Native species outgrow post-cyclone weeds

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Summary Tropical cyclone Larry carved a swathe through the forests of Far North Queensland in March 2006. Weed recruitment was rapid and diverse, with short-lived species dominating initially. In 2009 we re-surveyed 62 × 0.1 ha plots, both across and along the cyclone track, which had been surveyed for weeds immediately after cyclone Larry. We report on changes in weed species, abundance and functional grouping between the two survey periods. Initial infestations were dominated by Asteraceae and Solanaceae, with relatively few species but high abundance at each site. Aggressive growth of native species largely replaced the initial weed recruits, though we anticipate that these will disappear as the canopy fully recovers. However, a few species, which can tolerate more intense competition and lower light levels, remain of concern. The management implications of these findings are discussed.

Keywords Weeds, cyclone, functional group, competition, recruitment.

INTRODUCTION

Severe Tropical Cyclone 'Larry' crossed the coast of north Queensland, Australia, on the morning of 20 March 2006, travelling due west. Maximum wind gusts at landfall exceeded 290 km h^{-1}, with very destructive winds forming a radius of 40–50 km and destructive winds extending to 120 km (Davidson 2006, Bureau of Meteorology 2007).

Cyclones are an important driver of the dynamics of the rain forests of Queensland's Wet Tropics Bioregion, with canopy disturbance and leaf loss exposing soil through landslips and tip-ups, and increased light levels reaching the understory. This exposure can lead to mass recruitment of light-demanding species, both native and alien species. There are an estimated 206 species naturalised within rain forest habitats in the Wet Tropics (Metcalfe and Ford 2008), including a number of highly invasive species such as *Miconia calvescens*, which invaded rain forest habitats in Polynesia after disturbance caused by hurricanes (Meyer 1998).

In order to assess the existing weed load in rain forest habitat within the Wet Tropics rain forests and the impact of cyclone 'Larry' in promoting weed spread and establishment, we conducted surveys in rain forest both across and along the cyclone track, within 12 months of the cyclone and again *c.* 3 years later. These surveys have been geospatially referenced in order that contextual environmental information can be generated. This will permit comparisons of pre-cyclone disturbance and the relationships between existing and post-cyclone weed load and the proximity of rain forest sites to internal or external fragmentation.

MATERIALS AND METHODS

Surveys were paired where possible to allow a minimal level of replication at each forest site. Each survey consisted of a 200 m transect walked through the selected forest area, scanning the vegetation 2.5 m either side for weeds to achieve a 0.1 ha survey area. Paired sites were located 200–500 m away from each other. Data were collected in 25 m long sections (i.e. eight quadrats/transect), with level of canopy disturbance, native species regeneration or germination inhibitors (e.g. heavy litter or dense ground cover), the number, identity and phenological state of all non-native (weed) species being recorded. Disturbance to the canopy at each transect was rated on a scale of 1 (intact) to 5 (completely open). Weed numbers were counted on a logarithmic scale, i.e. in individuals from one to ten plants, in tens from 10 to 100, in rounded hundreds from 100 to 1000, etc. For example, 6 plants would be recorded as 6; 66 plants as 70 and 666 plants as 700.

Post-cyclone native regeneration was dominated by (i) large-gap-demanding species (which can only establish in substantial tree fall gaps, e.g. *Homalanthus novoguineensis*), (ii) small-gap-demanding species (which require a limb-fall or equivalent sized gap to provide sufficient light for establishment, e.g. *Castanospora alphandii*) or (iii) shade-tolerant species (which may establish and grow under closed canopy conditions, e.g. *Beilschmedia bancroftii*). Plants that we could not identify in the field were vouchered for later determination; appropriately-labelled vouchers lodged at the Australian Tropical Herbarium, Cairns (CNS) and Queensland Herbarium, Brisbane (BRI). Nomenclature follows Bostock and Holland (2002).

RESULTS

In 2006 thirty-nine of the 62 (62.9%) transects had weeds present. Of the 496 quadrats across all transects, 148 (29.8%) had weeds present. Weed diversity and abundance was highest in the most disturbed sites (i.e. lowest canopy cover). By 2009 only 17 (33.3%) of transects had weeds present, though transects were often heavily invaded, and 107 (26.2%) of quadrats had weeds in them. Weed persistence was greatest at the most disturbed sites.

In 2006/07 a total of 62 transects from 36 sites was surveyed (496 quadrats); 4137 individual plants of 23 species of weeds from 13 families were encountered across all transects. *Crassocephalum crepidioides* (thickhead) and *Solanum mauritianum* (tobacco bush) were the most abundant weed species. Six weed species were represented by only one individual. In 2009 a total of 51 transects from 31 sites were surveyed (408 quadrats); 516 individual plants of 11 species of weeds from eight families were recorded. *Ageratum conyzoides* (bluetop) and *Rubus alceifolius* (giant bramble) were the most abundant weeds. Four species were represented by a single individual.

Three years after the cyclone, canopy disturbance remained similar (47% of quadrats with open canopies in 2006, 42% in 2009) but both abundance and diversity of weeds had declined. Overall weed abundance had decreased by 85%; the two most common weed species in 2006 had declined to less than 2% of their original abundance, and 14 species had disappeared altogether. No new weed species were encountered. However, the small tree *Miconia calvescens* was equally abundant in 2009 and 2006, and the scrambler *Rubus alceifolius* was nearly three times more abundant.

DISCUSSION

Severe tropical cyclone 'Larry' caused extensive damage across the studied region, with some areas in the lowlands loosing nearly 100% of their canopy (Metcalfe *et al*. 2008). In such areas, weed diversity and abundance was high, although there was considerable variation, largely driven by the suppression of weed recruitment either by dense debris piles or aggressive regeneration of native species. Existing plants of some native ground-covering herbs (e.g. various Commelinaceae), vines (e.g. *Faradaya splendida*) and bamboos (*Mullerochloa moreheadiana*) responded very rapidly to opening of the canopy, resulting in dense understory canopies that prevented recruitment of weedy species. In a couple of plots very dense recruitment (>300 plants in a 25 m section) of a single weed species (e.g. *Crassocephalum crepidioides*) suppressed the establishment of other weed species, resulting in low weed species diversity. High weed abundance scores were also recorded in some transects with less completely damaged canopies, but where very high recruitment had occurred in a nearby tree fall gap or other similar localised disturbance.

Decline in weed abundance and diversity appears to be primarily driven by continued re-growth or regeneration of native species. Gingers and allies, ferns and a number of scandent or scrambling shrubs and palms, in addition to vigorous vine re-growth, rapidly suppressed seedlings and smaller-statured herbs – 10 of the 14 weed species that disappeared between 2006 and 2009 were herbaceous, the others were small shrubs.

However, the species with greatest resilience to native regrowth are the woody species (see also Murphy *et al*. 2010). *Rubus alceifolius* actually increased in abundance, and gaps dominated by this species dating back to disturbance caused by cyclone Winifred (1986) are still evident on the coastal ranges and tablelands. So woody species such as *Rubus* and *Miconia*, which are well dispersed, capable of responding quickly to new disturbances and then persisting, are thus of greatest concern. Consequently, it seems most productive to allow native species regrowth to control short-lived herbaceous species, and to target management activities at maintaining control of woody weeds in open or disturbed habitat adjacent to larger areas of intact or extensive rain forest.

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