University of Victoria | Graduate Studies

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

of

GILLIAN HARVEY

BA (University of Victoria, 2013)

"Spatial Analysis of Marine Mammal Distributions and Densities for Supporting Coastal Conservation and Marine Planning in British Columbia, Canada"

Department of Geography

Tuesday, December 13, 2016
10:00AM
David Turpin Building
Room B215

Supervisory Committee:
Dr. Trisalyn Nelson, Department of Geography, University of Victoria (Supervisor)
Dr. Paul Paquet, Department of Geography, UVic (Member)
Dr. Caroline Fox, Department of Oceanography, Dalhousie University (Outside Member)

External Examiner:
Dr. Jason Fisher, School of Environmental Studies, UVic

Chair of Oral Examination:
Dr. Laura Parisi, Department of Gender Studies, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Human impacts on ocean ecosystems are driving declines in marine biodiversity, including marine mammals. Comprehensive spatial data are vital for making informed management decisions that may aid species recovery and facilitate the sustainable use of ocean ecosystems. However, marine mammal studies are often data limited, thereby restricting possible research questions. Developing novel analytical approaches and incorporating unconventional datasets can expand the scope of analysis by increasing the information content of existing data sources. The goal of our research is to support conservation and management of marine mammals in British Columbia (BC), Canada, through the application of advanced spatial statistical methodology to characterize spatial distribution and density patterns and provide assessments of data uncertainty.

Our first objective is to generate statistical models to map spatially continuous predictions of marine mammal distributions and densities within BC's north coast and apply methodology from spatial statistics to identify hotspots of elevated use. We predict the distribution and density patterns of nine marine mammal species by employing a species-habitat model to relate species densities to environmental covariates using a generalized additive model. We use spatial statistical hotspot analysis (Getis-Ord G*i**statistic) and an aspatial threshold approach to identify hotspots of high density from species-specific maps. Our analysis reveals that hotspots selected using a top percentage threshold produced smaller and more conservative hotspots than those generated using the G*i**statistic. The G*i**statistic demonstrates a robust and objective technique for quantifying spatial hotspots and offers an alternative method to the commonly applied aspatial threshold measure. We find that maps show agreement with prior research and hotspots align with ecologically important areas previously identified by expert opinion.

Our second objective is to apply map comparison techniques to compare cetacean density maps from disparate data collection methods (systematic surveys and citizen science) to evaluate the information content of each map product and quantify similarities and differences. Discrepancies are quantified by performing image differencing techniques on the rank order values of each map surface. We subsequently use the G*i**statistic to isolate regions where extreme differences occur. To assess similarities, a G*i**statistic is applied to both maps to locate spatially explicit areas of high cetacean density. Where clusters of high density values in both maps overlap we infer higher confidence that the datasets are representing a true ecological signal, while areas of difference we recommend as targeted locations for future sampling effort. We contextualize map similarities and differences using a dataset of human activity in the form of cumulative human effect scores.

Overall, our analytical approach integrates novel spatial datasets from systematic surveys, citizen science, and remote sensing to provide updated information on cetacean distributions in BC. Our study generates geographic data products that fill knowledge gaps and results provide baseline information valuable for future decision-making. The methodology applied in this study can be generalized across species and locations to support spatial planning and conservation prioritization in both marine and terrestrial contexts.