ECOLOGICAL RESISTANCE AND BUFFERS OF ENVIRONMENTAL CHANGE

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Cover Image: Leafy seadragons live within southern kelp forests of Australia. Photo credit: Jeffery Jeffords (Copyright purchased by The University of Adelaide, signed by Sean Connell.)

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Giulia Ghedini

August, 2016

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ABSTRACT

The development of frameworks that account for community stability and its loss to environmental disturbance (e.g. regime shifts) is central to ecology, particularly for reducing uncertainty of ecological change in increasingly variable environments. Notably, community responses to disturbance often appear abrupt and surprising, raising concerns for our ability to anticipate and manage such regime shifts. In this thesis, I explore the conceptual model that compensatory dynamics may negate the effects of disturbance prior to community restructure (i.e. changes in species composition) and that their recognition may advance our ability to anticipate loss of stability. I examine the idea that the failure to recognise the weakening of mechanisms of resistance to intensifying disturbance underpins the surprise of regime shifts. My assessment centred on a plant-herbivore interaction (herbivorous gastropods-turf algae) that counters the loss of kelp forests to competitors (turf expansion) as driven by abiotic disturbances that coalescence across multiple scales of space (global to local) and time (gradual to abrupt).

My tests of the hypothesis that herbivores negate the positive effects of abiotic change on turf production suggested that ecological systems might compensate for disturbance *via* mechanisms that prevent structural changes. Whilst global (carbon enrichment) and local abiotic change (nutrient enrichment) may drive shifts in ecological systems by altering dominance relationships between competing species (e.g. shifts from kelp- to turf-dominated reefs), adjustments in strength of herbivory appeared to negate such change. My tests suggested that resistance to change may result from the aggregate effects of individual responses (*per capita*

consumption) where these generate dynamics that prevent change in community processes (productivity). Such dynamics may be underpinned by the necessity of individuals to maintain homeostasis in varying environments. Critically, combinations of gradual (warming) and abrupt abiotic change (heat waves) appeared to disrupt these buffering mechanisms and resulted in rapid loss of resistance. Further tests indicated that, if we are to anticipate the extent of ecological change, we may not only have to consider spatial and temporal variability in abiotic conditions, but also biotic processes that might increase the range of variation in ecological responses.

Overall, these results suggest that, if we understand compensatory dynamics as mechanisms of resistance to the effects of disturbance (i.e. that prevent community restructure), we may not only improve predictions of community change, but also be able to prevent undesirable change in the first place. Critically, our ability to manage for ecological change cannot only rely on building resilience, but needs to move towards a more explicit consideration of resistance mechanisms; such shift in thinking is necessary to fully understand how ecological communities respond to disturbance. Assessments of how fine-scale responses (individual and species responses) stabilise broad-scale patterns (community processes and ecosystem functioning) may offer critical insights not only to advance theories of community stability, but also to improve our capacity to anticipate and manage regime shifts.

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Chapter 4

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