

ECOLOGY OF SALMONIDS IN ESTUARIES AROUND THE WORLD: ADAPTATIONS, HABITATS AND CONSERVATION

Colin D. Levings

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Ecology of Salmonids in Estuaries around the World is a comprehensive review of the current global understanding of salmonid estuarine ecology. Additionally, it focuses on knowledge gaps, potential future studies and conservation implications. With anadromous salmonids in peril worldwide, and the last comprehensive review of salmonids in estuaries completed in the 1990s, this book is both timely and relevant. This review is the product of a collaborative effort among graduate students in a fisheries science class.

Colin Levings has distilled his vast knowledge from a lifetime of work on estuarine processes and salmonid ecology into a clear, concise and accessible book for a wide audience. The intended readers include emerging scientists, conservation practitioners and citizen scientists. We believe this book suits this audience, and would best serve as a reference when planning research, conservation or restoration projects. Levings begins with foundational chapters on estuarine processes and salmonid evolution and adaptation, and proceeds to specific ecological and environmental challenges faced by salmonids, and how to study them. Each chapter builds upon the last, but can also act as an independent reference for the various aspects of salmonid ecology covered by Levings. These complex and global topics are focused around three major themes: habitats, adaptations and conservation, with an acute focus on anadromous salmonids maintained throughout the book.

When examining estuarine habitats, Levings leaves little unsaid, allowing readers from any background to gain a fundamental understanding of what an estuary is. He addresses water balance, geomorphology, sediment loading, vertical salinity and temperature profiles, hydrology, wave action, tidal exchange, zonal changes and river discharge, all of which shape the physicochemical properties that occur within estuaries and are known to influence salmonid ecology. He introduces the types of habitat and subhabitats available, some of their key features, and numerous examples from the scientific literature documenting how they are utilized by salmonids. He also introduces key water quality parameters known to affect salmonid health, and discusses their optimal ranges for salmonids based on undisturbed estuaries. The water quality parameters introduced early on are later discussed with specific reference to the impacts of human disturbance on estuary and salmonid health. This format is slightly repetitive, and

it may have been more useful to merge the two sections into one comprehensive chapter. The author gives a thorough overview of the existing literature on salmonid behaviour within estuaries, including migration, residency, cover-seeking behaviour and more. This chapter is a treat for any reader interested in the ecology of salmonids. Leaving no stone unturned, Levings also describes the estuarine food webs that support salmonids, and the powerful forces of predation and competition, which have shaped the various salmonid life histories we see today. These descriptive chapters are infused with important questions about how these habitats are and should be studied.

Levings highlights the genetic plasticity of salmonid populations and discusses the adaptations needed to survive and thrive in these dynamic habitats. He delves into the possible mechanisms for the evolution of anadromy, and gives several examples of stocked salmonid populations that have expanded their ranges into estuaries, which demonstrates both their adaptability and the value of exploiting estuarine habitats. The book also discusses the rise in invasive species in estuaries globally, and raises the question of how this may be impacting natural salmon populations in the Northern Hemisphere: are they adaptable enough to compete in these changing systems?

Using conservation as a continuous theme, Levings makes clear his intentions for *Ecology of Salmonids in Estuaries around the World* to be used as a resource for salmonid and estuarine management, and we feel that he has achieved this goal. The author synthesizes the cocktail of modern threats faced by salmonids in disrupted estuaries, including environmental change, anthropogenic impacts, competition with invasive and hatchery fish, and even pathogens and parasites. He then puts the physical and biological struggles of salmonids in perspective by incorporating a summary of the harvesting practices used for salmonids, reminding the reader of their global commercial and cultural importance, and the major contributors to their decline. However, we believe that Levings falls short in emphasizing the role that overfishing has played in the current state of salmonid populations, both in their reduction globally and in the many indirect effects that have come from a long-standing emphasis on managing and studying salmon through a harvesting lens. This shortcoming may not be a concern for seasoned fisheries ecologists who fully understand the complexities of this topic, but given the intended audience of emerging scientists, conservation practitioners and citizen scientists, this shortcoming is worrisome. Fortunately, this limitation does not affect Levings' description of realistic conservation goals, factors to include in management strategies, and the important distinction between restoration for productivity versus ecological integrity. Importantly, he emphasizes the need to establish clear and universal biological indicators that can be used to monitor and restore estuarine habitat for salmonids.

Colin Levings finishes on an optimistic note, acknowledging the great scientific contributions to estuarine and salmonid ecology globally and the advancement of salmonid conservation initiatives since the 1970s. One of our favourite portions of this book is a detailed list of suggestions for priority research efforts on salmonid ecology for the future. We also appreciate that he finishes with a reminder that there is no single “smoking gun” in salmonid decline, and that if we hope to preserve salmonids in estuaries, we must continue to focus on cumulative effects on fitness and bolster management plans with conservation and restoration initiatives.

Levings has channelled his life’s work into one accessible book; this is an incredible feat and an admirable contribution to the science and conservation community. The comprehensive reference section, supporting (online) material and appendix are resources that should be added to any salmonid or estuarine ecologist’s toolkit. While we felt that


a few chapters relied on the appendix in a way that disturbed the flow of reading, and the figures were lacking in clarity, overall this book is an incredibly valuable resource. Readers will benefit from Levings’ intimate understanding of past and present research on the ecology of salmonids and estuaries. His emphasis on specific areas for future study with detailed suggestions and descriptions of available methods to do so makes this a particularly useful reference for research design and planning.

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