THE Oceania Pollinator Initiative

OPI

Monitoring Pollinators:

case studies from Australia and New Zealand

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Introduction

To establish baselines for monitoring trends in pollinator services in Oceania, we have adopted diverse methods depending on the type of plant-pollinator interaction and the purpose of the investigation. Monitoring is undertaken for a variety of reasons, e.g. to detect change in pollinator communities in fragmented landscapes, to gauge the impact of exotic pollinators on native and exotic plant species, or to determine the contribution of alternative native pollinators in crops. Pollination systems in Oceania depend on the pollinating fauna available which is of very low diversity on most of the small remote islands (e.g., New Zealand) but higher in diversity in large continental sized islands (e.g., Australia). In island systems, exotic naturalized insects and plants are significant components of many habitats. Exotics may have positive or negative effects on native pollination systems (Newstrom and Robertson 2005). In some cases, it is clear that only exotic pollinators (e.g., bumblebees or honeybees) are capable of pollinating exotic plants. This type of interaction is called an "*invasive mutualism*" because without the exotic pollinator the exotic plant would not set seed and spread (e.g., broom, Simpson et al. 2005). In other cases, exotic pollinators may benefit native flora because they replace lost pollinators (e.g. birds on the mainland of New Zealand). Similarly, exotic plants rich in floral resources may benefit native pollinator populations but this could lead to abandonment of native plants leaving them bereft of pollinators.

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Monitoring for Conservation in Australia

10 year monitoring of a native legume

Monitoring for pollinator decline is a time consuming operation that involves replication of sites over the landscape and over many years. The legume shrub *Pultenaea campbelli* (Fabaceae) (Fig 1) is a rare species that exists in a fragmented landscape in northern New South Wales, Australia. In our monitoring study we have value added to our temporal data set (ten year monitoring period) by using plant populations of different sizes. In this way we have detected a relationship between fruit to flower ratios against population area over time (Fig 2) which is correlated with floral visitor patterns against population size (Fig 3).

This study is an example of using indirect or remote methods such as fruit to flower ratios in a pollinator dependant species to obtain efficient results when visitation data are difficult to collect.

Fig 1 A species of Lycaenid butterfly on the flowers of *Pultenaea campbelli*

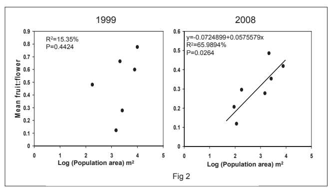

Fig 2 Fruit to flowers ratios in plants of *P. campbelli* in a ten year interval 1999 (N = 6 populations) and 2008 (N= 7 populations) showing that in 2008 plant population size is correlated with fruiting success and that overtime there has been a decrease in reproductive performance in this insect-dependant species.

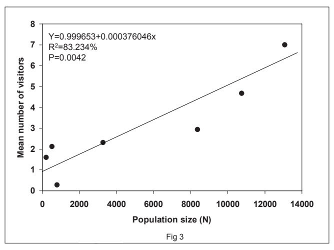

Fig 3 Mean number of insect visitors to flowers of *P. campbelli* in 2007 (N = 7 populations) showing that floral visitation is positively correlated with plant population size.

An Australian Invasive Mutualism

The invasive species *Phyla canescens* (Lippia) relies on pollinators for seed set. We have determined using video monitoring at virgin flowers, followed by bagging, that the introduced honeybee, *Apis mellifera,* is facilitating the spread of this weed by being the only pollinator in introduced landscapes in Australia.

Fig 4 The honeybee *Apis mellifera* is an introduced species in Australia and here a feral worker is visiting an inflorescence of the introduced and invasive weed Lippia (*Phyla canescens*). Lippia is not capable of automatic self-pollination (Gorrell & Gross 2007, unpub. data).

Fig 5 The monitoring set-up at patches of Lippia. Video footage is gathered for 10-20 minutes at 'virgin' flowers of *Phyla canescens.* The plant patch is then re-bagged to capture fruits and to extrapolate the efficacy of floral visitors. The video footage was scored for the number of visitors per minute and compared with fruit to flower ratios for the same flowers which showed that feral honeybees are the obligate pollinators for this invasive species (Gross & Gorrell 2008, unpub. data).

Native exotic crossovers in New Zealand

Disrupted pollination systems

New Zealand flowers evolved with no large social bees (Lloyd 1985). The native bee fauna is comprised of 32 species of solitary bees in *Leioproctus*, *Hylaeus* and *Lasioglossum* (Donovan 2007). Exotic social bees, honeybees (*Apis mellifera*) and bumblebees (*Bombus* spp.), introduced for agriculture in the 19th century, are fully naturalized throughout New Zealand. Evolutionarily we would expect exotic pollinators to prefer exotic plant species and native pollinators to prefer native plant species. However, many exotic bees are supergeneralists and may displace native bees. Many exotic plant species are rich in nectar and pollen and may draw native pollinators away from native plants (Newstrom and Robertson 2005).

Rapid assessments of pollinator abundance

To investigate crossover among native and exotic plants and pollinators, we made rapid assessments of day active floral visitors along transects in regenerating scrub habitats. For methods see www.landcareresearch.co.nz/research/biocons/pollination/
We observed a total of 370 plants in 58 exotic and 34 native plant species at 4 times a day for at least 12 days at each of 7 sites. We made a total of 15,000 observations and counted 32,000 floral visitors.

Extensive crossover in both directions

The pattern of crossover is shown in the graphical summary (Fig 6). Many native plant species are dominated by exotic bees while some exotic plant species are dominated by native bees. These baseline data can be used in the future to detect trends in crossover patterns or declines in floral visitor abundance. Further research is needed to determine the impact of crossovers, the pollinator performance of floral visitors, and the floral resource base needed to maintain native pollinator populations.

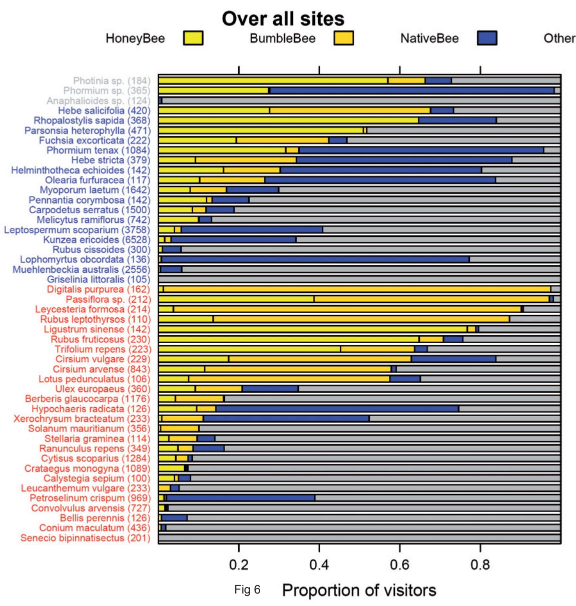

Fig 6 The relative proportion of exotic bee, native bee and other floral visitors to native and exotic naturalized plant species summed over 7 sites in New Zealand. Red letters indicate exotic and blue letters native plant species. Numbers in brackets indicate total number of visitors observed for each species.

Native pollinators in crops in New Zealand

Native insects as alternative pollinators

Native pollinators in crops may become more important as honey bee populations decline from pests and diseases such as Varroa and Colony Collapse Disorder (Winfree et al. 2007). To assess the potential role of native insects in crops, we monitored commercial onion and pak choi over 5 years in 5 regions of New Zealand. We observed floral visitors and used window pan traps to intercept flying insects in the crop during peak flowering.

Diversity and Abundance of Natives

We found 9 species of native bees and at least 16 species of native flies visiting onion flowers. Fig 7 shows the relative abundance of native bees (*Leioproctus* and *Lasioglossum*) versus exotic bees (*Apis mellifera* and *Bombus* spp.) in traps in onion fields during 2004 and 2005 across all regions.

Pollinator Performance of Natives

We compared pollen loads and pollen deposition on onion stigmas for 15 flower visiting species. Pollen deposition on virgin stigmas correlated strongly with pollen loads (loose pollen) and insect body length. The larger native bees in *Leioproctus* and flies (Calliphoridae and Tachinidae) carried and deposited a number of pollen grains comparable to honey bees. Smaller native bees in *Lasioglossum* transferred much less pollen but their high abundance in the crop counterbalanced this. Future research aims to understand the lifecycle and landscape factors that influence native pollinator population dynamics. Management strategies can then be formulated to increase the reliability of native pollinators in crops.

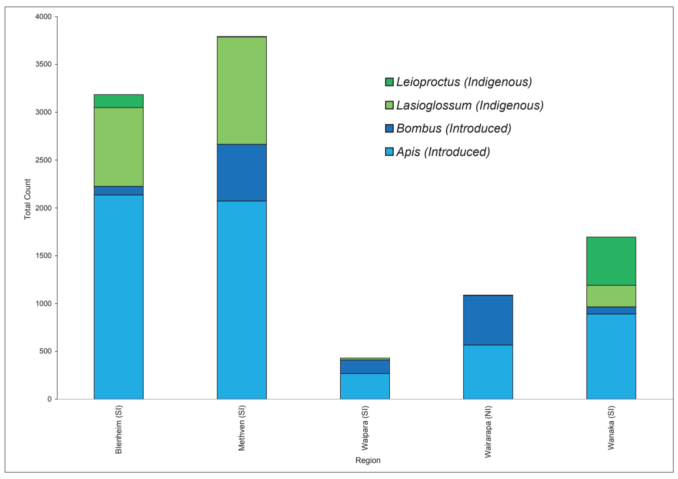

Fig 7 The relative proportion of native and exotic bees from traps in onion fields during peak flowering in regions of New Zealand. SI = South Island NI = North Island

Leioproctus huakiwi on onion.

Lasioglossum sordidum on pak-choi.

References:

Donovan, B. J. 2007. Apoidea (Insecta: Hymenoptera). Fauna of New Zealand 57, 295 pp.
Lloyd DG, 1985 Progress in understanding the natural history of New Zealand plants. New Zealand Journal of Botany 23: 707-722
Newstrom LE, Robertson AW 2005: Progress towards understanding pollination systems in New Zealand. Invited Godley review New Zealand Journal of Botany 43:1-59.
Simpson, S., Gross, C.L., Silberbauer, L. (2005). Brooms and honeybees: an alien liaison. Plant Biology 7(5): 541-548
Winfree R, Williams NM, Dushoff J, Kremen C 2007. Native bees provide insurance against ongoing honey bee losses. Ecology Letters, 10(11): 1105-1113.