

# POPULATION DYNAMICS AND THREATS TO THE PROSTRATE BROOM *CARMICHAELIA JUNCEA*, FOX RIVER, SOUTH WESTLAND

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## INTRODUCTION

The prostrate broom *Carmichaelia juncea* is well adapted to colonising recently stabilised river beds and silts (Heenan, 1995). The species was once found from Hawkes Bay to Lake Manapouri. However it has declined to the extent that it is currently ranked as nationally endangered (de Lange et al 2004), and is currently known from just one North-west Nelson and three South Westland localities.

Recent research has confirmed browsing by hares as a major threat at some sites (Grüner in prep.). Other causes of decline include competition from both native and introduced plant species, browsing by possums and chamois, alteration of natural flooding regimes (Norton et al. 1998) and hybridisation with *C. australis* (in north-west Nelson; S. Courtney, pers. comm.) and *C. arborea* in South Westland (Buxton 1993).

Although the causes of decline are relatively well known, little is known about the population dynamics of this species. This paper describes changes in one of the three South Westland populations over a period of seven years.

## STUDY AREA

*C. juncea* is found in a number of patches within a 1.5 km section of the Fox River, about 2 km south of Fox Glacier township. It was previously recorded in the general vicinity by Buxton (1993) as *C. nigrans* and by Norton et al. (1998). For the purpose of this study three discrete patches of the species were identified and marked as separate subpopulations in July 1998.

The Fox 1 subpopulation is located immediately upstream of the State Highway 6 bridge on the true right bank of the Fox River (Fig. 1), and is that described by Norton et al. (1998) as occurring on freshly bulldozed river gravels. It also occupies recently deposited silt. The Fox 2 subpopulation is located 500 m downstream of the bridge and the Fox 3

subpopulation is located 1 km upstream of the bridge. At both of these sites *C. juncea* occurs on stable vegetated islands.

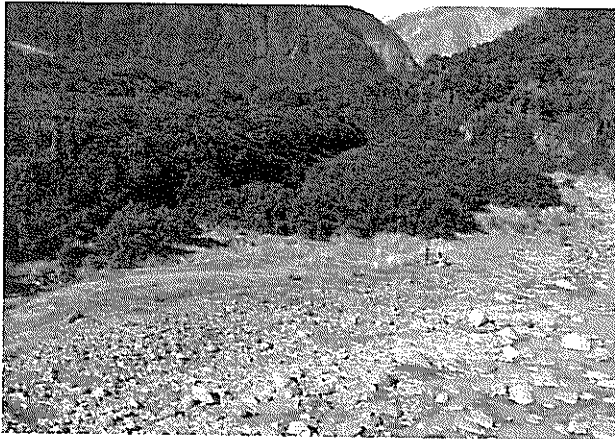


Fig. 1: Location of the Fox 1 *Carmichaelia juncea* subpopulation viewed from the State Highway 6 bridge, looking upstream:

- upper: September 1998 during a flood. The water is close to inundating some of the *C. juncea* subpopulation. Note the recently bulldozed track in the centre of the photo.
- lower: April 2005. The bulldozed track is largely obscured by the dense cover of tutu and other woody species that have grown since 1998.

## METHOD

In July 1998 and April 2005 coordinates along a north-south and an east-west transect were recorded for the locations of individual plants and mats of *C. juncea* in the Fox 1 subpopulation. The ends of the north-south transect were marked by waratahs.

Distance (m) and compass bearing from waratahs were used to locate individual plants at all three sites for a growth rate study. Numbered aluminium tags were attached by lacing wire to the longest branch of individual plants, with 18, 16 and 10 branches being tagged at the Fox 1, 2 and 3 sites respectively. Between July 1998 and March 2001 their lengths were measured (mm) and any evidence of browsing and competition (defined as stems overtopped by taller growing species) was recorded. Change in branch length (cm), percentage cumulative branch mortality and the proportion of branches browsed or exposed to competition were determined for each of the three sites.

## RESULTS

### Population dynamics July 1998-April 2005

The Fox 1 subpopulation of *C. juncea* consisted of 19 plants within an area of about 400 m<sup>2</sup> in July 1998. It had grown to approximately 550 plants within an area of about 2500 m<sup>2</sup> by April 2005 (Fig. 2), although by then it was not possible to determine the exact number of individual plants at this site, due to the dense mat-like growth form of some. These were mapped as rectangles (Fig. 2).

Comparison of the distribution of *C. juncea* plants in 1998 and 2005 suggests that the subpopulation is gradually moving downstream. Most of those recorded in 2005 were further downstream than the 19 plants present in 1998. However, despite the presence of suitable recent silts further downstream none were further than about 15 m downstream of the most downstream plant in 1998. Similarly, despite the presence of suitable habitat, only a few plants were found upstream of the 1998 plant locations, and these were only 10-15 m upstream. Juvenile plants, distinguished by the presence of relatively large-leaved branches, were scattered throughout the subpopulation.

Threats to the Fox 1 subpopulation in 1998 included flooding (Fig. 1 upper), some browsing by hares and use of the area by vehicles. Vehicle

access was subsequently restricted by the placement of large boulders beneath the bridge. In 2005, there was very little evidence of hare browsing at this site. Two patches of *C. arborea* and the putative hybrid *C. arborea* x *C. juncea* were present (mapped as stippled rectangles in Fig. 2).

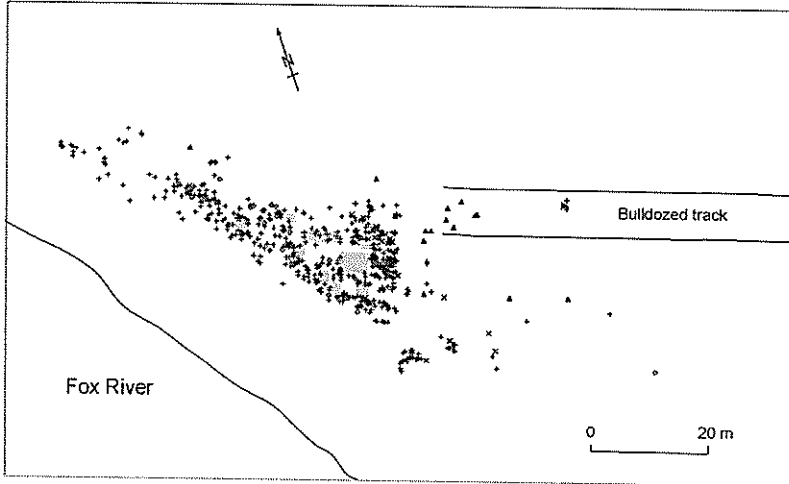


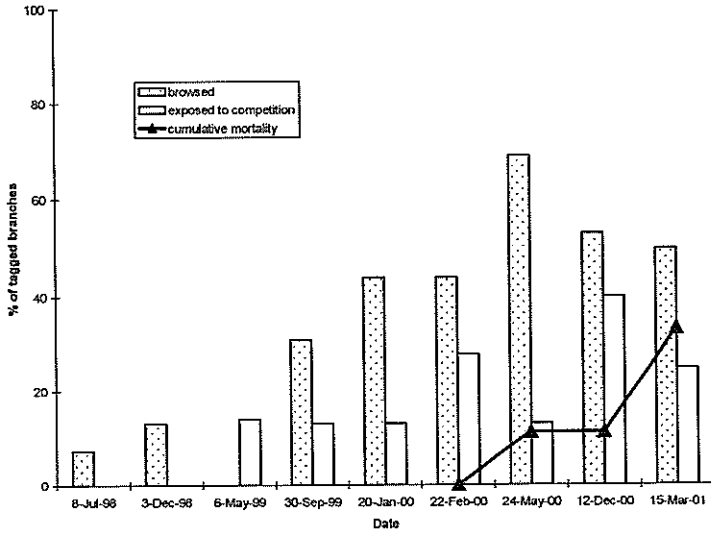
Fig. 2: Distribution of the Fox 1 *Carmichaelia juncea* subpopulation in July 1998 (▲) and April 2005 (+ adult plants; o juveniles; X dead plants; grey shading mats of *C. juncea*; stippled areas hybrid swarms of *C. arborea* and *C. juncea*). The Fox River flows from right to left.

In 1998, the total number of plants in the Fox 2 and 3 subpopulations could not be recorded due to the mat-like growth form of the species that occurred at both these sites. A search in April 2005 using the waratahs as a reference failed to locate any plants at either of these sites, which had become overgrown by taller vegetation by the end of the study period.

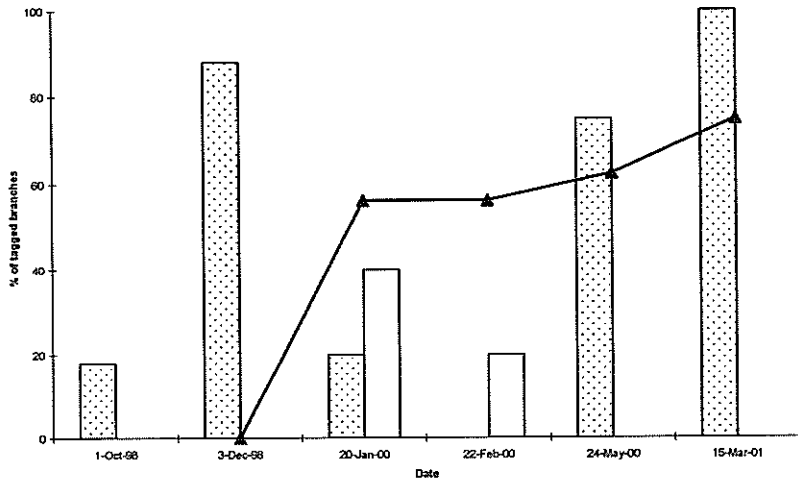
#### Plant Growth and Survivorship July 1998 to March 2001

At the end of the study period, the average branch length of *C. juncea* for the 10 surviving branches of the Fox 1 subpopulation had decreased by 15 cm. It became apparent during monitoring that this measurement provides only an approximation to plant growth because it only included the length of the longest part of the branch above the tag. A more accurate measure of growth would have been that used by Grüner (in prep) who measured the length of each branch and all its side branches.

A



B



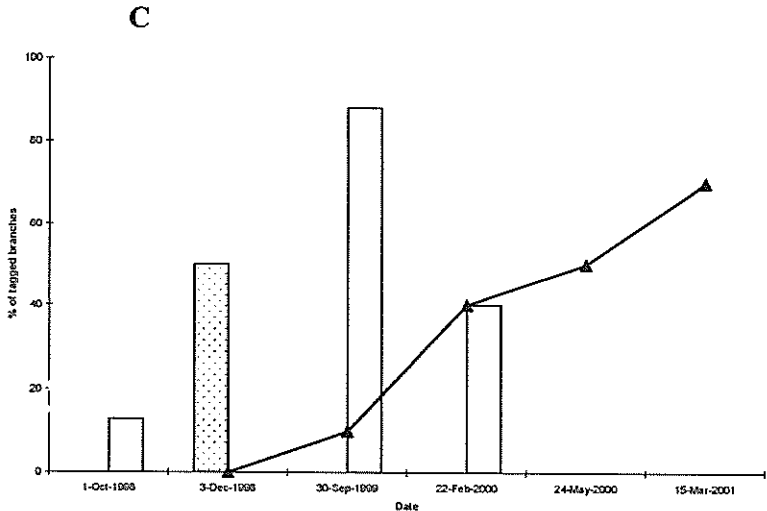


Fig. 3: Tagged *Carmichaelia juncea* cumulative percentage branch mortality, percentage of branches browsed by hares and percentage of branches exposed to competition by taller growing species for the three Fox River subpopulations.

Cumulative percentage mortality, percentage browsed by hares and percentage exposed to competition by taller growing species, for tagged branches of *Carmichaelia juncea*: a, Fox 1; b, Fox 2; c, Fox 3 subpopulations.

Fig. 3 also shows the proportion of plants showing evidence of browsing and competition at each of the three sites. The proportion of branches exposed to competition increased over time at the Fox 1 subpopulation reaching a peak of 40% in December 2000 (Fig. 3a). Many of the locations of plants found in 1998 are now overgrown by taller species such as tutu (*Coriaria arborea*) (compare Fig. 1a and 1b). The proportion of branches browsed by hares also increased over time, with consistently around half the tagged branches browsed in the second half of the monitoring period.

Hare browsing occurred in intense bouts at the Fox 2 subpopulation (Fig. 3b). For example, in December 1998, 88% of the measured branches were browsed. A considerable increase in branch mortality was subsequently recorded by January 2000. At this site, competition was noted for up to 40% of the surviving stems during the middle of the study period. At the Fox 3 subpopulation, hare browse was observed on only

one occasion (Fig 3c). High levels of competition were noted during the middle of the study period and an increase in branch mortality followed this.

## DISCUSSION

### Population dynamics

The three subpopulations of *C. juncea* have all undergone considerable change over the seven years of monitoring. At the Fox 1 site the number of individuals has increased nearly 30 fold. This is most likely attributable to the notable current absence of herbivores such as hares, and the creation of suitable habitat, provided through changes in the river course and initially by human disturbance in the form of bulldozed tracks.

The seeds of most *Carmichaelia* species, including *C. juncea*, have no special adaptations for dispersal, their only means of dispersal being movement by wind or water (Norton in prep). Thus, given the regular flooding of the Fox 1 site (e.g. Fig 1 upper) it is not surprising that most of the subpopulation has shifted downstream, although it is notable that the downstream end of the current subpopulation is only about 15 m further downstream than the 1998 subpopulation. A similar lack of longer distance dispersal is evident in the major South Westland population in the Waiho. *C. juncea* used to occur on recently deposited gravels near the terminal face of the Franz Josef glacier until the population was washed out by a flood in the early 1970s (Wardle 1975 and pers. comm.). It has not recolonised these areas, despite the presence of a population of several thousand individuals about 8 km downstream.

The complete loss of the Fox 2 and 3 subpopulations was probably a result of succession, as taller indigenous species such as tutu (*Coriaria arborea*) and *Carmichaelia arborea* have established on the stable silts and gravels. Much of the area where the Fox 1 subpopulation grew in 1998 has also become overgrown (Fig 1 lower). Competition from adventive plants did not appear to be a major threat at any of the three sites.

### Plant growth and survivorship

As expected, browsing and competition appear to influence the growth and survivorship of *C. juncea* at the Fox River sites, with the amount being recorded during the study suggesting that their relative importance varies between sites and over time (Fig 3). Although hare browsing was noted between 1998 and 2001, in 2005 none was noted at the Fox 1 site

and the subpopulation had greatly increased. A study of *C. juncea* in the Waiho River in South Westland also recorded very high levels of hare browsing that resulted in both reduced seed production and regeneration (Grüner in prep.), but more recent observations found little browse pressure at this site (P. Knightbridge & I. Grüner pers. obs).

For the Fox 3 subpopulation, little evidence of browsing was recorded and survivorship seemed more closely related to competition. Similarly, a study of *C. juncea* at Welcome Flat in the Copland Valley, South Westland involving individuals with and without enclosing cages also found no evidence of fresh browsing despite the presence of herbivores such as possums and chamois (Grüner in prep.).

### Constraints for monitoring

During the study period, the loss of a number of the aluminium tags used to mark branches prevented ongoing measurement of some branches. This loss may have been through browsing, removal by kea, or burial by river silt or vegetation. Although metal detectors were successfully used to locate some tags, the failure to readily locate all of them on every visit made the method very time consuming and also resulted in gaps in the data. However, due to the ever-changing nature of the riverbed environment, the tendency of *C. juncea* to form dense mats where individuals are indistinguishable, and the relatively short life span of individual stems, permanent marking of stems is fraught with difficulty.

## CONCLUSION

The results from this work and similar work by Grüner (in prep.) suggest that even though browsing by hares can be patchy in time and space, it can constrain population growth of *C. juncea*. This study also confirms that the lifespan of *C. juncea* in stable sites where taller vegetation can establish is relatively short (in this case about eight years from the time a bulldozed track was established), and that the species is highly dependent on the creation of suitable new habitat by floods. Contrarily, the apparently poor dispersal of seed suggests floods could also threaten the persistence of the species in a catchment if suitable new habitat is not created nearby.

The status of *C. juncea* in the Fox River has changed dramatically in seven years. In 1998 there were three small discrete subpopulations. By 2005 only one of these survived, but this was now a large subpopulation with over 500 individuals. It is difficult to judge whether *C. juncea* is



more or less secure in the Fox catchment in 2005 than it was in 1998. Provided browse pressure remains low, the larger number of individuals present now could release a considerably larger amount of seeds into the riverbed than in 1998. However, due to the dynamic habitat, a large flood could destroy the Fox 1 subpopulation at any time, and threats such as high hare numbers or competition with adventive grasses could prevent establishment of plants from seed germinating from the seed bank.

It is clear from this study that in the presence of suitable habitat and the absence of hares, *C. juncea* can increase rapidly in abundance. Dispersal is likely to occur rapidly downstream and more slowly upstream. Given that the lower reaches of the South Westland catchments that *C. juncea* grows in are mostly modified by agricultural development and are relatively weedy, upstream dispersal is more likely to result in establishment of new populations. Thus the long term survival of *C. juncea* in South Westland is likely to require both localised hare control or exclusion, and human-assisted dispersal of seed to suitable sites. A trial of the latter has begun upstream of the Waiho Valley population and early results are promising (I. Grüner pers. comm.)

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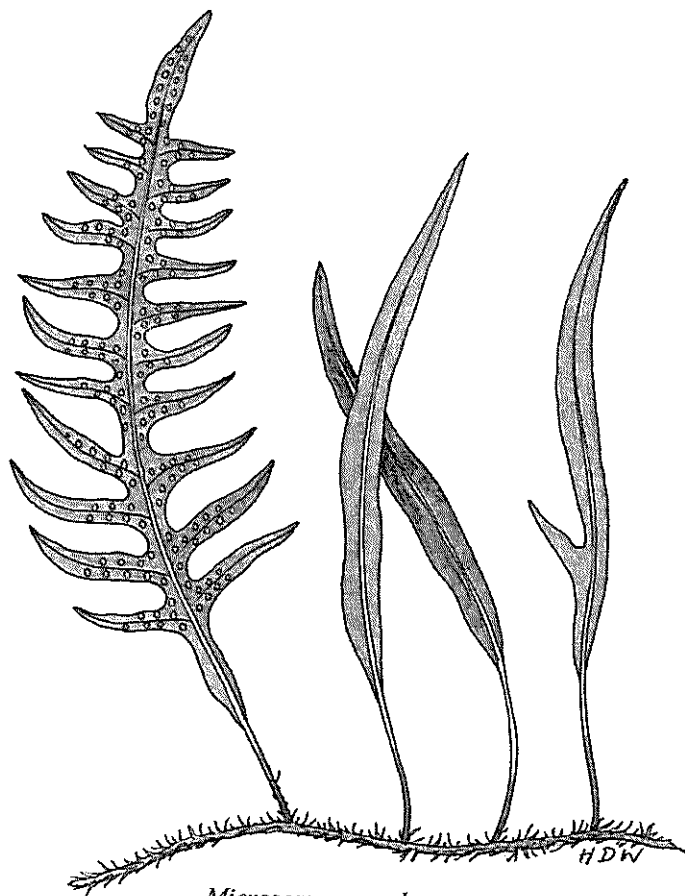
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*Microsorium scandens*  
Fragrant fern, mokimoki