Ministry for Primary Industries
Manatū Ahu Matua

Aging 'non-forest' to 'forest' transition of gorse and broom

Final Summary Paper

Part of MPI Technical Paper No: 2018/19

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ISBN No: 978-1-77665-924-1 (online)

ISSN No: 2253-3923 (online)

July 2018

New Zealand Government

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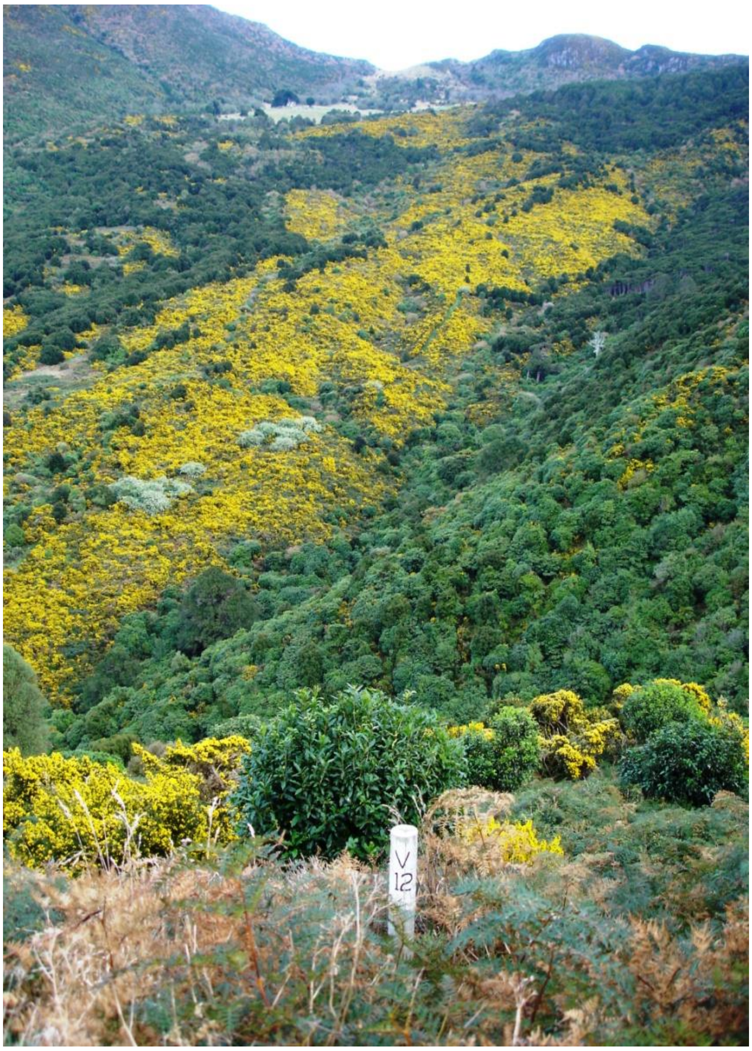
When can gorse and broom be called “forest”?

Popular summary of outcomes from SLMACC contract LCR30615 to Landcare Research, written by Fiona Carswell & Stella Belliss.

“Forest land” in the New Zealand Emissions Trading Scheme (ETS) has a sufficient presence of forest trees (i.e., species that can reach at least 5 m height at maturity) that achievement of 30% crown cover of forest trees per hectare is likely. Therefore it is important that New Zealand accounts for land that was already forest at the end of 1989 and also recognises when land has changed status post-1989 and become “forest land” as a result of human-induced action. In many parts of New Zealand, gorse and broom have been observed to act as a “nurse” crop for regenerating broadleaved native trees. This study defines the conditions under which it is likely that gorse or broom will turn into forest, estimates the usual length of time for gorse or broom to turn into forest and examines whether remote sensing can detect the transition from gorse or broom to forest.



Example of gorse (yellow) with native trees (bright green) coming through. Most of the land in this picture would qualify as “forest”. Photo is taken at Hinewai Reserve on Banks Peninsula.

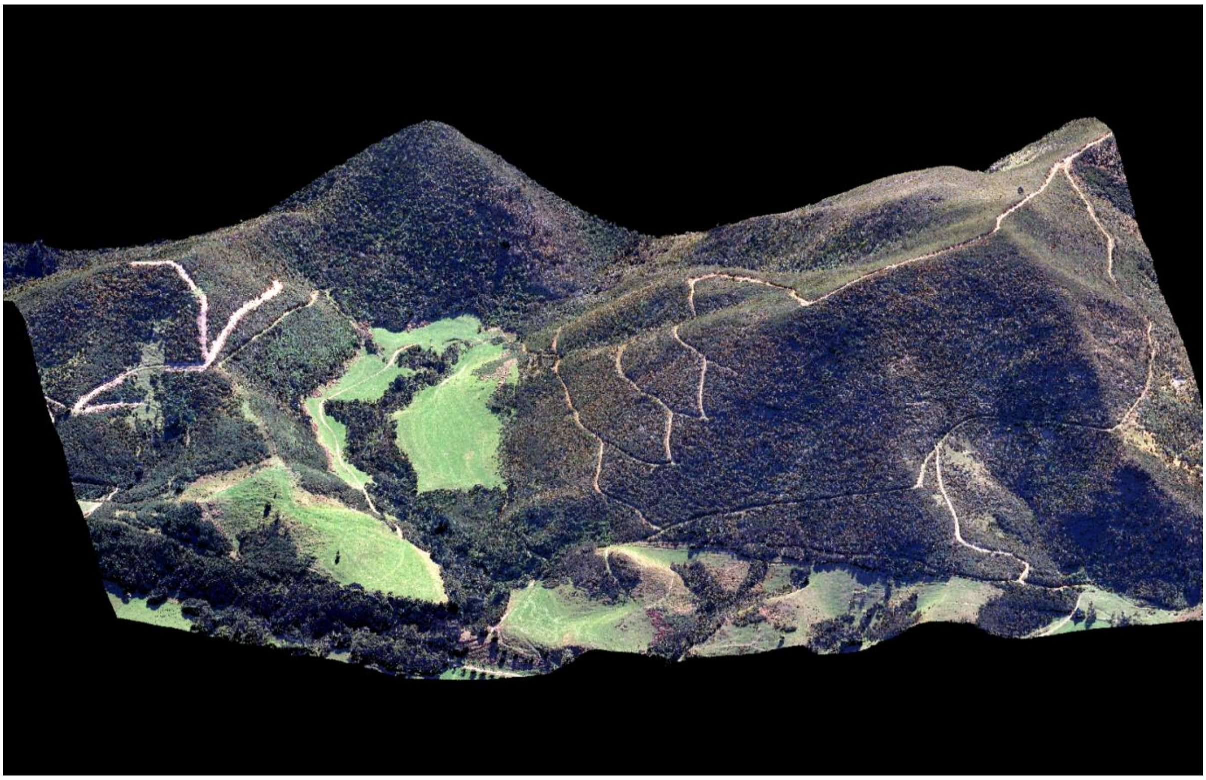
We surveyed a large area of New Zealand for the presence of forest trees within gorse and broom and then related forest regeneration to climatic factors, age of gorse or broom, and distance to native seed sources. Regeneration to forest becomes more likely as gorse or broom gets taller/older and on steeper ground. This is thought to be because the stands are more open, but not so open that grass can dominate. Regeneration is less likely the further gorse or broom is from seed source and in harsher climatic conditions such as low minimum temperature and low rainfall. Therefore inland North Island and much of the South Island has a lower probability of native trees getting to the stage of emerging through the gorse and broom. Chances of regeneration can be maximised by preventing disturbance such as fire, and by removing and controlling both domestic and wild browsing animals.

We aged gorse and broom and emerging native trees at five sites round New Zealand – 3 for gorse and 2 for broom. At each site we picked 15 plots that spanned the range of no trees through <30% cover of trees to >30% tree cover. Plants were aged by counting rings. We found that the average gorse age was 6.18 ± 1.21 years when the first trees established, compared with a mean broom age of -0.22 ± 0.88 years. This means that unlike gorse, for the two broom sites, forest trees are generally not establishing into the first cycle of broom and that there is at least one growth-death-new broom cycle (c. 15 years) before the forest species become established. Across all sites an additional 11.1 ± 0.9 years was required until 30% crown cover of forest trees was achieved. These numbers reflect the optimum transition for the hand-picked plots at a site with lots of trees; a few additional years will be required for a given hectare at the same sites to achieve 30% crown cover. There was a significant difference between species, with gorse sites tending to transition to forest more quickly (mean time to 30% cover from initial establishment of forest trees = 10.2 ± 0.53 years) than broom sites (mean = 12.2 ± 0.75 years).

We found that carbon in regenerating gorse stands can be predicted relatively accurately by measuring gorse height. A new relationship between gorse height and carbon was produced that allows for the inclusion of trees as well as gorse. This relationship suggests that gorse of 30 years of age is generally around 4 m high and contains approximately 125 t C/ha (= 458 t CO_2e/ha).

Remote sensing could make a significant contribution to an independent assessment of whether gorse or broom have turned into 'forest' if it can be used to detect the tops of forest tree species that have already pushed through the gorse and broom. To do this, remotely sensed images would need to a) distinguish whether the dominant canopy is gorse or broom and not another narrow-leaved shrubland species such as manuka, b) distinguish between the dominant gorse or broom canopy and the tree tops sitting above the canopy and c) identify the species of tree tops sitting above the canopy in order to determine if they can reach 5 m height at maturity.

Currently, there is no single remote-sensing tool or sensor that could be used to accurately identify when areas transition from gorse and broom shrubland to 'forest'. Some remote-sensing sensors – especially those with a blue spectral band and/or shortwave infrared – are useful for detecting gorse and broom when they are in flower. However, as both can flower over quite long periods, it would be difficult to get large areas accurately mapped without many images being used. However, very high resolution LiDAR, flown with simultaneous digital colour aerial photography shows promise, as does hyperspectral imagery. Neither type of imagery is currently available at the required resolution for much of New Zealand. Preliminary investigations suggest that acquisition of such imagery would be around $45 million and that there would be significant additional costs associated with intensive image processing.



Featherston gorse site from 3D LiDAR. Colour values from orthophotography have been used to colour each point in the 3-dimensional LiDAR point cloud; these can then be viewed in any orientation to assist interpretation. The resolution of this LiDAR survey is 1.3 pings per m^2, insufficient to pick up emergent crowns from the shrublands (although see the individual trees at the bottom of the image). To achieve this, a resolution somewhere between 4 and 25 pings per m^2 would be needed.