Proposal - Anticipate, prevent and reverse ecosystem transformations: linking species interactions and resilience

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The frequency of undesired ecosystem transformations---like the (often sudden) shift from a transparent to a turbid lake, from a woodland to a grassy landscape or from a self-sustaining fishery to a collapsed one1--- is dramatically increassing. Most of our current understanding of 'why', 'when' and 'how' these transformations occur are based on studies of one or a few species. However, species in an ecological community form a network of interactions that underpin ecosystem functioning, structure, and ultimately its response to disturbances2–5.

Resilience is the amount of disturbance that an ecosystem could withstand without tipping into a regime shift---a large, persistent transformation in its functioning and structure6,7. A necessary step to anticipate, prevent and reverse those unwanted transformations, is to understand the processes that support or undermine resilience4,8. **The overall objective of my proposed research is to quantify the role played by species interactions in modulating ecosystem resilience**.

The intensity of the effects of climate change, land use, biodiversity loss, nutrient enrichment, and biotic invasions on ecosystems is escalating, and the trend is likely to continue9. Even though the effect of those drivers permeates across entire communities, most of our understanding of their effects and the ecosystem response is based on studies of one or few species. Throughout my research I will use a complex network approach, which recognises that species live within a community, that they interact, and are connected to each other. This approach---built upon tools from statistical physics and the social sciences---has been key in revealing structural patterns that transcend specific ecosystems10–12.

Because of its importance for the provision of ecosystem services and the maintenance of global biodiversity2,13,14, I will focus on mutualistic interactions between plants and pollinators. The first objective of my research is to determine how the structural and dynamic characteristic of ecological networks determine the suceptibility to biotic invasions of an ecosystem---a significant component of human-caused global change15. I will use recently-developed simulation methods to model community-wide coexistence dynamics to explicitly quantify the ecosystem's stability from population fluctuations16,17, and to determine when invasions are likely to lead to a regime shift18–20.

Biotic invasions often occur in ecosystems that have already been degraded21. Also, theoretical and empirical evidence shows that the degree of uniquenes on species' roles has major effects on ecosystem stability and species coexistence22–27. My second objective is to determine how biodiversity loss---from a functional role perspective---affect the pre-invasion ecosystem resilience. To answer that question I will take advantage of my supervisor's access to over seventy empirical networks. By comparing the role of species in invaded vs. non-invaded ecosystems, and before and after regime shitfs, I will determine how diversity within species functional groups affects ecosystem resilience19.

I will use this very same approach for my third objective: to translate the gained insight into useful lessons for ecosystem management. Recent work in theoretical physiscs has highlighted the posibility of controling a complex system, by inducing perturbations that compensate for previous disturbances28. Because this approach has never been used in ecology, I propose to build upon to to find how ecosystems can be managed to maximise resilience, rather than individual species. I aim to determine the feasibility of using this approach to move an ecosystem from one state to another, or to rescue it from the brink of failure.

Over the last years I have been focused on studying the ecology of tropical marine organisms. I have withnessed how entire ecosystems are transformed due to human pressures. Understanding what makes ecosystems vulnerable, and how to prevent and revert those undersirable transformations---not only on marine ecosystems---became my top scientific interest; I want to answer fundamental questions in ecology and ultimately improve the management of the ecosystems I love. I am aware that this is likely to guide my scientific career for the next decade. My proposed PhD research, and the support from the NZIDRS, are going to be instrumental to reach those goals.

### References

Funder guidelines:

* Your proposal should be thoroughly researched, well thought out, feasible, and clearly articulated
* Your proposal should identify specific areas of study and outline methodology
* Include an assessment of the benefits (both professional and personal) that you expect from your proposed research

Considerations:

1. Hook attention from the get go
2. Make sure it fits what they want
3. Audience = no idea about anthing
4. I matter. Sell myself. Carrer highlights and contributions to date
5. Good title. Grandma should understand it, avoid questions, short and to the point, tell why is so bloody important
6. Tell. What I'm gonna do. WHy is so exciting. What will it solve
7. Tell inmediatelly what I'm intending to reseracg. An assessor wants to see that you’ll be proposing to do x, y and z such that you can answer big questions a, b and c efficiently, effectively and convincingly.
8. Convince it's exciting. Make anyone who read it excited
9. Explain applied outcomes. how your results will affect the real world, either through policy, technology or remediation
10. State hypothesis and predictions and how to test them. Be realistic about them
11. Methodologically specific.
12. Communication strategy. Reaches for the public with clever and inovative ways

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