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

of

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BSc (University of British Columbia, 2012)

“Microplastics in Coastal Marine Ecosystems: Some Methodological, Anthropogenic, and Ecological Considerations”

Department of Biology

Tuesday, April 13, 2021
9:00 A.M.
Virtual Defence

Supervisory Committee:
Dr. John Dower, Department of Biology, University of Victoria (Supervisor)
Dr. Sarah Dudas, Department of Biology, UVic (Co-Supervisor)
Dr. Helen Gurney-Smith, Department of Biology, UVic (Member)
Dr. Francis Juanes, Department of Biology, UVic (Member)
Dr. Christopher Pearce, Department of Geography, UVic (Non-Unit Member)

External Examiner:
Dr. Bethanie Carney Almroth, Department of Biological and Environmental Sciences, University of Gothenburg

Chair of Oral Examination:
Dr. Gary MacGillivray, Department of Mathematics and Statistics, UVic

Dr. Stephen Evans, Acting Dean, Faculty of Graduate Studies
Abstract

Microplastic particles (MPs) are widely distributed in aquatic environments and present a potential risk to marine life. This thesis considers several issues relating to the sources and fate of MPs in the marine environment, wild and farmed shellfish, and food webs of southern coastal British Columbia, Canada, as well as methodologies for sampling and analyzing these particles.

Chapter 1 introduces MPs as a contaminant and reviews what is known about their source and fates in marine environments. The ecotoxicology of MPs, methods for studying them, and the objectives of this thesis are also explored.

Chapter 2 compares the potential MP concentration estimates provided by two different seawater sampling methods. Jar samples filtered to 8-μm yielded MP concentrations averaging approximately 8.5 times higher than bucket samples filtered to 63 μm, per L of water (at the site level), driven largely by differences in the number of microfibres. An analysis of MP concentrations and mesh sizes reported in the literature suggests that using a 300–350-μm mesh may underestimate total MP concentrations by one to four orders of magnitude compared with samples filtered through much smaller mesh sizes (e.g., less than 100 μm), and despite the effect of sample volume. Particles less than 300 μm in diameter make up a large component of MPs commonly found in fish and invertebrates. As such, common sampling practices fail to adequately measure a biologically relevant class of MPs, thereby undermining the ability to quantify ecological risk.

Chapter 3 determines the influence of shellfish aquaculture activity, and its use of plastic equipment, on MPs in bivalves and their environment by comparing MP concentrations in Manila clams (Venerupis philippinarum) and Pacific oysters (Crassostrea gigas) grown on commercial shellfish beaches with those grown on non-aquaculture beaches from six areas. MP concentrations in water and sediment were also determined in four of the areas. MP concentrations did not differ between shellfish aquaculture and non-aquaculture sites for either bivalve species or for sediment and water samples. Beach sediment type had a minor effect, with more gravelly or sandier beaches associated with higher MP concentrations in oysters or clams, respectively. Oysters on sites using many synthetic anti-predator nets contained more MPs than those on sites without any plastic, but analysis of particles using Fourier-transform
infrared spectroscopy suggested a predominance of textile fibres including nylon and polyester, which are not typically used in shellfish aquaculture.

Chapter 4 uses stable isotope food web analysis and hierarchical Bayesian generalized linear mixed models to explore whether bioaccumulation and biomagnification are occurring in coastal marine food webs at three locations. Bioaccumulation was higher for smaller-bodied suspension feeding animals such as bivalves. However, biomagnification was not occurring in animal digestive tracts, and trophic dilution was demonstrated in fish livers. Trophic transfer was shown to occur between prey and predator for rockfish, but higher concentrations in full stomachs compared with empty ones suggested rapid excretion of ingested MPs.

Chapter 5 provides some general conclusions on the status of MPs in the British Columbian environment, as well as risks to seafood consumers. It also explores future work that will be needed to understand the complex ecotoxicology of MPs.