University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BSc (Oregon State University, 2015)

"Origins of Nutrient Patterns in the Coastal Margin: Implications for Tree Species Richness and Understory Composition"

School of Environmental Studies

Wednesday, April 17, 2019
2:30 P.M.
David Turpin Building
Room B255

Supervisory Committee:
Dr. Brian Starzomski, School of Environmental Studies, University of Victoria (Supervisor)
Dr. Darcy Mathews, School of Environmental Studies, UVic (Member)

External Examiner:
Dr. Morgan Hocking, Senior Fisheries Biologist, Ecofish Research

Chair of Oral Examination:
Dr. Laurel Bowman, Department of Greek and Roman Studies, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

MacArthur and Wilson's dynamic equilibrium theory of island biogeography has proven a useful framework for exploring species richness patterns on islands and fragmented landscapes, but many observed patterns of richness cannot be fully explained by the model. Many amendments have been proposed to account for such discrepancies, including the subsidized island biogeography hypothesis. The hypothesis proposes that nutrient subsidies, those translocated from one ecosystem to another, can indirectly influence species richness on islands by directly increasing terrestrial productivity. However, the lack of a formal statistical model makes it difficult to assess the strength of the hypothesis. I created a formal subsidized island biogeography model to determine how nutrient subsidies, in addition to area and distance from mainland, influence tree species richness. My model showed that an increase in terrestrial nitrogen abundance results in a decrease of tree species richness. Soil and plant $\delta\,^{15}$N values were higher than expected but relationships between environmental conditions and nitrogen abundance patterns do not indicate that soil processes are predominately responsible for high $\delta\,^{15}$N values. It is likely that nutrient subsidies from the marine environment are responsible for ^{15}N enrichment. However, the range of observed nitrogen abundance is similar to inland coastal-zone forests, indicating that islands are similarly nitrogen deprived and may not be receiving enough nutrient subsidies to alter productivity. Tree species decline may therefore be more strongly related to the environmental conditions leading to patterns of nitrogen abundance rather than the abundance of nitrogen itself.

Nutrient subsidies can accumulate passively on islands through vectors such as beach-cast marine algae or marine fog, but biotic vectors such as seabirds can mediate the flow of subsidies on to land. I proposed that bald eagles (*Haliaeetus leucocephalus*) are vectors of nutrient subsidies, depositing nutrient-rich guano at nest sites which could alter soil chemistry and vegetation composition. In an exploratory study of seven nest sites, I found higher soil phosphorous at eagle nest sites relative to control sites (~ 33% higher). Phosphorous is a limiting nutrient in coastal temperate forests, additions help to alleviate chlorosis and slow growth especially when paired with nitrogen. Higher potassium concentration also occurred on eagle-inhabited islands but was not associated specifically with current nest sites, perhaps reflecting differential persistence of macronutrients in the soil. I expected to observe elevated nitrogen isotope signatures ($\delta\,^{15}$N) given bald eagles' position in the trophic web and the

potential for volatilization of guano but soil $\delta^{15}N$ abundance was not statistically higher at eagle nest sites. Total soil nitrogen was also not statistically higher at eagle nest sites. There were no significant differences between vegetation composition at eagle nest sites and reference sites, but reference sites tended to be dominated by shrub species. Guano can undergo several chemical processes in the soil, leading to different patterns of nutrient abundance, which may muddy the connection between subsidies and nutrient patterns. Coupling foliar nutrient data with soil nutrient data may provide additional insight into the deposition and incorporation of subsidies.