University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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MRes (University of St. Andrews, 2011)
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"Disentangling Human Degradation from Environmental Constraints: Macroecological Insights into the Structure of Coral Reef Fish and Benthic Communities"

Department of Biology

Wednesday, April 19, 2017
1:00 P.M.
David Turpin Building
Room A144

Supervisory Committee:
Dr. Francis Juanes, Department of Biology, University of Victoria (Supervisor)
Dr. Andrew Edwards, Department of Biology, UVic (Member)
Dr. Brian Starzomski, School of Environmental Studies, UVic (Outside Member)
Dr. Ivor Williams, National Oceanic and Atmospheric Administration

External Examiner:
Dr. Jameal F. Samhouri, Ecosystem Science Program Manager, Northwest Fisheries Science Centre

Chair of Oral Examination:
Dr. Lara Lauzon, School of Exercise, Science, Physical Health and Education, UVic

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Abstract

Tests of ecological theory at macroecological scales can disentangle abiotic influences from anthropogenic disturbances, and thus provide insights into fundamental processes that structure ecological communities. In tropical coral reef systems, our understanding of community structure is limited to small-scale studies conducted in moderately degraded regions, while larger regional or ocean scale analyses have typically focused on identifying human drivers of reef degradation. In this thesis, my collaborators and I combined stable isotope specimens, underwater visual censuses, and remote sensing data from 43 Pacific islands and atolls in order to examine the relative roles of natural environmental variation and anthropogenic pressures in structuring coral reef fish and benthic communities. First, at unexploited sites on Kiritimati Atoll (Kiribati), isotope estimates indicated that trophic level increased with body size across species and individuals, while negative abundance ~ body size relationships (size spectra) revealed distinct energetic constraints between energy-competing carnivores and energy-sharing herbivores. After demonstrating size structuring of reef fish communities in the absence of humans, we then examined evidence for size-selective exploitation impacts across the Pacific Ocean. Size spectra 'steepened' as human population density and proximity to market center increased, reflecting decreases in large-bodied fish abundance, biomass turnover rate, and mean trophic level. Depletion of large fish abundances likely deteriorates functions such as bioerosion by grazers and food chain connectivity by top predators, further degrading reef community health. Next, we considered the relative roles of abiotic, biotic and anthropogenic influences in determining reef benthic state across spatial scales. We found that from fine (0.25 km2) to coarse (1,024 km2) grain scales the phase shift index (a multivariate metric of the relative cover of hard coral and macroalgal) was primarily predicted by local abiotic and bottom-up influences, rather than grazing or human impacts, such that coral-dominated reefs occurred in warm, productive regions at sites exposed to low wave energy. Our size-based analyses of reef fish communities revealed novel exploitation impacts at ocean-basin scales, and provide a foundation for delineating energetic pathways and feeding interactions in complex tropical food webs. Furthermore, we demonstrate that abiotic constraints underpin natural variation among fish and benthic communities of remote uninhabited reefs, emphasizing the importance of accounting for local environmental conditions when developing meaningful baselines for coral reef ecosystems.