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

of

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BSc (University of Victoria, 2015)

“A Hidden Markov Modelling Approach to Understanding Ancient Murrelet Behaviour and Foraging Habitat”

Department of Geography

Friday, April 17, 2020
2:00 P.M.
Conducted Remotely

Supervisory Committee:
Dr. Christopher Bone, Department of Geography, University of Victoria (Co-Supervisor)
Dr. Patrick O’Hara, Department of Geography, UVic (Co-Supervisor)
Dr. Laura Cowen, Department of Mathematics and Statistics, UVic (Outside Member)

External Examiner:
Dr. Marie Auger-Méthé, Department of Statistics, University of British Columbia

Chair of Oral Examination:
Dr. Gregory Rowe, Department of Greek and Roman Studies, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

Seabird species are increasingly threatened around the world due to a range of anthropogenic impacts affecting at-sea and breeding habitat. One such species is the Ancient Murrelet, an Alcid species nesting on the Pacific Coast of Canada. Ancient Murrelets are an important species in Canadian waters as approximately 50% of the world’s breeding population nest in a small region of the British Columbia coast. Ancient Murrelets are listed as a species of Special Concern, due to threats in their breeding colonies; threats to their at-sea habitat, such as disturbance from shipping traffic, oil pollution, and fisheries bycatch, are currently poorly-documented due to the challenges associated with studying seabirds in their offshore environments. Conservation efforts to protect this species require information on movements and habitat use at sea. Therefore, there exists a critical need for research that provides new knowledge on where murrelets are travelling and the habitats in which they are foraging.

The objective of this thesis research is to investigate movement behaviour and at-sea habitat of Ancient Murrelets during breeding season foraging trips. Movement modelling using hidden Markov models differentiated the tracks into behaviour states, and identified foraging locations at sea. Foraging locations were used in regression modelling to investigate the degree to which variability in Ancient Murrelet foraging locations could be explained by seafloor depth, slope and tidal current, and spatial measures such as distance from the breeding colony. From characteristics of movement paths, hidden Markov models identified three movement behavior states, which were interpreted as transit, resting, and foraging behaviours. Logistic regression models suggested that depth, seafloor slope, tidal speed, and distance from the colony exhibited a negative influence on locations where birds chose to forage. Nevertheless, of the locations where foraging took place, foraging intensity was found to be higher in deeper areas suggesting Ancient Murrelets may be focusing efforts in areas of higher prey abundance. The combination of individual movement analysis and habitat analysis provides an important first step in gaining a greater understanding of Ancient Murrelet behaviour and foraging habitat at sea. These findings can inform marine management planning in this region and conservation of this vulnerable species.