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 Victoria, 2016)

"Satellite Remote Sensing of *Nereocystis luetkeana* (Bull kelp) and the use of kelp by Juvenile Salmon in the Salish Sea"

Department of Geography

Friday, November 29, 2019
1:00 P.M.
Clearihue Building
Room B007

Supervisory Committee:
Dr. Maycira Costa, Department of Geography, University of Victoria (Co-Supervisor)
Dr. Francis Juanes, Department of Biology, UVic (Co-Supervisor)
Dr. Clifford Robinson, Department of Geography, UVic (Member)

External Examiner:
Dr. Emily Rubidge, Seascape Ecology and Conservation, Fisheries and Oceans Canada

Chair of Oral Examination:
Dr. Alexandra D'Arcy, Department of Linguistics, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

The macro-algae *Nereocystis luetkeana* or bull kelp is an important canopy-forming species in the rocky nearshore ecosystems of the Salish Sea. It provides structural habitat for many fish and invertebrates including juvenile salmon. In the Pacific Northwest, major declines in Chinook and Coho salmon populations have led to increased scientific efforts to determine the causes behind these losses. High mortality of juvenile salmon during their first months in the marine environment may be linked to loss of habitat such as kelp beds, which can provide shelter, concentration of prey and energetically favorable conditions. This work seeks to understand the role of kelp habitat in the early marine growth period of juvenile salmon. Initially, methods using satellite imagery were developed for mapping the location of kelp beds adjacent to a salmon bearing river in Cowichan Bay, on the West Coast of British Columbia. These methods were then applied to a time series of imagery from 2004 to 2017, to determine how kelp beds are changing over time and the possible drivers of those changes. The results found spatial and temporal variability in kelp beds with a decline from a high in 2015 to the lowest levels in 2017. The observed changes were over a short period considering the natural variability of Nereocystis and continued long term monitoring will help to determine if the declines are permanent. Spatial and temporal variability were found to relate to substrate type, current strengths and potential lag effects of declines due to warmer than average sea surface temperatures. Lastly, the maps created through satellite-based methods served to inform surveys investigating the importance of kelp habitat to the declining populations of Chinook and Coho salmon. To address this, remote underwater video and visual snorkel surveys were used to determine the presence and absence of juvenile salmon in paired kelp and no-kelp sites throughout the season when the fish are known to be present in the region. Higher densities of juvenile salmon were detected in kelp-associated areas; however, this effect was detected both before kelp growth in early spring and during kelp presence. Transects conducted on the inner edge of kelp beds, adjacent to rocky shorelines were determined to have the highest salmon densities indicating that physical factors such as substrate type and wave energy associated with these areas may be preferential to juvenile salmon.