A New Zealand Case Study: Changes in Abundance and Diversity of Endemic Weta in Response to the Eradication of Introduced Mammals

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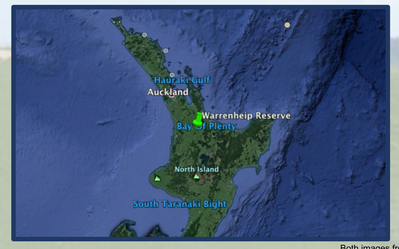
Abstract

Predator proof fencing enables us to establish areas free of mammalian pests, providing the opportunity to study how native flora and fauna react to the absence of these predators. Many members of New Zealand's *Anostostomatidae* and *Rhaphidophoridae* families, collectively know as Weta, are directly preyed upon by mammalian predators including rats, mice and stoats and impacted by native habitat degradation caused by humans and invasive mammals like deer, possums, and goats. All of these flightless, often times very large insects are endemic to New Zealand. This study is part of a longitudinal monitoring effort to assess the effects of predator exclusion and native forest regeneration on diversity and relative abundance of Weta in the Warrenheip Reserve. A predator proof fence (*Xcluder™ fence)* was developed and implemented in this reserve in 1999, mammals were eradicated in 2001, and 50,000 native trees and shrubs have since been planted in this 16ha reserve. All vegetation along a belt transect (300m long, 3 meters wide) inside the reserve known as Erin's Weta Walk (EWW) and a reference site (Ref) outside the reserve (500m^2) was searched. During our study we found Auckland Tree Weta (*Hemideina thoracica),* several species of Cave Weta (*Rhaphidophoridae spp.),* at least one species of Ground Weta (*Hemiandrus spp.),* and Mahoenui Giant Weta *(Deinacrida Mahoenui)*, an endangered species deliberately introduced in 2001 and 2002. The total number of Weta found in the reserve was 370 (6 nights) and 115 (5 nights) outside the reserve. The difference in the average number of Weta per stem increased significantly from 2000 to 2016 in EWW. The establishment of a predator free environment, combined with the reestablishment of native vegetation, has proved to be beneficial to the maintenance of biodiversity in Weta populations.



Both images from Google Earth

Materials and Methods

Our Research was part of a longitudinal Study, with previous data collected in April, 2000; November, 2011; and April 2012. Our data (2016) was collected from November 12th through November 18th, but no data was collected on the 15th due to rain. EWW was searched 6 nights and the Ref was searched 5 nights. Because Weta are nocturnal (Gibbs, 1998), our survey was done during the evening. It was considered night at the onset of darkness, which is defined as when a headlamp is needed to see the details on a stem 1m away.

Types of Weta starting from the top left moving clockwise, ground, tree, cave, and giant

Ground Weta: http://weta.pbs.massey.ac.nz

Weta Surveys

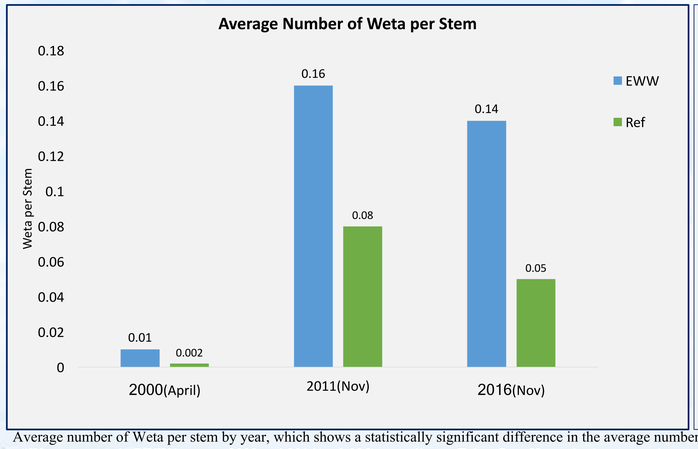
- Search area = 1m off the trail, and approx. 3m vertically on stems
- Searched both stems and unit cover
- Weta found were recorded w/ flagging tape tied on the substrate
- All tape was left until the conclusion of the survey
- Species, sex, age, and weta # were all recorded on tape
- Data sheets were then filled per night

Vegetation surveys

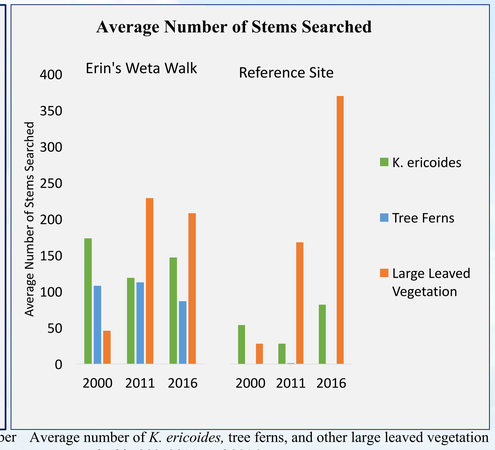
- Search area = 1m off the trail, and approx. 3m vertically on stems
- A stem was > 1.35m, regardless of DBH
- Non-stems were considered unit cover types
- Broken in to categories and subcategories
- Recorded as total percent per site

Unit Cover Code	Unit Cover Descr.	Substrate Code	Substrate Description
Fern Cover [**FC**]	Any fern < 135 cm		Any fern < 1.35 meters, i.e. excludes tree ferns
Forest Floor [**FF**]	Not living plants	Abiotic [**AB**]	A forest floor consisting of bare ground and rocks
		Biotic [**BI**]	A forest floor consisting of something that was once living, i.e. leaves and debris
Ground Cover [**GC**]	Any plant < 30 cm, not ferns	Mosses [**MO**]	Ground covered in moss
		Seedlings [**SD**]	Woody plants
		Herbaceous [**HB**]	Non-woody plants, i.e. grasses, flowers, etc.
Saplings and Shrubs [**SS**]	plants > 30 cm but <135cm, not ferns	Saplings [**SA**]	Vegetation is larger than 30 cm and less than 135 cm
		Shrubs [**SH**]	Shrubby, multi-stemmed vegetation, with a height greater than 30 cm but less than 135cm

Results



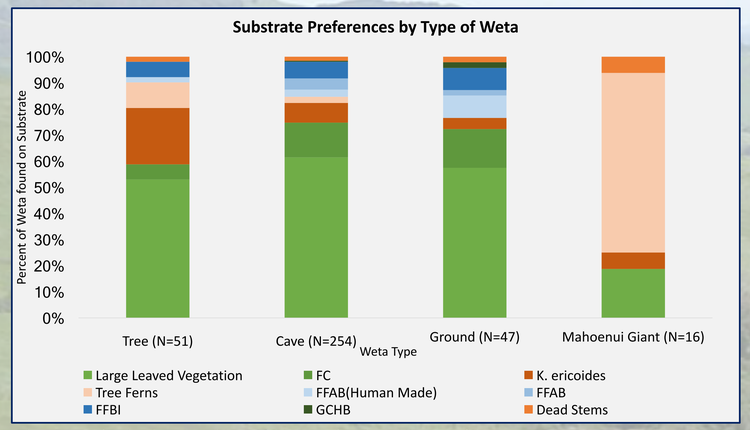
Average number of Weta per stem by year, which shows a statistically significant difference in the average number of Weta per stem in EWW between 2000 and 2016(p=0.025) according to Tukey Post-Hoc pairwise comparison



Average number of *K. ericoides,* tree ferns, and other large leaved vegetation stems searched in 200, 2011, and 2016

Average Number of Weta per Stem (far left): The Average Number of Weta per stem has increased in both EWW and Ref since 2000. In both sites the number of Weta per stem decreased since 2011. The Average number of Weta per stem remains higher in EWW than in Ref.

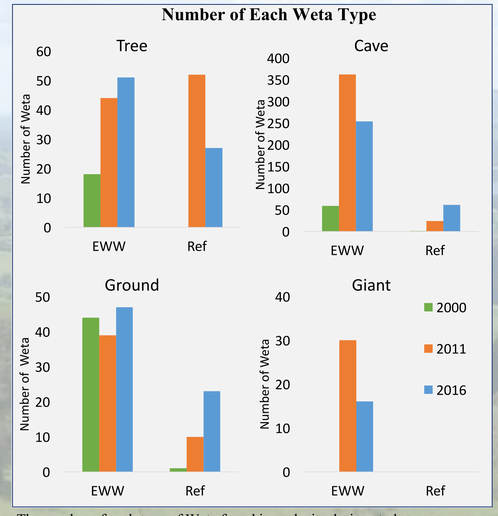
The Average Number of Stems Searched (left): The average number of *K. ericoides* stems searched has remained relatively consistent but in both EWW and Ref the number increased slightly since 2011. The average number of tree ferns searched has also remained relatively consistent in EWW, but decreased slightly since 2011, none were searched in Ref. The average number of large leaved vegetation stems searched has increased since 2000, and slightly decreased since 2011 in EW, the number has continued to increase since 2000 in Ref.



The percent of each substrate each type of Weta was found on. All stems of the same species were grouped together, regardless of height or DBH. Large Leaved vegetation includes all stems that were neither tree ferns nor *K. ericoides.*
*N=total number of Weta found

Substrate Preferences by Type of Weta (left): The largest percent of Tree Weta found were on large leaved vegetation, followed by *K. ericoides*. The largest percent of Cave Weta were found on on large leaved vegetation, followed by fern cover and then FF categories (FFBI, FFAB(Human Made), and FFAB). The largest number of Ground Weta were found on large leaved vegetation, followed by FF categories, and then fern cover. The largest number of Giant Weta were found on Tree Ferns, followed by large leaved vegetation.

Number of Each Weta Type (right): Since 2000, the number of Tree Weta has increased in EWW and decreased in Ref. The number of Cave Weta in EWW increased since 2000 but decreased since 2011 and has increased since 2000 in Ref. The number of Ground Weta has stayed relatively consistent in EWW but is greater than in 2000 and 2011, and has increased since 2000 in Ref. The number of Giant Weta has decreased since 2011 in EWW.



The number of each type of Weta found in each site during study years.
*Note that Giant Weta were not introduced in EWW until 2001 and 2002 and were never introduced in Ref.

Discussion and Conclusion

- There has been an overall increase in Weta populations since 2000 in both Erin's Weta Walk and in the Reference Site
  - The increase in Weta populations in both Erin's Weta Walk and in the Reference Site from 2000 to 2016 were both statistically significant
  - The small decrease in Weta found from 2011 to 2016 was not significant, and may be due to the weather, which was colder and wetter than average
  - It must also be taken into consideration that the number of stems searched in both transects has also increased tremendously over the last 16 years. This means that in order for the average number of Weta per stem to increase as it has done, the Weta numbers must have increased at a rate greater than the rate that the number of stems has increased
- Erin's Weta Walk consistently has more Weta than the Reference Site
  - This suggests that the elimination of invasive, mammalian predators combine with the reestablishment of native vegetation positively impacts Weta populations
- Since their introduction in 2001 and 2002, Mahoenui Giant Weta continue to reside in the reserve
  - Because they were introduced 15 years ago, and we found a number of juveniles, we believe there must be a breeding population

Our study supports that the exclusion of mammalian predator through the use of a predator proof fence in the privately owned Warrenheip Reserve, combined with native forest regeneration as a result of planting native trees and vegetation positively impacts Weta diversity and abundance. We recommend the implementation of more predator-excluded areas using methods like the *Xcluder™ fence* to create mainland islands that provide sanctuary to native species heavily impacted by mammalian predation and grazing-mammal caused habitat alteration, including Weta. Because many mammalian pests, such as rats and mice, can repopulate quickly, it is critical that in areas where mammals are controlled but not exterminated, poisoning and trapping persists at high intensities. This is extremely important to avoid sudden population spikes in mammalian populations, which would put native species at imminent risk (Jones & Toft, 2006). Mainland Islands, where mammalian pests have been eradicated can provide sanction to native New Zealand flora and fauna, including Weta, and are critical to Native biodiversity preservation.

Acknowledgements

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Literature Cited

Gibbs, G. W. (1998). Why are some weta (Orthoptera: Stenopelmatidae) vulnerable yet others are common? *Journal of Insect Conservaion* , *2*, 161-166.

Jones, C., & Richard Toft. (2006). *Impacts of mice and hedgehogs on native forest invertebrates: a pilot study*. Department of Conservation, Research & Development Series 245. Wellington, New Zealand: Science & technical Publishing.