Stability and resilience of ecological networks

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Introduction

Species in a ecological community form networks of interactions that determine the functioning of the ecosystem. Chiefly, interactions can be antagonistic —like those between hosts and parasites or plant and herbivores— or mutualistic —like those between plants and pollinators or coral and their symbiotic algae.

Anthropogenic pressures are a major driver of ecosystem change. The way ecosystems respond to those drivers is largely determined by the structure or their interaction networks. Because ecosystem interactions are of tremendous importance for global biogeochemical cycles, ecosystem services, and the maintenance of global biodiversity, understanding the implications of network structure for ecosystem response is paramount.

For my dissertation I propose to study the role of species' interactions on the response of ecosystems to drivers of change. Specifically I aim to build a general understanding of how network structure and species coexistence interplays with the ecosystem's stability, resilience and adaptive capacity.

These three concepts —introduced by Holling (1973) and later reviewed by Gunderson (2000)— have been key in quantifying the dynamics and behaviour of ecosystems. **Stability** describes the property of a system to return to an equilibrium point after disturbance. On the other hand **Resilience** is a meassure of stability that mediates transitions between ecosystem stable states; it is defined by "the amount of disturbance that an ecosystem could withstand without changing self-organized processes and structures" (stable states) or as "the return time to a stable state following a perturbation". In turn the **adaptive capacity** describes “the processes that modify ecological resilience”.

I start by stuyding the outcome of species invasions under different structures of mutualistic networks. Species invasions are a major driver of change in many ecosystems, with important consequences on ecosystem functioning and biodiversity (Ehrenfeld 2010; Powell, Chase, and Knight 2011; Thomsen et al. 2014). Mutuallistic networks, on the other hand, are crucial for the maintenance of global biodiversity. For instance mutuallistic networks are responsible of 90% of seed dispersal in tropical plants (Bascompte and Jordano 2007) and the pollination of arround 70% of the global food crops (Tylianakis 2013).

In reality ecosystems dynamics are comprised by feedbacks that include more than one type of interactions. In fact most of our understading of the ecosystem’s suceptibility to invasion and its stability comes from studies in the context of antagonistic interactions. We already know that the network’s structural patterns that promote stability vary depending on the type of interaction (Thébault and Fontaine 2010; Sauve, Fontaine, and Thébault 2014), but little is known about the factors that make an ecosystem more resilient against invasors and other drivers.

Besides mutualistic, antagonistic interactions are also generate ecosym feedbacks are comprised by both I then follow by expanding the

under different network structures. I use mutuallistic networks as the system model

Drivers include overfishing, nurtients, climate change and invasive species

Ecosystem responses include changes on biodiversity, habitat modification (fragmentation, complexity), disease outbreaks, foodweb distortion, and potentially increassed fragility, loss of resilience

It is unknown

Feedbacks are the ones that create the non linearitues

Ecosystems are subject to

It is still unknown how ecosystem respond to different drivers of change

There is a paucity of information on how ecosystem respond to escalating drivers.

Regime shifts There are Understanding the role that

Environmental drivers to ecosystem responses.

1

Species invasions and network structure

Species invasions, caused by successful introductions or ecosystem feedback that affect system dynamics. How they affect system stability.

Starting with a mutualistic case-study.

Competition introduces feedbacks in the system and non linear dynamics.

2

Stability of plant antagonistic + mutualistic networks

asd (Thébault and Fontaine 2010) asd (Sauve, Fontaine, and Thébault 2014)

T. Hughes talk/

Integrating antagonistic and mutualistic, invasibility. Simulation of environmental drivers that affect ecosystems. Rather than

3

Functional redundancy and network resilience

From an individual perspective to a group perspective.

Timeline

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