Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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“A Cumulative Effect Assessment Using Scenario Analysis Methodology to Assess Future Cowichan River Chinook and Coho Salmon Survival”

Department of Geography

Wednesday, April 21, 2021
10:00 A.M.
Remote Defence

Supervisory Committee:
Dr. Johannes Feddema, Department of Geography, University of Victoria (Co-Supervisor)
Dr. Stephen Cross, Department of Geography, UVic (Co-Supervisor)
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Dr. Stephen Evans, Acting Dean, Faculty of Graduate Studies
Abstract

This dissertation describes a proposed methodology for Cumulative Effects Assessment (CEA) with the purpose of improving the process by making it both more substantive and quantitative. The general principles of the approach include the following: use of effect-based type of analyses where selected Valued Component (VC) sensitivities are identified first and then effect pathways are determined building bottom-up linkages from VC sensitivities to potential stressors or combinations of stressors to effect drivers and forces behind the drivers. Models are developed based on statistical or historic trend analysis or literature review that predict response of the effect indicators (VCs) to changes in effect drivers. Further, scenarios of divergent futures are created that involve different developments of each effect driver or force, and finally the models are applied to each scenario to project the state of the studied VCs in each scenario. A practical implementation is conducted to demonstrate the use of the proposed methods on future population trends of two anadromous salmon species from the Cowichan River, British Columbia, chinook and coho. The assessment is conducted for both early freshwater and marine phases of their life. In fresh water, the assessment focuses on two main factors affecting salmon survival, streamflow and stream temperature and establishes two main drivers affecting these stressors, land use and climate change, and two main forces behind these stressors, Local and Global human development driven change, respectively. Effects of stream temperature and streamflow on salmon freshwater survival are simulated using two models; one is based on chinook freshwater survival correlations with stream temperature and is developed only for chinook, and the other is based on literature-derived temperature and streamflow thresholds and is developed for both species. Connections between the stressors (stream temperature and streamflow) and drivers (land use and climate change) are established through a hydrologic model and stream temperature regression model. For the marine environment, models are created using Pearson correlation and stepwise regression analysis examining links between survival of Cowichan River chinook and Strait of Georgia hatchery-raised and wild coho and various environmental variables of the nearshore zone of Strait of Georgia and Juan de Fuca Strait. The models are applied to project future salmon survival under four future scenarios for 2050 that are created by combining two opposite scenarios of land use in the watershed, forest conservation and development, and two climate change scenarios, extreme and moderate. Scenario projections show a decrease in overall (combined early freshwater marine) survival by 2050.
for all three studied salmon populations. None of them are likely to survive in scenarios with extreme climate change, while scenarios with moderate climate change show positive survival rates although lower than present-day baseline levels. Analysis also showed that land use management within the Cowichan River watershed can also affect freshwater survival of both chinook and coho and marine survival of chinook through influence of river discharge on nearshore processes. However, our land-use management scenarios have considerably weaker effect than climate change on salmon survival. Therefore, we conclude that land use management alone is not sufficient to offset effects of climate change on salmon survival.