

# ENHANCING BIOCONTROL OF BROOM BY USING MODELLING PREDICTIONS

Mathematical models have been developed for broom and gorse (see *Enhancing biocontrol of gorse by using modelling predictions, Techniques for assessing the impact of biocontrol agents*) that enable us to make a series of predictions about the impact of various management regimes, including biological control, in the long term. The likelihood of successfully controlling these long-lived woody weeds may be compromised if the impact of management techniques is not understood. Below we summarise some key conclusions.

## Commonly used management techniques

A recent survey in one of the worst broom-infested parts of the country, North Canterbury, has shown a variety of methods are used to control broom, and most people use more than one. Chemical control was the preferred option (98%), followed by grazing (48%), manual methods (grubbing, hand pulling, cutting, and slashing etc.) (31%), fencing (to allow increased grazing pressure and tree planting, and to isolate clean areas) (22%), pasture renewal (20%), application of fertiliser or lime (17%) and burning (12%).

So despite all the efforts to control broom here and in other parts of New Zealand, why is the problem still getting worse? The cost of control can be prohibitive, especially on marginal land. The terrain may make it difficult to carry out control. People make a start but don't follow through, or they get the timing of control activities wrong. This is why a biological control programme for broom has been initiated.



Severe infestation near Hanmer

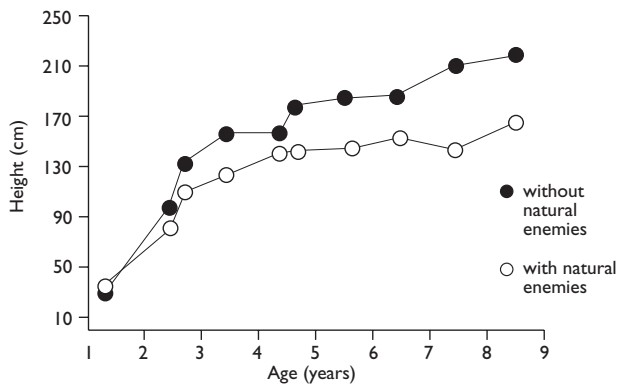
## Biological control

A seed-feeding agent, the broom seed beetle (*Bruchidius villosus*), has been introduced to reduce the amount of seed produced by broom. A foliage-feeding agent, the broom psyllid (*Arytainilla spartiophila*), has been introduced to reduce the vigour, biomass, and longevity of broom bushes, and another foliage-feeding agent, the broom twig miner (*Leucoptera spartifoliella*), was accidentally introduced more than 50 years ago. Another three agents, the broom leaf beetle (*Gonioctena olivacea*), broom gall mite (*Aceria genistae*) and broom shoot moth (*Agonopterix assimilella*) will be released widely in the near future. It is too soon to know what collective impact these agents will have in New Zealand. However, a classic study carried out in the 1960s and 70s in the UK indicated that natural enemies have a major impact on the growth and mortality of broom (see *Graph 1*). Early indications suggest that our biological control agents should be able to reduce the size of plants, maximum age of plants, seed production, rate of spread, and the probability of recruitment of replacement plants.

See also *Broom psyllid, Broom seed beetle, Broom twig miner*.



# BROOM



Graph 1: Natural enemies in the UK have an impact on broom growth.

## What do we know about broom population dynamics?

In New Zealand broom usually grows 1.5–3.0 m tall. Broom infestations are typically made up of plants of a variety of ages and some recruitment occurs under mature plants, so stands tend to persist. By contrast, in its native range in Europe broom stands tend to be even-aged, and when mature plants die they tend to be replaced by grass – major disturbance events are usually required for broom stands to persist. In the UK broom only lives for about 8–10 years but it lives at least twice as long here. Plants start flowering around 2–3 years old. Seed is produced in spring and most falls within 5 m of the parent plant. A high proportion of seeds are dormant and substantial seed banks can accumulate in the soil and survive for decades. They cannot germinate if buried deeply. Vertebrate seed predation (e.g. by mice) can be extremely high for seeds on the soil surface.

## What does the model predict?

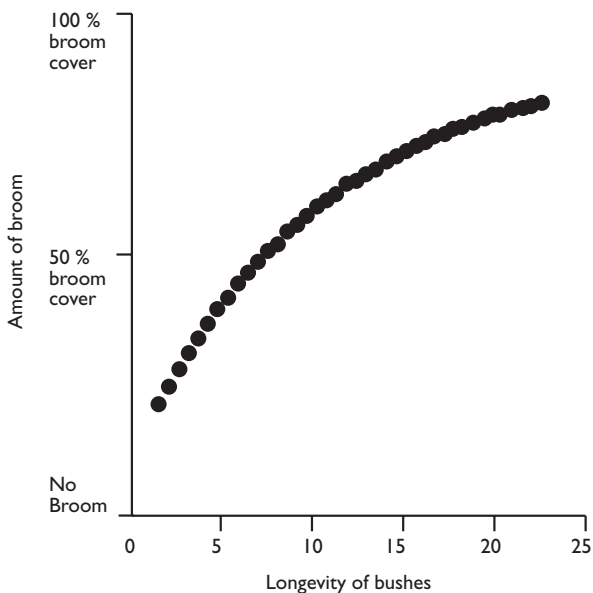
If a broom infestation is subjected to frequent large-scale disturbances, e.g. herbicide, fire, ploughing, or flooding in a braided river etc., that prevent any broom plants from ever seeding, then the infestation should eventually die out as the seed bank becomes exhausted. This means that if you treat your broom infestation at least every 2 years in a way that ensures no plants set seed, then eventually you

will win. It is also critical to treat outlying plants because otherwise they will be able to set up new seed banks and replenish old ones. However, if you cannot maintain this pressure for as long as it takes to exhaust the seedbank, or you miss the odd treatment along the way (allowing some plants to set seed), then you will be fighting a losing battle. Obviously this is likely to be impractical, so how can biological control ease the burden?

The more seeds that broom produces the higher the likelihood that infestations will spread around the edges and that some will find their way to new areas (broom has not yet reached anything like the limits of its range here in New Zealand and can grow at higher altitudes than gorse). Therefore the broom seed beetle should reduce the rate with which broom invades new areas.

The model predicts that under certain conditions seed feeders could also help to reduce existing broom populations, but only if they are used in conjunction with appropriate and careful management practices. Even if the broom seed beetle can destroy most of the seeds produced, broom infestations are unlikely to decline if management practices allow the few remaining seeds to grow – there will still be more than enough new plants to replace old ones. However, if these few remaining seeds are not given a good environment to grow in, then broom infestations should begin to decline. Reducing the survival of seedlings is the key to control, and this can be achieved by promoting competition from grasses and avoiding disturbance. The occasional use of fire is likely to make the problem worse, as it creates ideal conditions for recruitment, and is likely to kill biological control agents and the seeds of competing plants. Herbicides may also kill control agents, depending on the chemical used and the method and timing of application (see *Broom agents & herbicides*).

Modelling suggests that the longer broom plants live, the more persistent and dense the



Graph 2: The longer plants live the worse a broom problem will be.

infestation will be (see *Graph 2*). If we can shorten the life span of broom plants, then infestations should decline. We don't actually need to kill plants, just shorten their life span, and we expect that the foliage-feeding agents we have here now, alone, will be capable of doing this.

### Possible control scenarios for severe infestations

#### *Low input option*

Every year spray any plants that appear around the boundary and any outliers in the general vicinity, so the infestation does not get larger. Make it difficult for seedlings to grow by promoting a dense sward of pasture plants (by oversowing, applying fertiliser etc.), and minimising disturbance (perhaps fence the entire area off, avoid fire, excessive grazing or

trampling; light grazing may be acceptable).

Ensure that all possible biological control agents are present and if necessary introduce them into the infestation.

#### *High input option*

Spray your whole infestation and any outliers at least every 2 years so that no plants ever get to set seed. Continue with this regime until the seed bank is exhausted.

#### Reference

Rees, M. & Paynter, Q. 1997. Biological control of Scotch broom: modelling the determinants of abundance and the potential impact of introduced insect herbivores. *Journal of Applied Ecology* 34: 1203-1221.

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