, Victoria, BC
for the Garry Oak Ecosystems Recovery Team
and the Nature Conservancy of Canada**

Funding supplied by the Habitat Stewardship Program of the Government of Canada

March 2002

Balneaves-J-M {A}; Davenhill-N-A, 1990

Title: Triclopyr The Forest Managers' Alternative To 2,4,5-T?

Source: New-Zealand-Journal-of-Forestry-Science. 1990; 20 (3): 295-306.

Publication Year: 1990

Language: ENGLISH

Abstract: Two triclopyr formulations (3,5,6-trichloro-2-pyridyloxyacetic acid) were evaluated at various rates sprayed over three tree species (*Pinus radiata* D. Don, *Cupressus macrocarpa* Hartweg, *Pseudotsuga menziesii* (Mirbel) Franco), and the likely impact on gorse (*Ulex europaeus* L.) regrowth after initial land clearing was assessed. Post-plant release spraying with triclopyr is feasible if rates do not exceed 0.6 kg/ha. Release spraying should be carried out before the flush of new growth in the spring (for *Ps. menziesii*, before bud swell) to avoid apical death, multi-leadering, and reduced growth. Triclopyr should be used in preference to triclopyr + picloram as it is less damaging to tree seedlings and gives more effective gorse suppression for the first year after tree planting.

Balneaves-John-M, 1992

Title: Silwet L-77 enhances rainfastness of glyphosate and metsulfuron-methyl when applied to gorse and Scotch broom.

Source: Plant-Protection-Quarterly. 1992; 7 (3) 109-111.

Publication Year: 1992

Language: English

Abstract: Glyphosate or metsulfuron-methyl with and without Silwet L-77 were applied to potted gorse (*Ulex europaeus*) and broom (*Cytisus scoparius*) plants, which were then subjected to simulated rainfall at intervals ranging from 2 min (0) to 24 hours after spraying. In the absence of Silwet L-77

rainfall reduced the effectiveness of both glyphosate and metsulfuron-methyl. Silwet L-77, especially at rates of 0.5%, aided rainfastness of glyphosate, and at 0.1% aided rainfastness of metsulfuronmethyl.

Balneaves-John-M, 1992.

Title: A comparison of surfactants to aid control of gorse and scotch broom with herbicides.

Source: Plant-Protection-Quarterly. 1992; 7 (4) 174-177.

Publication Year: 1992

Language: English

Abstract: Of the surfactants tested, only Silwet L-77 significantly enhanced the efficacy of glyphosate on gorse when used at 2.16 and 3.24 kg a.i. ha-1 providing 100% mortality by 72 weeks. Frigate and Cidekick 11 appeared to antagonize glyphosate (3.24 kg a.i. ha-1) control of gorse at the rates tested (2.0% and 0.75%, respectively). Metsulfuron-methyl at 120 g a.i. ha-1 achieved 100% mortality of gorse without surfactant; while at 90 g a.i. ha-1 the addition of Silwet L-77, Activator 90 or LI-700 gave faster brown-out and complete control. Bond appeared to antagonize metsulfuron-methyl. Triclopyr at 3.6 kg a.i. ha-1 gave 100% gorse mortality without surfactant; the addition of Silwet L-77, Frigate, or Cidekick II increased the speed of kill. These surfactants added to 2,4,5-T/picloram (4.32/0.3 kg ha-1) boosted gorse mortality to 100%. Complete mortality of Scotch broom was only achieved using glyphosate at 3.24 kg a.i. ha-1 with the addition of either Silwet L-77 and LI-

-700. Metsulfuron-methyl at 90 g a.i. ha-1 gave complete control but only with the addition of Silwet L-77. Activator 90 increased mortality of broom when added to both herbicides. Bond was ineffective with glyphosate and LI-700 was ineffective with metsulfuron-methyl (at the lower rate).

Balneaves-J-M; Gaskin-R-E {a}; Zabkiewicz-J-A, 1993.

Title: The effect of varying rates of glyphosate and an organosilicone surfactant on the control of gorse.

Source: Annals-of-Applied-Biology. 1993; 122 (3) 531-536.

Publication Year: 1993

Language: English

Abstract: The herbicidal effect of glyphosate applied to gorse (*Ulex europaeus* L.) was improved by the addition of increasing amounts (0.5-20 g/litre) of Silwet L-77, an organosilicone surfactant. Increasing the rate of herbicide also enhanced control. There was a highly significant interaction between surfactant rate and herbicide dosage; as the amount of Silwet L-77 was increased the rate of glyphosate could be reduced without loss of herbicide efficacy. However, without any added organosilicone surfactant, glyphosate did not provide more than 73% control of gorse at any rate up to 6.5 kg a.i./ha. With the addition of Silwet L77, complete

mortality of all plants could be achieved with 2.2 kg glyphosate/ha.

Chan-Kathleen-L; Turner-Charles-E, 1998

Title: Discovery of the gall mite *Aceria genistae* (Nalepa) (Acarina: Eriophyidae) on gorse and French broom in the United States.

Source: Pan-Pacific-Entomologist. Jan., 1998; 74 (1) 55-57.

Publication Year: 1998

Language: English

Clements-David-R {a}; Peterson-David-J; Prasad-Raj, 2001

Title: The biology of Canadian weeds. 112. *Ulex europaeus* L.

Source: Canadian-Journal-of-Plant-Science. [print] April, 2001; 81 (2): 325-337.

Language: English

Abstract: Gorse (*Ulex europaeus* L.) is a leguminous shrub native to western Europe and North Africa. During the past century it has greatly expanded its adventive range in Australia, New Zealand, Chile and Europe, and along the Pacific and Atlantic coasts of North America. In Canada, it is found in British Columbia (Vancouver, Vancouver Island, the Gulf Islands and Queen Charlotte Islands) where it is classed as a noxious weed. Gorse is also found from Virginia to Massachusetts on the east coast of North America. The shrub rapidly invades dry and disturbed areas, forming dense thickets that can suppress and inhibit native vegetation, including economically important conifer seedlings. It can occupy the same habitats as Scotch broom (*Cytisus scoparius* (L.) Link) but usually occurs on drier sites. Both of these legumes threaten native plant communities but *U. europaeus* persists longer and possesses conspicuous spines. Invasive characteristics of gorse include its evergreen habit, prolific seed production, longevity of seeds in the soil and nitrogen fixation. Human activities such as agriculture and construction of logging roads have accelerated the spread of gorse in British Columbia, but there is still an historic opportunity to restrict the population expansion that this species has exhibited in many other countries. Various methods of control (chemical, manual, biological and integrated) are evaluated.

Culliney-Thomas-W {a}; Nagamine-Walter-T {a}, 2000.

Title: Introductions for biological control in Hawaii, 1987-1996.

Source: Proceedings-of-the-Hawaiian-Entomological-Society. [print] August 30, 2000; 34: 121-133.

Language: English

Abstract: Introductions and liberations of natural enemies for the biological control of agricultural and forest pests in Hawaii are presented for the period 1987-1996. A total of 24 arthropod and 2 fungal species were released or

re-released (augmentation) by the Hawaii Department of Agriculture for the control of 4 weeds (*Clidemia hirta*, *Coccinia grandis*, *Passiflora mollissima*, and *Ulex europaeus*) and 9 insect pests (*Bemisia argentifolii*, *Brontispa chalybeipennis*, *Elasmopalpus lignosellus*, *Frankliniella occidentalis*, *Heteropsylla cubana*, *Liriomyza* spp., *Nezara viridula*, *Plutella xylostella*, and *Sipha flava*).

Delettre-Y-R, 1994

Title: Fire disturbance of a chironomid (Diptera) community on heathlands.

Source: *Journal-of-Applied-Ecology*. 1994; 31 (3) 560-570.

Publication Year: 1994

Language: English

Abstract: 1. Three different heathlands (dry, mesic and tall) were submitted to prescribed fire either in spring or in summer in Brittany (France). After the fire, the terrestrial Chironomidae were studied for 4 years using emergence traps. 2. The community consisted of eight chironomid species, of which five were numerically abundant and widespread at the regional level. 3. During the first post-fire year, the abundance of all species strongly decreased on all burnt sites except the mesic one. 4. In the following years, the species assemblages of burnt sites fluctuated, depending on the original type of heathland and changes in several parameters related to the fire intensity (biomass loss, plant cover, soil moisture). 5. While a light fire induced a restrained modification of the community on the mesic heathland, the total destruction of plants and litter on the dry heathland induced the growth of a gramineous layer where a single chironomid species proliferated. 6. On tall burnt heathlands, chironomid abundance strongly increased 2 years after burning and then dramatically declined, suggesting the use of an ephemeral resource. 7. Side-effects occurred on nearby unburnt heathlands due to the dispersal of adults from disturbed patches.

Edwards-Peter-J {a}; Ekins-J-Rue, 1997

Title: Morphology of gorse (*Ulex europaeus* L.) and its consequences for browsing by ponies.

Source: *Bulletin-of-the-Geobotanical-Institute-ETH*. 1997; 63 (0) 69-75.

Publication Year: 1997

Language: English

Abstract: 1. A method for determining the age of gorse plants (*Ulex europaeus* L.) in the field is described. Using this method it is shown how the vigour and morphology of gorse shoots change markedly with plant age. 2. In plants which have regrown after burning or cutting, the most vigorous growth occurs after 3-5 years, and there is a steady decline in vigour in older plants. 3. Ponies feeding on gorse in winter preferentially browse the shoots of young plants, despite their formidable spines, apparently

because the shoots are longer and thus more accessible. The management of gorse as winter browse for ponies is discussed.

Garcia-Gallo-A {A}; Wildpret-De-La-Torre-W; Del-Arco-Aguilar-M-J; Perez-De-Paz-P-L, 1989

Title: On The Presence Of *Ulex-Europaeus* L. In Tenerife Canary Islands.

Source: *Boletim-da-Sociedade-Broteriana*. 1989; 62 (2): 221-226.

Publication Year: 1989

Language: SPANISH

Abstract: Several considerations about the bushes dominated by *Ulex europaeus* L. subsp. *europaeus* in Tenerife, are made, as well as, we mentioned the meddlings of *Cytisus scoparius* and *Spartium junceum* in the insular territory.

Gloaguen-J-C, 1993.

Title: Spatio-temporal patterns in post-burn succession on Brittany heathlands.

Source: *Journal-of-Vegetation-Science*. 1993; 4 (4) 561-566.

Publication Year: 1993

Language: English

Abstract: Heathlands in the Paimpont area, Brittany, were ravaged by numerous fires in the summer of 1976. The period in which the fires occurred, and their intensity had important consequences for recolonization processes. In the tall *Ulex europaeus* heathland described in this paper, fire occurred relatively late (mid-July), and was of high intensity. Colonisation was mainly from propagules, often from species foreign to the original heathland. Plant succession together with vertical and horizontal structure was studied in permanent plots over 13 yr. Three stages were distinguished. Vertical structure varied greatly among the three stages. It was very simple in the colonisation phase, became more complicated during the competition phase, but became simpler again in the stabilisation phase. This was particularly evident for the moss layer, which, 13 yr after the fire, was made up of *Polytrichum commune* alone. Mosses showed interspecific competition with size as the decisive factor: the large mosses gradually eliminated the smaller ones. Horizontal structure was studied using spatial autocorrelation, which provided some indication of the distinctiveness and scale of spatial pattern. Some species were weakly aggregated such as *Ceratodon purpureus*, *Polytrichum piliferum*, and *P. juniperinum*, while others, like the *P. formosum*-*P. commune* complex, *Agrostis curtisii* and *Ulex minor* were strongly aggregated. In the current community, 13 yr after the fire, a mosaic can be distinguished with three components: (1) a moss layer of *Polytrichum commune* on which a herbaceous layer, dominated by *Agrostis curtisii* has developed; (2) a birch wood (both *Betula pendula* and *B. pubescens*), which

established on the Polytrichum - Agrostis combination; (3) patches of Ulex minor heathland, with a few Erica and Calluna plants. Extreme simplicity and stability are the two prominent features of the present vegetation state.

Gutierrez-Daid; Menendez-Rosa; Obeso-Jose-R, 1996

Title: Effect of ovule position on seed maturation and seed weight in Ulex europaeus and Ulex gallii (Fabaceae).

Source: Canadian-Journal-of-Botany. 1996; 74 (6) 848-853.

Publication Year: 1996

Language: English

Abstract: We examined the effect of ovule position within the pod on the probability of seed maturation and on seed weight in two woody legumes, Ulex europaeus and Ulex gallii. Results showed that ovule position had a significant effect on the probability of seed maturation in both species. Ovules in a central position were found to have a higher probability of maturation in U. europaeus, whereas those in a styler position were favored in U. gallii. Ulex europaeus showed no effect of position on seed weight. The smallest seed within the pod was more frequently at styler positions in U. gallii. These results might be explained by several non-exclusive hypotheses: time of fertilization, constraints on seed development (e.g., fruit shape and access to maternal resources), and genetic quality. The effects of seed weight on progeny performance estimated as probability of germination and seedling weight were tested in a laboratory experiment. Neither U. europaeus nor U. gallii exhibited any effect of seed weight on the probability of germination. However, seedling weight was dependent on seed weight in both species.

Harradine-A-R {A}; Jones-A-L, 1985

Title: Control Of Gorse Ulex-Europaeus Regrowth By Angora Goats In The Tasmanian Midlands Australia.

Source: Australian-Journal-of-Experimental-Agriculture. 1985; 25 (3): 550-556.

Publication Year: 1985

Language: ENGLISH

Abstract: Angora wethers were evaluated for the control of gorse regrowth (Ulex europaeus) after burning. Unreplicated plots containing approximately 0.5 ha gorse and 0.5 ha perennial ryegrass (Lolium perenne) dominant pasture were stocked with A, 6 goats/ha; B, 10 goats/ha; C, 5 goats + 4 sheep (Polwarth wethers)/ha; or D, 5 sheep/ha in June 1981. After 2 years, percentage gorse control was estimated to be 82, 96, 92 and 56%, and percentage gorse ground cover was 36, 16, 13 and 47% for treatments A, B, C and D, respectively. Between spring 1981 and spring 1982, when gorse was

freely available for browsing pasture consumption by goats averaged 15% (A) and 40% (B) of available pasture. Where goats were present, pastures contained a greater proportion of perennial ryegrass and less barley grass (*Hordeum* sp.) and slender thistle (*Carduus pycnocephalus*) than where only sheep were grazing. Mean mohair production per goat from October 1982 to September 1983 was 3.2, 2.3 and 2.4 kg for treatments A, B and C, respectively. Gross fleece values (\$/ha) for the same period were \$143 (A), \$173 (B), \$135 (C) and \$92 (D). The preferential browsing of gorse and the acceptable mohair yields indicate that Angora goats could be used in a complementary grazing relationship with sheep for gorse control and product diversification in the Tasmanian Midlands.

Hely-Christelle {a}; Forgeard-Francoise, 1998

Title: Heterogeneity of a high *Ulex europaeus* heath in regards to fire propagation (Brittany, France).

Source: Canadian-Journal-of-Botany. May, 1998; 76 (5) 804-817.

Publication Year: 1998

Language: French; Non-English

Abstract: This study analyzes plant material in a high *Ulex europaeus* heath to provide information on the partitioning of this ecosystem for fire propagation models. The aboveground biomass, followed for 15 months, has a spatially heterogeneous distribution that is a result of the layered pattern of the various branches. This pattern creates an internal moisture gradient that decreases from the apex to the base of the plant. This gradient also varies according to the species phenology. New, green branches with a high moisture content are at the top of the plant (upper strata), whereas woody branches with a lower moisture content are found near the ground (lower strata). Dry branches and spines, which produce most of the litter, are homogeneously distributed throughout the plant. Temporally, the layered pattern is homogeneous through the year and thus creates a constant fire risk. Soil organic horizons are temporally, spatially, and compositionally heterogeneous. The L layer! is always two to three times thinner and drier than the duff layer (F+H). The total depth, weight, and moisture content of the organic horizons vary considerably across both the plot and square metre scales. The distance from a plant has a significant influence on the depth distribution of the soil organic horizons. Fuel distribution on both the soil surface and the plant must be considered to understand fire behaviour in this ecosystem.

Hewage-C-M; Bandara-B-M-R; Karunaratne- V {a}; Wannigama-G-P; Pinto-M-R-M; Wijesundara-D-S-A, 1998.

Title: Antibacterial activity of some medicinal plants of Sri Lanka.

Source: Journal-of-the-National-Science-Council-of-Sri-Lanka. March, 1998; 26 (1) 27-34.

Language: English

Abstract: 101 Plant extracts from 55 plants were screened for antibacterial activity against *Staphylococcus aureus*, *Escherichia coli*, and *Mycobacterium fortuitum*. *Hortonia angustifolia* (root) showed very high activity against *Mycobacterium fortuitum*; *Artemisia dubia* (leaf), *Celtis cinnamomea* (stem), *Curcunta longa* (tuber), *Lobelia aromataatica* (leaf), *Ocimum grassimum* (aerial part), *Pimenta officinalis* (stem bark), *Thespesia populnea* (stem), *Ulexeuropaeus* (whole plant) showed significant activity against at least one of the above organisms.

Hill-R-L {A}; Gourlay-A-H; Martin-L, 1991

Title: Seasonal And Geographic Variation In The Predation Of Gorse Seed *Ulex - Europaeus L.* By The Seed Weevil *Apion-Ulicis* Forst.

Source: *New-Zealand-Journal-of-Zoology*. 1991; 18 (1): 37-44.

Publication Year: 1991

Language: ENGLISH

Abstract: Gorse seed weevil, *Apion ulicis* Forst, was released into New Zealand in 1931 to help control gorse, *Ulex europaeus L.* This study examines the effect of the weevil in reducing annual seed production of gorse at three sites over 3 years. Weevils oviposited only during spring, and infested up to 90% of immature pods during that period. However, the many pods produced both earlier and later than this escaped attack. Lack of synchrony between weevil reproductive activity and gorse pod production limits the impact of the weevil on the annual gorse seed crop. Better adapted populations of *Apion ulicis* may exist in southern Europe and these could be introduced to increase predation on seed.

Hill-R-L {a}; O'-Donnell-D-J; Gourlay-A-H {a}; Speed-C-B, 1995

Title: Suitability of *Agonopterix ulicetella* (Lepidoptera: Oecophoridae) as a control for *Ulex europaeus* (Fabaceae: Genisteae) in New Zealand.

Source: *Biocontrol-Science-and-Technology*. 1995; 5 (1) 3-10.

Publication Year: 1995

Language: English

Abstract: The larvae of *Agonopterix ulicetella* (Stainton) (Lepidoptera: Oecophoridae) feed on the green foliage of gorse, *Ulex europaeus L.*, and this insect is a potential biological control agent of this weed in New Zealand. The biology of the insect is described and its known parasitoids are listed. In experiments to measure oviposition preference, 46 plant species from 11 families were exposed to adult moths. Gorse was highly preferred over other plants, and there was no oviposition on 33 species tested. Eggs were found on *Spartium junceum*, *Chamaecytisus palmensis*, *Lupinus arboreus*, *L. polyphyllus*, *Genista tinctoria* and occasionally on eight other species. In

experiments to measure the ability of first instar larvae to feed on 70 test plant species, 59 did not support development beyond the first instar and only seven species supported development to the pupal stage. These results show that under laboratory conditions this moth can lay its eggs and complete development on five members of the tribe Genisteae other than gorse. *A. ulicetella* was released in New Zealand in 1990 but has not yet established.

Hill-R-L {a}; Markin-G-P; Gourlay-A-H; Fowler-S-V; Yoshioka-E, 2001.

Title: Host range, release, and establishment of *Sericothrips staphylinus* Haliday (Thysanoptera: Thripidae) as a biological control agent for gorse, *Ulex europaeus* L. (Fabaceae), in New Zealand and Hawaii.

Source: *Biological-Control*. [print] May, 2001; 21 (1): 63-74.

Language: English

Abstract: This paper presents the results of tests to determine the host range of *Sericothrips staphylinus* Haliday (Thysanoptera: Thripidae), an agent selected for control of *Ulex europaeus* (Fabaceae). It also describes the biology of the thrips and its release and establishment in New Zealand and Hawaii. Eighty-three plant species were tested. Research was conducted in several institutions by use of five testing methods. Adult thrips survived for up to 15 days without food or longer on nonhost plants (causing small feeding scars). Female thrips laid eggs on several species of the Fabaceae other than *U. europaeus*, but with one exception, larvae died.

Chamaecytisus palmensis (Christ) Bisby et K. Nichols supported the development of one adult in nine laboratory tests. Thrips produced adults on this plant in field cage tests, but in small numbers compared to controls. *S. staphylinus* appears to be narrowly oligophagous, but might establish on *C. palmensis*. At 19°C, females laid 1 egg per day on seedlings, for up to 8 weeks. Lifetime fecundity averaged 76 eggs per female. Development from egg to adult took 42 days. Thrips originating from the United Kingdom were released at 129 sites in New Zealand and have established at 59% of sites to date. Thrips originating from the United Kingdom, Portugal, and France were released in Hawaii, and all established. Thrips have caused heavy foliar damage at some field sites, and growth of the target weed has been significantly reduced in laboratory experiments. However, the impact of *S. staphylinus* on the gorse problem in New Zealand and Hawaii remains to be seen.

Hoddle-M-S {A}, 1991.

Title: Gorse Pod Susceptibility And Oviposition Preference To The Gorse Seed Weevil *Apion-Ulicis* Forster Coleoptera Apionidae.

Source: *New-Zealand-Journal-of-Zoology*. 1991; 18 (1): 31-36.

Publication Year: 1991

Language: ENGLISH

Abstract: Gorse (*Ulex europaeus* L.) is an economically important weed in New Zealand.

To contain its spread, the gorse seed weevil, *Apion ulicis* (Forster) was released in 1931. Some aspects of the bionomics of this insect have been studied previously, but the oviposition behavior of *A. ulicis* was not investigated. Results indicated that *A. ulicis* can oviposit in gorse pods in the age range 10-35 days. Pods 21 days old and pods that have not been previously attacked by other females were preferred. The implications of these results are discussed in relation to the biological control of gorse in New Zealand.

Hoshovsky, Marc, 1989

Element Stewardship Abstract for *Ulex europaeus*. The Nature Conservancy.

Johnson-P-N {a}, 2001

Title: Vegetation recovery after fire on a southern New Zealand peatland.

Source: *New-Zealand-Journal-of-Botany*. [print] June, 2001; 39 (2): 251-267.

Publication Year: 2001

Language: English

Abstract: The effects of fires on conservation values and in determining present-day vegetation are poorly known in New Zealand. This study of vegetation recovery at Awarua Bog, Southland, began after a fire in 1985. Nine samplings were recorded over 10 years from permanent transects in six vegetation types: mixed *Baumea-Empodisma* bog, *Leptospermum* scrub, *Pteridium* fernland, *Sphagnum* bog, *Chionochloa* grassland, and *Ulex* scrub. Rapid initial vegetative regrowth was mainly by rhizomatous species. Low-growing species (herbaceous dicotyledons, grasses, bryophytes) peaked in abundance 15-22 months after fire but subsequently declined in cover or disappeared. *Leptospermum* shrubs established rapidly from seed; epacrid shrub species established later and more slowly. Former dominants (e.g., *Empodisma minus*, *Gleichenia dicarpa*, and *Chionochloa rubra*) were slow to recover. *Sphagnum* recovery was mainly by slow recolonisation of fire-bared peat, rather than regrowth of fire-damaged former cushions. Cushion bog (*Donatia novae-zelandiae*) is particularly sensitive to fire and very slow to recover. Fire provides open sites for gorse (*Ulex europaeus*) establishment, but also easy access for its eradication. Long-term fire prevention and prompt containment protect conservation values.

Johnston-Peter-R {a}; Parkes-Stephanie-L {a}; Broadhurst-Philip-G, 1995

Title: Fungi associated with gorse and broom in New Zealand.

Source: *Australasian-Plant-Pathology*. 1995; 24 (3) 157-167.

Publication Year: 1995

Language: English

Abstract: Interest in the possibility of biological control of gorse and broom with fungal pathogens prompted a survey across New Zealand of fungi associated with diseased stem and leaf tissue of these weeds. New disease records made during the survey include: *Ascochyta ulicis*, *Botryosphaeria dothidea*, *Gibberella avenacea*, *G. baccata*, *Glomerella cingulata* and *Septoria slaptonensis* on gorse; *Armillaria* sp., *Botryosphaeria dothidea*, *Colletotrichum acutatum*, *Gibberella avenacea* and *G. baccata* on broom. Of the species found during the survey *Pleiochaeta setosa* on broom and *Gibberella tumida* on broom and gorse may have potential for development as mycoherbicides. Notes are provided on the biology of all species known from gorse and broom in New Zealand, including those found during the survey, others previously reported in the literature, and species deposited in Herbarium PDD.

Krause-M-A {A}; Beck-A-C; Dent-J-B, 1988

Title: Control Of Gorse In Hill Country An Economic Assessment Of Chemical And Biological Methods.

Source: *Agricultural-Systems*. 1988; 26 (1): 35-50.

Publication Year: 1988

Language: ENGLISH

Abstract: Gorse (*Ulex europaeus*) is the most feared scrub weed in New Zealand grazing

land. This weed has infested 657,000 ha of New Zealand's pastures and past attempts at eradication of gorse from hill country have met with limited success. Traditionally, gorse has been controlled by chemical spray programs. Recent research has shown that the grazing by goats and sheep is a possible alternative for gorse control. A simulation model was constructed which includes the physical and economic aspects of a hill country grazing system. This model was used to compare the control of gorse using either chemical or goat/sheep grazing combinations. Extensive sensitivity analysis and experimentation was carried out to evaluate the alternative strategies under different price and production scenarios.

Lee-W-G {A}; Allen-R-B; Johnson-P-N, 1986

Title: Succession And Dynamics Of Gorse *Ulex-Europaeus* Communities In The Dunedin Ecological District South Island New Zealand.

Source: *New-Zealand-Journal-of-Botany*. 1986; 24 (2): 279-292.

Publication Year: 1986

Language: ENGLISH

Abstract: Successional patterns in gorse (*Ulex europaeus*) communities were determined

from an analysis of 125 plots in the Dunedin Ecological District. Stem diameter and height growth of gorse averaged 5 mm yr⁻¹ and 200 mm yr⁻¹, respectively. Plants attained a maximum age of 29 years, a maximum height of 7.0 m, and a maximum diameter of 217 mm at 100 mm above the ground. Gorse matured at about 15 years after establishment with a mean stem density of 60,000 ha⁻¹, mean basal area value of 51 m² ha⁻¹, and a mean litter depth of 55 mm. Other naturalised woody species, particularly broom (*Cytisus scoparius*), declined in importance in older gorse stands. The establishment of native woody species was favored by lower density, taller gorse, where litter depth was shallow, and areas of bryophyte or bare soil were available. In these stands native species reached numerical and basal area equivalence with gorse after 10-15 years on the site. However, at 60% of the sites younger than 25 years, native woody species were not establishing and it is unlikely that they will do so until after the first cycle of gorse (25-30 years) is completed. The implications of these results for the management of gorse in biological reserves are discussed.

Markin-G-P {a}, 1998

Title: Introduction and establishment of the biological control agent *Apion ulicis* (Forster) (Coleoptera: Apionidae) for control of the weed gorse (*Ulex europaeus* L.) in Hawai'i.

Source: Proceedings-of-the-Hawaiian-Entomological-Society. April, 1998; 33 (0) 35-42.

Publication Year: 1998

Language: English

Abstract: In 1984, 10,000 adults of the gorse seed weevil, *Apion ulicis* (Forster), were collected on the island of Maui and released at 10 sites on the southern slope of Mauna Kea, Hawaii Island. Monitoring showed that the weevils were successfully established at eight release sites. They gradually built up their populations for three years, after which they spread out from their release points. Establishment failure at two sites was attributed to poor synchronization of the biology of the weevils with the phenology of the gorse. By 1993, the final year of this survey, weevils had reached every point sampled throughout the 15,000-ha range of gorse and attacked 59.4% of the pods sampled. Estimates of the weevil populations, based on the number of adults in beating samples, indicated that the initial 10,000 weevils had multiplied to approximately 350 million, a 3.22 fold increase each year. On the neighboring island of Maui, where the insect has been established since 1955, a comparable population in Haleakala National Park has remained relatively stable for the last 10 years with about 90% of the pods being infested. It is estimated that if the weevils on Mauna Kea continue the present rate of

population increase, they will reach this level in four to five years. Unfortunately, a chemical control program being conducted by the land manager may interfere with this prediction.

Memmott-J {a}; Fowler-S-V; Hill-R-L, 1998

Title: The effect of release size on the probability of establishment of biological control agents: Gorse thrips (*Sericothrips staphylinus*) released against gorse (*Ulex europaeus*) in New Zealand.

Source: *Biocontrol-Science-and-Technology*. March, 1998; 8 (1) 103-115.

Publication Year: 1998

Language: English

Abstract: Many biocontrol agents released against alien weeds and pests fail to establish in the field. Here, we ask whether better release strategies could improve the likelihood of successful establishment. A manipulative field experiment was used to investigate the relationship between the probability of establishment and the number of individuals released for a weed biocontrol agent. In this experiment, replicated releases of 10, 30, 90, 270 and 810 gorse thrips, *Sericothrips staphylinus* Haliday, were made on to isolated gorse bushes in New Zealand. The sampling efficiency was determined using a further experiment in which known numbers of thrips were released on to bushes. The data obtained showed that in approximately nine out of 10 releases of 10 thrips, at least one thrips would be found. The thrips in the size of release experiment were sampled 1 year after their release. A higher proportion of the small releases became extinct during this time period. Thrips were recovered from 100% of the releases of 270 and 810 thrips, but only from 33% of releases of 10, 30 and 90 thrips. Using gorse thrips as an example, a protocol was developed to determine the optimal release size for biocontrol agents. It is suggested that for a fixed number of insects available for release, smaller releases may increase the overall establishment rate. While a single large release can easily become extinct by chance, it is extremely unlikely that a large number of small releases will do so over the same time period. The optimal release size (ie. that which maximizes the average number of successful establishments) for gorse thrips in New Zealand might be fewer than 100 thrips/ release site. This contrasts with the current strategy in New Zealand of 1000 thrips/release and the suggestion in the biocontrol literature that large releases optimize establishment. Over 1 year of observation the thrips had no effect on gorse growth rate.

Mitchell-R-J {a}; Marrs-R-H {a}; Le-Duc-M-G {a}; Auld-M-H-D, 1997

Title: A study of succession on lowland heaths in Dorset, southern England: Changes in vegetation and soil chemical properties.

Source: *Journal-of-Applied-Ecology*. Dec., 1997; 34 (6) 1426-1444.

Publication Year: 1997

Language: English

Abstract: 1. Lowland heaths are high-profile ecosystems for conservation action in England, but they are under threat from invasion by *Betula* spp., *Pinus sylvestris*, *Pteridium aquilinum*, *Rhododendron ponticum* and *Ulex europaeus*. 2. Ten heathland sites in the Poole Basin area of Dorset, where succession to one or other of the above species had occurred, were studied to examine the changes in vegetation and soil chemical properties. 3. A series of hypotheses to explain (i) vegetation successional trajectories, and (ii) soil chemical properties associated with vegetation change were tested using multivariate models (DECORANA -vegetation; CANOCO - vegetation and soil). 4. A range of pathways was found along which heathland communities move during succession, with some successional pathways remaining closer to heathland than others. 5. The *Betula* spp. succession caused the greatest changes in terms of the vegetation present. The *Ulex europaeus* and *Pinus sylvestris* trajectories retained some typical heathland species. 6. Different soil nutrients were found to increase along different successional pathways, which were associated with the different successional species invading. 7. *Pinus sylvestris* had similar soil nutrient concentrations to those of the heathland. Sodium concentrations increased during the *Rhododendron ponticum* succession. Concentrations of ammonium-nitrogen and nitrate/nitrite-nitrogen increased during the *Pteridium aquilinum* and *Ulex europaeus* succession. The *Betula* spp. had the greatest effect on the soil nutrients with increased pH, extractable phosphorus and exchangeable calcium. 8. The results are discussed in relation to practical heathland management and the restoration of heathland after succession. Specifically, it is more sensible and cost-effective to restore heathland on sites where *Pinus sylvestris* successions have occurred, than where *Betula* spp. successions have occurred.

Mitchell-R-J {a}; Marrs-R-H; Auld-M-H-D, 1998

Title: A comparative study of the seedbanks of heathland and successional habitats in Dorset, Southern England.

Source: *Journal-of-Ecology*. Aug., 1998; 86 (4) 588-596.

Publication Year: 1998

Language: English

Abstract: 1. Many areas of lowland heaths are being lost due to invasion by *Betula* spp., *Pinus sylvestris*, *Pteridium aquilinum*, *Rhododendron ponticum* and *Ulex europaeus*. One of the factors influencing the success of restoration of heathland on such sites will be the content of their viable seedbanks.

2. Ten heathland areas in the Poole Basin area of Dorset, where succession to one or more of the above species had occurred were studied. The viable seedbanks of the successional sites were compared with those of nearby heathland using Canonical Discriminant Analysis. 3. The seedbanks of all the successional stages were significantly different from the seedbank of the heath. 4. The seedbanks from the *Pinus sylvestris* and *Pteridium aquilinum* successional stages contained significantly lower numbers of heathland species than did the heathland seedbank, although few non heathland species were present. 5. The seedbanks from the *Betula* spp., *Rhododendron ponticum* and *Ulex europaeus* successional sites contained both significantly lower numbers of heathland species and significantly higher numbers of non heathland species than the heathland seedbank. 6. The results are discussed in relation to the restoration of heathland on successional sites and the use of the seedbank as a source of propagules for the establishment of heathland species.

Mitchell-R-J {a}; Auld-M-H-D; Hughes-J-M; Marrs-R-H, 2000.

Title: Estimates of nutrient removal during heathland restoration on successional sites in Dorset, southern England.

Source: Biological-Conservation. [print] October, 2000; 95 (3): 233-246.

Publication Year: 2000

Language: English

Abstract: Lowland heaths are high-profile ecosystems for conservation action in Britain, but many areas have been invaded by successional species.

Management to restore heathland on successional sites provides an opportunity to remove nutrients from part of the system and helps maintain the low soil nutrient levels typical of heathland. Estimates were made of the nutrients removed during management on successional sites dominated by *Betula* spp., *Pinus sylvestris*, *Pteridium aquilinum*, *Rhododendron ponticum* and *Ulex europaeus* in Dorset. When both the above ground biomass and litter are removed between 12-45 kg P ha⁻¹, 561-2661 kg N ha⁻¹ and 157-776 Ca ha⁻¹ are removed, depending on the successional species. Results are also provided for Mg, K and Na. For Ca, Mg and N the nutrients removed are equivalent to between 41 and 197 years of atmospheric inputs, for P it may be as much as several thousand. Equations are provided to enable predictions of nutrient offtake on other sites to be made. The importance of nutrient removal in relation to heathland re-establishment, successional change, the effects of atmospheric nitrogen deposition and habitat management requirements are discussed.

Morin-Louise {a}; Gianotti-Alison-F; Barker-Richard; Johnston-Peter-R, 1998

Title: Favourable conditions for the bioherbicide candidate *Fusarium tumidum* to

infect and cause severe disease on gorse (*Ulex europaeus*) in the controlled environment.

Source: *Biocontrol-Science-and-Technology*. June, 1998; 8 (2) 301-311.

Publication Year: 1998

Language: English

Abstract: The development of the pathogenic fungus *Fusarium tumidum* on gorse (*Ulex europaeus*), a major weed of pastures and plantation forests in New Zealand, was studied under controlled conditions. *F. tumidum*, like most other foliar fungal pathogens, requires moisture to infect plants. Long, continuous dew periods (gtoreq 24 h) after inoculation of plants provided favourable conditions for infection. The fungus, however, also caused severe disease on young plants (2 months old) exposed to two or three 12-h dew periods interrupted by 12-h dry periods. A delay of 24 h before inoculated plants were exposed to dew did not affect the severity of the disease. *F. tumidum* infected plants over a wide range of temperatures (5 -27degree C), but more plants were killed as temperatures increased during the initial infection phase. All gorse plants tested (up to 4 months old) were susceptible to the fungus, but younger plants were more easily killed. Nevertheless, the biomass of older plants that were severely diseased but not killed by the fungus was significantly reduced. The effectiveness of *F. tumidum* in killing plants increased with the density of inoculum sprayed The fungus applied at a density of 1 X 10⁶ conidia/ml killed more than 95% of 1.5-month-old plants. This basic knowledge of the *F. tumidum*-gorse system will assist in the development of a pilot bioherbicide to control gorse and broom (*Cytisus scoparius*), another economically important weed in New Zealand which is also susceptible to the fungus.

Norambuena-H {A}; Carrillo-R; Neira-M, 1986

Title: Introduction Establishment And Potential Of Apion-Ulicis For Control Of *Ulex Europaeus* In Southern Chile.

Source: *Entomophaga*-. 1986; 31 (1): 3-10.

Publication Year: 1986

Language: SPANISH

Abstract: *Apion ulicis* Forster introduced from New Zealand established successfully on *Ulex europaeus* at all sites in southern Chile where it was released (parallel 37 to 43 degrees Lat. Sur). The levels of seed consumption found in the plants infested by *A. ulicis* demonstrated that *A. ulicis* may be a valuable biological control agent of this weed in Chile in spite of its rather slow dispersion rate.

Nunez-Regueira-Lisardo {a}; Rodriguez-Anon-J-A; Proupin-Castineiras-J, 1996

Title: Calorific values and flammability of forest species in Galicia. Coastal and hillside zones.

Source: Bioresource-Technology. 1996; 57 (3) 283-289.

Publication Year: 1996

Language: English

Abstract: Changes in heat values and in flammability with the seasons of the year for the different species which make up the woodland map of two zones, Sada (coastal area) and Santiago (hillside and plateau area), situated in La Coruna (Galicia, Spain), are reported. These data were evaluated as a help for fighting forest fires, which have been very frequent in this region during the last decade. The species studied are the most abundant in the areas: *Eucalyptus globulus* Labill., *Pinus pinaster* Aiton, *Ulex europaeus* L., *Rubus fruticosus* L., *Pteridium aquilinum* L., *Sarothamnus scoparius* (L.) Link, *Quercus robur* L., *Castanea sativa* Miller and *Acer pseudoplatanus* L. The calorific values were measured by static bomb calorimetry. These data were complemented with flammability determinations and completed with chemical analyses of the different species.

Partridge-T-R {A}, 1989

Title: Soil Seed Banks Of Secondary Vegetation On The Port Hills And Banks Peninsula Canterbury New Zealand And Their Role In Succession.

Source: New-Zealand-Journal-of-Botany. 1989; 27 (3): 421-436.

Publication Year: 1989

Language: ENGLISH

Abstract: Soil seed banks at 21 sites covered with poor quality pasture, bracken fernland, scrubland of broom or gorse, and various forest types, were examined by germinating seed in soil samples. At most sites the composition of upper and lower soil layers was similar. Persistent, deeply buried seed banks of *Cytisus scoparius*, *Ulex europaeus*, and more rarely *Sophora microphylla*, were discovered at seven sites, four of which lacked that particular species in the above-ground vegetation, and are thus considered to be a former vegetation type. Forest sites tended to have more seeds and more species represented in the soil seed bank. Although an average of only 35% of the species in the seed bank were represented above ground at the sampling point, this rose to 60% within 5 m, and 72% within 10 m of that point. Those species further away were mostly widespread pasture weeds, even within forest sites, and are interpreted as being recently dispersed and transient. Large quantities of *Juncus* spp. in some sites are believed to be transported by water movement through the soil. Some species, including certain site dominants, were poorly or never represented in the soil seed bank. It is considered that the seed bank has an important role in establishing the initial floristic composition

following disturbance. However, differential seedling survival, resprouting, and competition probably help in maintaining the predisturbance vegetation at non-forest sites. Where forest is disturbed, especially by burning, there is the potential for a completely different vegetation to develop from the seed bank.

Prasad, Raj and S. Kushwaha, 2001.

Ecology of Invasive Weeds: Impact and Management of the Exotic Weeds, Gorse (*Ulex europaeus*) and Scotch Broom (*Cytisus scoparius*) in British Columbia, Canada. The Proceedings of the Asian-Pacific Weed Science Society Conference, May 28-June 1, 2001. Beijing China.

Puentes-M-A {A}; Pereiras-J; Casal-M, 1988

Title: Seed Bank Of *Ulex-Europaeus* L. Shrublands In Galicia Nw Spain I. First Results.

Source: *Revue-d'Ecologie-et-de-Biologie-du-Sol*. 1988; 25 (2): 215-224.

Publication Year: 1988

Language: ENGLISH

Abstract: Seed bank of *Ulex.apprx.europaeus* L. shrublands in Galicia (NW Spain). I. First results. Seed bank of two different aged shrubland was studied in Galicia (NW Spain). The number of seeds/m² found was 645 (Castro Valente stand) and 1 045 (Balouta stand), with a viability of 95.02 and 96.82% respectively. In both cases, the largest number of seeds appeared in the upper 5 cm.

Radcliffe-J-E {A}, 1985

Title: Grazing Management Of Goats And Sheep For Gorse *Ulex-Europaeus* Control.

Source: *New-Zealand-Journal-of-Experimental-Agriculture*. 1985; 13 (2): 181-190.

Publication Year: 1985

Language: ENGLISH

Abstract: A grazing management trial in North Canterbury [New Zealand] compared the effects of goats or sheep grazed alone, or in mixtures with 2 goats equivalent to 1 sheep (all dry stock), with either rotational grazing or set stocking. An extra 'fast rotation' with sheep was included. Three years of grazing after a gorse (*Ulex europaeus* L.) burn and oversowing resulted in both goat-only management treatments, and the sheep + goat mixture rotationally grazed, reducing gorse to negligible levels. Sheep alone were usually ineffective, although, under 'fast rotation', gorse was contained for the first year. When 4 of these grazing treatments (goats only, sheep + goat mixtures, with rotational grazing, set stocking) were repeated in a subsequent year, all treatments similarly reduced gorse to negligible levels. All goat pastures, irrespective of grazing management, contained more white clover [*Trifolium repens*] than did sheep pastures,

and rotationally grazed swards had more ryegrass (*Lolium perenne*) and less browntop (*Agrostis capillaris*) than did set-stocked swards.

Rees-M {a}; Hill-R-L, 2001

Title: Large-scale disturbances, biological control and the dynamics of gorse populations.

Source: *Journal-of-Applied-Ecology*. [print] April, 2001; 38 (2): 364-377.

Language: English

Abstract: 1. Simulation and analytical models were developed for gorse *Ulex europaeus*. The simulation model incorporated spatially local density-dependent competition, disturbance, asymmetric competition between seedlings and established plants, a seed bank, local seed dispersal, an age structured established plant population, and temporal variation in the probability of disturbance. The analytical models were simple approximation of the simulation. 2. The models extended our previously published model for Scotch broom *Cytisus scoparius* to include large-scale disturbances and possible management options, such as the use of fire, herbicides and oversowing with perennial grasses. Fire was assumed to influence established plant mortality, seed survival in the seed bank, and the probability of germination. 3. We reviewed published data on the demography of gorse in New Zealand, the current management techniques, and the ongoing biological control programme. 4. Over a wide range of biologically reasonable parameter values, the analytical models accurately predicted the outcome of the simulations. The analytical models worked well, providing gorse occupied a high proportion of the available sites and large-scale disturbances did not occur too frequently. 5. The potential impact of seed-feeding biological control agents on gorse abundance was assessed, using the models, for several environmental and management scenarios. In particular, we explored how large-scale disturbance, such as fire and herbicide application, influences the outcome of biological control. 6. The success of a biological control programme was found to depend critically on the frequency and intensity of disturbance, whether disturbed sites became suitable for recruitment, and the effects of disturbance on germination and seed mortality. 7. The models highlight the need to manage recruitment opportunities carefully in order to maximize the effect of biological control agents. The models also indicate that details of plant population biology can have a profound effect on the success of any management strategy.

Richardson-B; Vanner-A; Davenport-N; Balneaves-J; Miller-K; Ray-J, 1993

Title: Interspecific competition between *Pinus radiata* and some common weed species: First-year results.

Source: New-Zealand-Journal-of-Forestry-Science. 1993; 23 (2) 179-193.
Publication Year: 1993
Language: English

Richardson-B; Vanner-A; Ray-J; Davenhill-N; Coker-G, 1996

Title: Mechanisms of *Pinus radiata* growth suppression by some common forest weed species.

Source: New-Zealand-Journal-of-Forestry-Science. 1996; 26 (3) 421-437.
Publication Year: 1996
Language: English

Abstract: In a trial designed to quantify the reduction of *Pinus radiata* D. Don growth caused by a range of weed species, tree seedlings were grown weed-free or with herbaceous broadleaves (a volunteer mixture of species from which grasses were excluded), *Cytisus scoparius* L. (broom), *Ulex europaeus* L. (gorse), *Buddleja davidii* Franchet (buddleia), *Holcus lanatus* L. (Yorkshire fog) plus *Lolium multiflorum* L. (Italian ryegrass), *Lotus uliginosus* Schk. (lotus), or *Cortaderia selloana* (Schult) Asch. et Graeb. (pampas). Water and nutrient levels were varied by factorial irrigation and fertiliser treatment. After 3 years tree stem volume was greatest in weed-free, lotus, gorse, and grass treatments and least with buddleia and pampas. The effect of herbaceous broadleaves and broom was intermediate. It was concluded that tall, fast-growing, weed species reduced *P. radiata* growth by restricting light availability to tree crowns. No convincing evidence was found to link the large growth losses with interference in water or nutrient supply.

Roze-Francoise, 1993.

Title: Plant recolonisation after fire in Brittany littoral heathlands.

Source: Acta-Oecologica. 1993; 14 (4) 529-538.
Publication Year: 1993
Language: English

Abstract: Ecological modifications following heath fires have been widely studied. This paper describes a novel situation, vegetational changes following two fires of different intensity, a flash fire and a humus fire, in littoral heathlands at Erquy and Frehel, respectively (Brittany - France). Sites had been studied in detail prior to fire, and post burn vegetation succession was studied in tall-dry-*Ulex europaeus*, short-dry-*Erica cinerea* and mesophyllic heathlands. Permanent line quadrats provided data on cover, structure and species composition. Changes in species frequencies suggested different successional phases. Flash-fire at Erquy was followed by stump regrowth and fluctuations. At Frehel different successional patterns followed regrowth from seed. Onshore winds could account for low

Bryophytic presence because environmental conditions are unfavourable to moss-spore arrival and also establishment of cliff species which conferred a small tuft structure in the early stages of succession. Cliff plants, together with *Holcus lanatus*, facilitated heathland re-establishment.

Richardson-R-G {a}; Hill-R-L, 1998

Title: The biology of Australian weeds 34. *Ulex europaeus* L.

Source: Plant-Protection-Quarterly. 1998; 13 (2) 46-58.

Publication Year: 1998

Language: English

Seo-Byung-Soo {a}; Richardson-Brian; Vanner-Arthur; Coker-Graham, 1997

Title: Effects of some common weed species on *Pinus radiata* seedling growth.

Source: Journal-of-Korean-Forestry-Society. 1997; 86 (1) 1-8.

Publication Year: 1997

Language: Korean; Non-English

Abstract: Second year results are presented from a trial designed to quantify the reduction in radiata pine (*Pinus radiata* D. Don) seedling growth caused by competition from a range of important weed species on a moist North Island site in New Zealand. Radiata pine seedlings (1/0) were grown on the weed free control and with either herbaceous broadleaves, grass, broom, pampas, buddleia, or gorse. Resource(nutrient and water) levels were varied by factorial +/- irrigation and fertilizer treatments. Radiata pine seedling volume growth 21 months after planting was greatest when it was grown on the weed free control or in association with gorse, and was least when grown with either buddleia or pampas. There was no evidence that the effects of the weeds on seedling growth were mediated by either competition for water or nutrients. Tall, fast-growing species that overtopped the seedlings (broom, buddleia, pampas) had the greatest effect on seedling growth and the magnitude of the effect was correlated with degree of overtopping. This implies that shading or competition for light is probably an important factor.

Soto-B {a}; Basanta-R; Diaz-Fierros-F, 1997

Title: Effects of burning on nutrient balance in an area of gorse (*Ulex europaeus* L.) scrub.

Source: Science-of-the-Total-Environment. 1997; 204 (3) 271-281.

Publication Year: 1997

Language: English

Abstract: Wildfires affect nutrient balance as a result of combustion of biomass, increased surface and subsurface runoff and increased soil erosion. In the present study, nutrient inputs and outputs to burnt and unburnt *Ulex* scrub

plots were monitored over a 2-year period. During burning, between 50 and 75% of the nutrients contained in above-ground plant tissues were directly lost due to volatilization and upward movement of particulates to the atmosphere. Only small amounts (less than 3% for all elements) were deposited at the soil surface as ash. During the first rains after burning, N, P and K losses were largely due to sediment transport in surface runoff, while Ca and Mg losses were roughly equally distributed between sediment losses and soluble-form losses (in surface runoff and subsurface flow) and Na losses were largely in soluble form. Post-burning nutrient inputs to the soil in throughfall were lower than in the control plots for N and K; in the case of the remaining elements (P, Ca, Mg and Na), inputs to the burnt plots and control plots differed little. In general, burning led to clear net losses of nutrients; annual losses were approximately 2.5-3.5 g m⁻² in the case of N and approximately 6.5-9.0 g m⁻² in the case of K. In the unburnt plots, by contrast, outputs were approximately equal to inputs.

Soto-Benedicto; Diz-Fierros-Francisco {a}, 1997

Title: Soil water balance as affected by throughfall in gorse (*Ulex europaeus*, L.) shrubland after burning.

Source: Journal-of-Hydrology-Amsterdam. 1997; 195 (1-4) 218-231.

Publication Year: 1997

Language: English

Abstract: The role of fire in the hydrological behaviour of gorse shrub is studied from the point of view of its effects on vegetation cover and throughfall. In the first year after fire, throughfall represents about 88% of gross rainfall, whereas in unburnt areas it is 58%. Four years after fire, the throughfall coefficients are similar in burnt and unburnt plots (about 60%). The throughfall is not linearly related to vegetation cover because an increase in cover does not involve a proportional reduction in throughfall. The throughfall predicted by the two-parameter exponential model of Calder (1986, J. Hydrol., 88: 201-211) provides a good fit with the observed throughfall and the gamma value of the model reflects the evolution of throughfall rate. The soil moisture distribution is modified by fire owing to the increase of evaporation in the surface soil and the decrease of transpiration from deep soil layers. Nevertheless, the use of the old root system by sprouting vegetation leads to a soil water profile in which 20 months after the fire the soil water is similar in burnt and unburnt areas. Overall, soil moisture is higher in burnt plots than in unburnt plots. Surface runoff increases after a fire but does not entirely account for the increase in throughfall. Therefore the removal of vegetation cover in gorse scrub by fire mainly affects the subsurface

water flows.

Sparling-G-P {a}; Hart-P-B-S; August-J-A; Leslie-D-M, 1994.

Title: A comparison of soil and microbial carbon, nitrogen, and phosphorus contents, and macro-aggregate stability of a soil under native forest and after clearance for pastures and plantation forest.

Source: *Biology-and-Fertility-of-Soils*. 1994; 17 (2) 91-100.

Publication Year: 1994

Language: English

Abstract: Total, extractable, and microbial C, N, and P, soil respiration, and the water stability of soil aggregates in the F-H layer and top 20 cm of soil of a New Zealand yellow-brown earth (Typic Dystrochrept) were compared under long-term indigenous native forest (*Nothofagus truncata*), exotic forest (*Pinus radiata*), unfertilized and fertilized grass/clover pastures, and gorse scrub (*Ulex europaeus*). Microbial biomass C ranged from 1100 kg ha⁻¹ (exotic forest) to 1310 kg ha⁻¹ (gorse scrub), and comprised 1-2% of the organic C. Microbial N and P comprised 138-282 and 69-119 kg ha⁻¹ respectively, with the highest values found under pasture. Microbial N and P comprised 1.8-7.0 and 4.9-18% of total N and P in the topsoils, and 1.8-4.4 and 23-32%, respectively, in the F-H material. Organic C and N were higher under gorse scrub than other vegetation. Total and extractable P were highest under fertilized pasture. Annual fluxes through the soil microbial biomass were estimated to be 36-85 kg N ha⁻¹ and 18-36 kg P ha⁻¹, sufficiently large to make a substantial contribution to plant requirements. Differences in macro-aggregate stability were generally small. The current status of this soil several years after the establishment of exotic forestry, pastoral farming, or subsequent reversion to scrubland is that, compared to levels under native forest, there has been no decline in soil and microbial C, N, and P contents or macro-aggregate stability.

Stronge-D-C; Fordham-R-A; Minot-E-O {a}, 1997

Title: The foraging ecology of feral goats *Capra hircus* in the Mahoenui Giant Weta Reserve, southern King Country, New Zealand.

Source: *New-Zealand-Journal-of-Ecology*. 1997; 21 (1) 81-88.

Publication Year: 1997

Language: English

Abstract: Feral goats (*Capra hircus*) were studied in the Mahoenui giant weta reserve, southern King Country, New Zealand, from March 1992 to February 1993. The reserve supports the main population of the undescribed Mahoenui giant weta (*Deinacrida* sp.). Gorse (*Ulex europaeus*) is the dominant woody browse plant in the reserve and provides protection, shelter and food for weta.

The activities, foraging behaviour and diet of feral goats within the reserve were measured by direct observation and analysis of rumen contents. Measures of nutrient levels indicate that gorse is adequate for goat growth only during late spring/summer, and becomes a maintenance food at other times of the year. Feeding (grazing and browsing) was the dominant activity of adult feral goats in the reserve. Females spent more time feeding than males. Grazing and browsing changed seasonally for both sexes, with grazing generally decreasing from autumn to summer, and browsing increasing from summer to spring. In every season females spent more time grazing than males, but males browsed more than females. Greater use of browse by males may be an effect of the presence of females. Browsing of gorse by goats may not be an important influence on weta survival.

Suckling-D-M {a}; Hill-R-L; Gourlay-A-H; Witzgall-P, 1999.

Title: Sex attractant-based monitoring of a biological control agent of gorse.

Source: Biocontrol-Science-and-Technology. March, 1999; 9 (1): 99-104.

Language: English

Abstract: *Cydia succedana* (Denis & Schiffermuller) has been introduced into New Zealand for the biological control of gorse seeds (*Ulex europaeus*). Traps baited with a sex attractant were developed for monitoring the flight timing and number of adult male moths, and were used as a new tool for monitoring the establishment, phenology and efficacy of the agent. The best lure tested was (E,E)-8,10-dodecadien-1-yl acetate, although high catches were also made with the E,Z isomer. There was no difference in the total catch across a range of doses from 1 to 300 µg/lure (7151 insects caught). Male flight was recorded at the bottom, middle and top of a hillside between 280 and 370 m altitude, along with the percentages of plants at each site bearing flowers and seed pods. There was an initial seasonal linkage between the catch of males and plant phenology, but a lack of synchrony was evident between the insect and the plant in the second generation, indicating a potentially important limitation for biological control at this site. The prospects for using sex attractants in traps as an aid for monitoring populations of weed biological control agents are excellent. Other potential applications include the cost-effective detection of establishment and the determination of the optimal size of founding populations to ensure establishment of control agents.

Wilson-Hugh-D, 1994

Title: Regeneration of native forest on Hinewai Reserve, Banks Peninsula.

Source: New-Zealand-Journal-of-Botany. 1994; 32 (3) 373-383.

Publication Year: 1994

Language: English

Abstract: One thousand hectares in the south-east sector of Banks Peninsula are being managed for the protection and restoration of native vegetation and wildlife under a policy of minimum interference. The probable pre-human vegetation cover (1000 yr B.P.), inferred from current evidence and some historical records, was continuous forest, c. 55% of it podocarp/hardwood forest and 45% Nothofagus forest. About 4% of this old-growth forest survives. The remaining area is a diverse mosaic of successional vegetation. Approximately 30% of the total area is closed-canopy second-growth native forest. About 53% is under scrub of naturalised gorse (*Ulex europaeus*) and broom (*Cytisus scoparius*). The remaining 13% is under pasture, fernland, and native tussockland. The predicted cover 50 years hence, assuming that fire can be excluded, is 95% secondgrowth native forest, 4% old-growth forest, and 1% tussock, shrubland, and scrub which will persist on bluffs. Successional pathways are diverse, involving both native and naturalised species. Monitoring of vegetational change to test predicted pathways and patterns began in October 1987. To date, observations show that in the absence of grazing animals and fire, regeneration of native forest is rapid, especially through gorse and broom scrub, and by the vigorous establishment of native seral hardwoods, especially kanuka (*Kunzea ericoides*).

Zielke, Ken, Jacob O. Boatang, Norm Caldicott, Heather Williams, 1992.

Broom and Gorse in British Columbia, A Forestry Perspective Problem Analysis. BC Ministry of Forests, April 1992.

Useful websites

www.agf.gov.bc.ca/croplive/croprot/weedguid/gorse.htm

BC Ministry of Agriculture and Food, Weed Guide.

www.efn.org/~ipmpa/Noxgorse.html

Noxious Weed IVM Guide – Gorse

www.weeds.org.au

Information on several Australian weeds, including gorse.

<http://weeds.tassie.net.au/txts/gorse.html>

Information from Tasmania.

Other information

Gorse. BC Forest Service Brochure

O'Brien, Colleen, 1999.

Gorse, The Spiny Competitor is Moving in. The Victoria Naturalist, Vol 56.1 (1999)