Impact - Ecosystem responses to escalating drivers: linking species interactions and resilience

Fernando Cagua

The overall objective of my proposed research is to improve our current understanding of ecosystem response to multiple anthopogenic drivers and their cumulative impacts. In particular, I will focus on the role of species interaction networks in modulating the resilience of ecosystems.

In particular, I will use model systems and drivers that have global relevance but are particularly important for New Zealand. Specifically, I will focus on 1) mutualistic plant-pollinator networks which are of tremendous importance for the maintenance of biodiversity and production of crops1,2; and 2) biotic invasions and defaunation which are a significant component of human-caused global changes for which New Zealand is notably vulnerable3. Furthermore, in my third objective, the use of theoretical and quantitative approach will facilitate the future extension of my research to other processes, ecosystems and drivers, allowing it to fit into a large context (or something like that suggesting you’ll reach more people or bridge more fields).

About two thirds (ref?) of New Zealand plants, including iconic native plants (like kowhai and pohutukawa), and economically important crops (like kiwifruit, apples and grapes), are pollinated by birds or insects. . New Zealand flora is particularly vulnerable to declines in pollination services4, yet those services have been distorted by the introduction of foreign bees5, and the population depletion of native birds6,7. Also, in contrast with other locations, pollination networks in New Zealand are dominated by generalist species8,9---plants that attract a wide range of pollinator species and pollinators that visit a wide range of plants. My proposed research will help elucidate how these structural differences are reflected on the resilience and stability of New Zealand's pollination systems when considering that original ecosystems have been changed by biotic invasions. Understanding how invasions interact with defaunation in ecological networks is a global research priority, and essential for conserving, restoring and managing New Zealand ecosystems4.

It has been recently shown that the architecture of empirical and simulated interaction networks mediates the response to drivers like defaunation and species invasions, and increases their ability to support greater numbers of species10–14. Very few studies have investigated the link between species interactions and resilience in the context of human-caused drivers15,16. My proposed research aims to fill this gap and to answer several exciting research questions that are raised when network theory is merged with resilience and critical transition theory.

My PhD will take place at [Daniel Stouffer's lab](http://www.stoufferlab.org/)---a Rutherfurd Discovery Fellow at the University of Canterbury. His group is very internationally active and has several current visiting scientists for example from the Universidade de Sao Paulo, the Ecole normale superieure of Paris, and the University of Western Sydney. My proposed project also aligns nicely with the interests of several highly cited researchers: [Jason Tylianakis](http://www.tylianakislab.org/) (University of Canterbury), [Jordi Bascompte](http://www.bascompte.net/) (University of Zurich), [Martin Scheffer](http://www.sparcs-center.org/) (Wagenigen University), and [Carl Folke](http://www.stockholmresilience.org/21/contact/staff/1-15-2008-folke.html) (Stockholm Resilience Center). In fact, I've already initiated contact with some of them and collaborations seem highly likely.

Many ecosystems respond non-linearly to global change and human activities. When stressors push ecosystems to their limits, ecosystems cross a tipping point after which they can suddenly collapse and enter into a new undesirable regime. By using fundamental ecological theory and quantitave approaches I aim to contribute to our understanding of how to predict and prevent these undesirable shifts, and importantly how to recover from them. With your support, I will tackle fundamental, globally important, ecological questions that are of especial relevance for New Zealand's natural heritage and agricultural sector.

Another benefit of listing your objectives in the proposal is that you will be able to refer to them directly in here without repeating yourself too much. You could go through each objective and say why it’s relevant, e.g. you’re going to use pollination networks in your first objective because they are particularly important in NZ.

### References

1.Bascompte, J. & Jordano, P. Plant-Animal Mutualistic Networks: The Architecture of Biodiversity. *Annual Review of Ecology, Evolution, and Systematics* **38,** 567–593 (2007).

2.Klein, A.-M. *et al.* Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences* **274,** 303–313 (2007).

3.Vitousek, P. M., D’Antonio, C. M., Loope, L. L., Rejmánek, M. & Westbrooks, R. Introduced species: A significant component of human-caused global change. *New Zealand Journal of Ecology* **21,** 1–16 (1997).

4.Newstrom, L. & Robertson, A. Progress in understanding pollination systems in New Zealand. *New Zealand Journal of Botany* **43,** 1–59 (2005).

5.Huryn, V. M. & Moller, H. An assessment of the contribution of honey bees (Apis mellifera) to weed reproduction in New Zealand protected natural areas. *New Zealand Journal of Ecology* **19,** 111–122 (1995).

6.Anderson, S. H. The relative importance of birds and insects as pollinators of the New Zealand flora. *New Zealand Journal of Ecology* **27,** 83–94 (2003).

7.Robertson, A. W., Kelly, D., Ladley, J. J. & Sparrow, A. D. Efects Mistletoes of Pollinator Loss on Endemic New Zealand ( Loranthaceae ). *Conservation Biology* **13,** 499–508 (1999).

8.Heine, E. Observations of the pollination of New Zealand flowering plants. *Transactions of the royal society of new zealand* **67,** 133–148 (1937).

9.Primack, R. B. Insect pollination in the New Zealand mountain flora. *New Zealand Journal of Botany* **21,** 317–333 (1983).

10.Rezende, E. L., Lavabre, J. E., Guimarães, P. R., Jordano, P. & Bascompte, J. Non-random coextinctions in phylogenetically structured mutualistic networks. *Nature* **448,** 925–928 (2007).

11.Bastolla, U. *et al.* The architecture of mutualistic networks minimizes competition and increases biodiversity. *Nature* **458,** 1018–1020 (2009).

12.Berlow, E. L. *et al.* Simple prediction of interaction strengths in complex food webs. *Proceedings of the National Academy of Sciences of the United States of America* **106,** 187–191 (2009).

13.Stouffer, D. B. & Bascompte, J. Understanding food-web persistence from local to global scales. *Ecology letters* **13,** 154–61 (2010).

14.Stouffer, D. B., Sales-Pardo, M., Sirer, M. I. & Bascompte, J. Evolutionary Conservation of Species’ Roles in Food Webs. *Science* **335,** 1489–1492 (2012).

15.Lever, J. J., Nes, E. H. van, Scheffer, M. & Bascompte, J. The sudden collapse of pollinator communities. *Ecology Letters* **17,** 350–359 (2014).

16.Tylianakis, J. M. & Coux, C. Tipping points in ecological networks. *Trends in Plant Science* **19,** 281–283 (2014).