University of Victoria | Graduate Studies

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

of

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BSc (University of British Columbia, 2011)

"Managing Human Footprint with Respect to its Effects on Large Mammals: Implications of Spatial Scale, Divergent Responses and Ecological Thresholds"

Department of Biology

Wednesday, September 7, 2016
1:00 P.M.
MacLaurin Building
Room D107

Supervisory Committee:
Dr. Cole Burton, Department of Biology, University of Victoria (Co-Supervisor)
Dr. Francis Juanes, Department of Biology, UVic (Co-Supervisor)
Dr. Jason Fisher, School of Environmental Studies, UVic (Outside Member)

External Examiner:
Dr. Natalie Ban, School of Environmental Studies, UVic

Chair of Oral Examination:
Dr. Marin Jun, Department of Mechanical Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

The environmental problems facing the world today are nearly all attributable to anthropogenic activities and landscape change. Addressing these challenges requires an understanding of precisely how species and ecosystems are responding to human impacts. Discerning linkages between stressors and their ecological repercussions, and using this to inform evidence-based conservation, can be challenging due to ecological complexity. We focused on the responses of five wide-ranging large mammal species – gray wolf (*Canis lupus*), Canada lynx (*Lynx canadensis*), coyote (*Canis latrans*), white-tailed deer (*Odocoileus virginianus*) and moose (*Alces alces*) – to human footprint (measure of human infrastructure and landscape change), using 12 years (2001-2013) of snowtrack surveys conducted across the boreal forest of Alberta by the Alberta Biodiversity Monitoring Institute. We explored three key challenges to linking complex ecological dynamics to concrete management actions. First, we asked whether the direction and magnitude of species responses vary depending on the spatial extent and grain of the study. Second, we asked whether these species respond more strongly to individual footprint features or to the cumulative effects of all footprint (measured as total footprint), and whether responses to footprint are consistent across species. Third, we evaluated the utility of thresholds for large mammal management and asked whether there is evidence for consistent threshold responses to total footprint across scales. In addressing the first two questions, we evaluated a set of generalized linear mixed effects models (GLMM) relating the relative abundance of each species to individual and cumulative effects of human footprint, using an information-theoretic approach. We compared the direction of species responses across our regional study area (approximately 400,000 km2) to those reported in previous smaller-extent studies (median 1,525 km2), and compared responses across three spatial grains (250m, 1500m, and 5000m transect buffers). In addressing the third question, we conducted a review on the utility of ecological thresholds, described as abrupt changes in response to a continuous driver, for large mammal management. We further tested for thresholds in species responses to total

footprint by comparing linear models (logistic regression) to piecewise regression models. We compared threshold values between two grains (approximately 33km2 - 1500m transect buffer, and 5500km2 - grouping transects into clusters), and across four regions (boreal forest extent, three landscape planning units). We found that the direction of species responses varied with spatial extent, but not grain, and that species responded strongly to a broad suite of footprint features, indicating the need to manage for cumulative effects. Despite the appeal of ecological thresholds, using these as targets is challenging and the success of doing so has rarely been evaluated. We found threshold models to be better supported across species, but due to variability and uncertainty in threshold values, the results are more suited as guidelines or hypotheses to be further tested, as opposed to specific management targets. Translating research on complex ecological systems into management actions is a continuing challenge, yet, ongoing biodiversity monitoring and adaptive management may refine our existing tools, and ultimately lead to better environmental stewardship.