Wise Up To Weeds!

What's Inside:

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Manaaki Whenua
Landcare Research

Do native animals benefit from the invasion of riparian zones by crack willow?

Willows have been extensively planted in New Zealand as shelter belts, for stock fodder, to prevent soil erosion, and along river and stream banks (riparian zones) to manage water courses. They are now the second most common exotic tree after radiata pine. In the past, crack willow (*Salix fragilis*) has been widely used for river control principally because it is easy to propagate from stem fragments. Like other willows, it grows quickly, has extensive root systems and will tolerate flooding. Many of these characteristics are also attributes of invasive weeds.

Margaret Stanley and Darren Ward from Landcare Research, Mt Albert, have recently undertaken a detailed study to find out if the invasion of the riparian zone by crack willow has affected this important ecosystem. "We chose the Mangatawhiri River, in the Hunua Ranges South East of Auckland, as our study site," Margaret said. The effects of willow invasion have been studied in braided South Island rivers and wetlands, but very little is known about the impact of willow on small rivers and streams that run through areas of native bush. "These habitats are common throughout New Zealand and are often hotspots for wildlife."

At their field site Margaret and Darren compared the bird and invertebrate (insects, spiders, mites) life on crack willow with that present on the native tree kānuka. "We chose kānuka because it is commonly found in riparian zones and like willow does not produce fleshy fruit – it only provides flowers as a food resource for birds," explained Margaret. Sampling was conducted once every season to match the different life stages of the trees – winter when willow has no leaves, spring when willow has buds and catkins, summer when kānuka has flowers, and autumn when both still have leaves. "We wanted to find out what resources willow provides to birds and insects and how this compared with a native alternative." They also wanted to know if the surrounding landscape

Darren removing a sticky trap from willow.

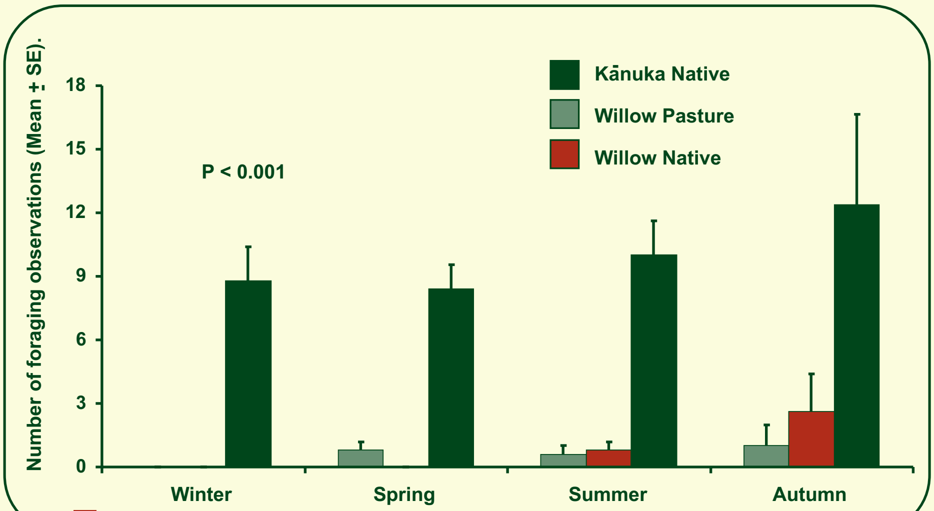
made any difference to the birds and invertebrates found on the two trees. For example, are the birds that use willow in pasture any different to those that use willow in native bush? "We sampled five different sites in each of three different habitat types: willow surrounded by pasture, willow surrounded by native bush, and kānuka surrounded by native bush."

During each sampling period birds were observed for 40 minutes at each site. The species present, their abundance and behaviour were recorded. " It is important to note the behaviour of the birds (such as foraging and perching), in order to know what the birds are using the trees for," said Margaret. "We found there were a lot more birds and bird species using kānuka than crack willow, regardless of season or whether the willows were in pasture or native bush." Another important finding was that the bird communities using crack willow were very different from those using kānuka. Native bird species were overwhelmingly found on kānuka, while introduced birds were most common on willow. Interestingly, they also found that while birds were often seen foraging on kānuka, almost no foraging observations were recorded for crack willows in either bush or pasture (see graph). "Instead we found the birds primarily used willows as somewhere to perch," Margaret observed. " From watching the birds, it seems to me that a fencepost or powerline would have done the trick just as well!"

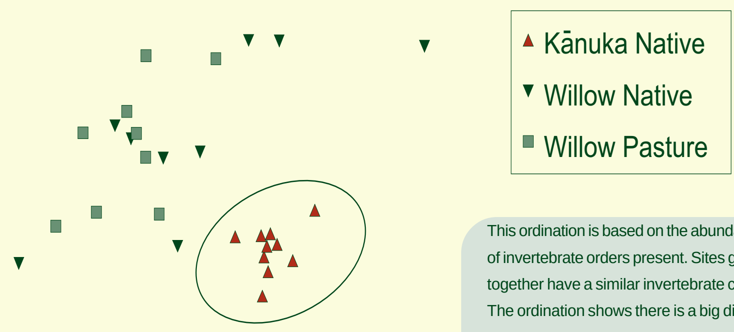
Margaret and Darren also sampled the invertebrate communities on crack willow and kānuka in the different habitat types and seasons. To collect the invertebrates they used sticky traps either attached to the bark or hanging from branches, and took vegetation clippings (20–30 cm of a branch with foliage). They found there were huge numbers of invertebrates on kānuka in all seasons, compared with willow in either pasture or native bush. "The sheer number of invertebrates present on kānuka compared to willow relates well to the observations of birds foraging on kānuka," explained Margaret. "Kānuka provides a better resource for birds than willow in terms of an invertebrate food supply." They also found the invertebrate community on crack willow was very different to that on kānuka (see scatter plot), with fewer mites, thrips, sap-sucking bugs, beetles and spiders.

To see if their results from Mangatawhiri River were representative of other similar river systems, Margaret and Darren set off around the North Island looking for likely streams with crack willow and kānuka, surrounded by either bush or pasture. "This wasn't an easy task, but in the end we found seven other sites," related Margaret. At these sites they took vegetation clippings and observed birds in each of the habitat types. "We were very pleased to see that the data for birds and invertebrates from these sites throughout the North Island matched the results from our more detailed study at Mangatawhiri."

Overall, Margaret and Darren's study has shown that replacing native trees such as kānuka with crack willow results in very different bird and invertebrate communities with less diversity. "Crack willow fails to provide the same resources for these animals as the native counterpart," concludes Margaret. "Invasion of riparian zones by crack willow has a detrimental effect on these valuable ecosystems!"



Number of birds foraging in willow and kānuka.



This ordination is based on the abundance and types of invertebrate orders present. Sites grouped together have a similar invertebrate composition. The ordination shows there is a big difference in the invertebrate composition between kānuka and willow, irrespective of whether the trees are in pasture or bush.

Composition of invertebrate communities on willow and kānuka.

Unravelling the link between ecological traits and the invasiveness of woody weeds

Many weed scientists believe that the most successful invasive weeds are likely to possess ecological traits that help them out perform other plants. These traits may be particularly important for invasion of disturbed or modified environments such as roadsides, urban areas, forestry blocks and pasture, where weeds are common. In particular, a high relative growth rate for seedlings – the ability to grow faster than their neighbours – may be one of the most important traits for determining the success of particular weed species in exploiting these disturbed habitats.

Peter Bellingham from Landcare Research, Lincoln, and a team of researchers have recently completed a large experiment to see if the invasiveness of a selection of New Zealand woody weeds could be explained by a number of ecological traits, including the relative growth rate of their seedlings.

Seedlings of 33 species from four families (Fabaceae, Mimosaceae, Pinaceae, Rosaceae) were grown outside in pots for 14 to 19 months (see table). "The species we selected are woody plants typical of disturbed habitats that have all established a self-sustaining population (= naturalised) in New Zealand, but have spread to varying degrees," explained Peter. "To define the invasiveness of each species, we calculated an invasion rate based on the number of ecological regions throughout New Zealand that the plant had spread to since naturalising here" (see table). Seedlings of each species were exposed to different treatments (fertiliser, drought, shade, clipping, burning, competition with another plant, or nothing) to mimic a range of conditions that would be experienced in the wild. "We wanted to find out if the seedlings of more invasive species had a higher relative growth rate, greater survival rate and wider tolerance to the treatments they were subjected to," Peter said.

Somewhat surprisingly Peter and his team were unable to find a link between the invasiveness of a species and the experimental measures they employed. "There were no statistically significant relationships between seedling relative growth rate, survival or tolerance and the invasiveness of the plants tested for any of the treatments," related Peter. "Our result was in direct contrast to a recent study by Grotkopp et al. (2002), who found more invasive pine species exhibited higher seedling relative growth rates, and this despite the fact our study included 12 species of pine." This difference can be explained in part by the fact that the two studies were focusing on different phases of the plant invasion process. "The species selected in our study had already naturalised in New Zealand and we were concerned with their ability to spread to new areas, while the majority of the pine species studied by Grotkopp et al. had not yet naturalised in new environments," Peter said. " It is possible seedling relative growth rate may be important for explaining the probability that a plant will naturalise (as described by Grotkopp et al.), but be unrelated to the rate of spread after naturalisation (as we found)."

The relationship between ecological measures such as seedling relative growth rate and plant invasiveness is also likely to be confused by the actions of humans. In the case of pines, humans have deliberately planted trees with fast growth rates for timber production, land stabilisation and revegetation. As a consequence these trees have been spread to many locations where they are now naturalised and have become weeds. "We conclude that for future studies of this type to tell us something definite about the relationship between ecological measures (such as relative growth rate) and plant invasiveness, it is important to try to separate out the influence of humans on the invasiveness of a particular plant species."

For more information see:

Bellingham, P. J.; Duncan, R. P.; Lee W. G.; Buxton, R.P. (in press): **Seedling growth rate and survival do not predict invasiveness in naturalized woody plants in New Zealand**. *Oikos*

Grotkopp, E.; Rejmánek, M.; Rost, R.L. 2002: **Toward a casual explanation of plant invasiveness: seedling growth and life-history strategies of 29 pine (*Pinus*) species.** *American Naturalist 159: 396–419.*

Blackberry, a common and widespread weed.

Table 1: Invasiveness of woody plant species naturalised in New Zealand and tested in this study.

Family	Weed species	Year first naturalised	No. ecological regions occupied	Invasiveness	Invasion rate
Fabaceae	*Chamaecytisus palmensis* (tree lucerne)	1919	27	2	0.024
	Cytisus multiflorus (white broom)	1899	6	3	0.011
	Cytisus scoparius (Scotch broom)	1872	40	1	0.020
	Lupinus arboreus (tree lupin)	1904	31	1	0.021
	Lupinus polyphyllus (Russell lupin)	1958	15	2	0.019
	Spartium junceum (Spanish broom)	1940	16	2	0.017
	Ulex europaeus (gorse)	1867	37	1	0.022
Mimosaceae	*Acacia dealbata* (silver wattle)	1870	23	1	0.025
	Acacia longifolia (Sydney golden wattle)	1897	11	2	0.012
	Acacia mearnsii (black wattle)	1971	14	2	0.022
	Acacia verticillata (prickly Moses)	1948	15	2	0.016
Pinaceae	*Larix decidua* (larch)	1919	7	1	0.020
	Picea abies (Norway spruce)	1957	5	3	0.016
	Picea sitchensis (Sitka spruce)	1957	7	3	0.021
	Pinus banksiana (jack pine)	1957	7	2	0.016
	Pinus contorta (contorta pine)	1957	15	1	0.030
	Pinus halepensis (Aleppo pine)	1925	6	2	0.018
	Pinus mugo (mountain pine)	1988	4	2	0.020
	Pinus muricata (bishop pine)	1940	11	2	0.015
	Pinus nigra (Corsican/Austrian pine)	1925	15	1	0.028
	Pinus patula (patula pine)	1957	3	2	0.020
	Pinus pinaster (maritime pine)	1830	20	2	0.022
	Pinus ponderosa (Ponderosa pine)	1925	13	3	0.023
	Pinus radiata (radiata pine)	1904	22	1	0.024
	Pinus sylvestris (Scots pine)	1919	8	3	0.023
	Pinus uncinata	1987	1	3	0.000
	Pseudotsuga menziesii (Douglas fir)	1925	12	1	0.021
Rosaceae	*Chaenomeles speciosa* (japonica)	1988	4	3	0.022
	Cotoneaster conspicuus	1977	4	3	0.031
	Prunus cerasifera (cherry plum)	1958	18	2	0.019
	Rosa rubiginosa (sweet brier)	1867	41	1	0.023
	Rubus fruticosus (blackberry)	1867	12	1	0.012
	Sorbus aucuparia (rowan)	1904	14	2	0.014

Each species used in the study was classified as either (1) widespread, common weed, (2) scattered, or local weed, and (3) scarcely naturalised, or very local weed. An invasion rate was also calculated for each species (measured as the slope of the regression of log (cumulative number of ecological regions occupied by a species) against time). Interestingly, there was a statistically significant relationship between the invasion rate and the date of first naturalisation: plants that had naturalised earlier tended to be more invasive. The average date of naturalisation for widespread, common weeds was 1898, for scattered or local weeds it was 1935, and very localised weeds naturalised on average in 1951.

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