

ZOOLOGY

Ecology of Salmonids in Estuaries around the World: Adaptations, Habitats, and Conservation

By Colin D. Levings. 2016. University of British Columbia Press. 388 pages, 75.00 CAD, Cloth.

Owing to a long history of human interaction with salmonids, this taxonomic family is lauded among the most charismatic fishes. The migration of many salmonid species between freshwater and the ocean facilitates their rapid growth and has long provided essential ecosystem and cultural services in northern temperate environments, and now also in the southern hemisphere where they have been widely introduced. Although most of the migratory salmonid's life is spent in the marine or freshwater environments, Colin Levings's new book, *Ecology of Salmonids in Estuaries Around the World*, emphasizes the importance of the estuary, an often-overlooked ecotone between salt and fresh waters that salmonids must navigate on their journeys from and to their freshwater spawning habitat. The book considers all facets of the salmonid's life and the influence of the estuary, ranging from physiological and behavioural changes while transitioning from salt to fresh water (and vice versa) to life history metrics such as growth and survival. The book draws on diverse literature focussing on many different species of salmonids and generates many original tables and figures in support of its various themes, including species diversity and distribution, osmoregulatory adaptations, and salmonid harvest and conservation.

Although the estuarine residency of salmonids represents a relatively brief period in the life of these fishes, Levings's book magnifies this period and addresses the diverse challenges posed by the estuary, even conceptualizing estuaries as ecological bottlenecks, where mortality – and therefore natural selection – operate on

many species. Regardless of whether readers approach this text with an appreciation of the biological role of estuaries, they are certain to close the book with a greater understanding of their importance. There are many reviews and books focussed on marine and freshwater lives of salmonids and Levings posits that there is lacking a general reference on salmonids in estuaries.

Most estuaries are situated close to human settlements and estuaries are a particularly sensitive habitat worldwide, now considered to be among the most degraded ecosystems on the planet. Although the narrow focus of this book on migratory salmonids during the portion of their lives passed only in estuaries may appear to be a topic better suited to a review paper, the book expands so broadly on the topic that it is clear that such a paper would not do justice to the subject. According to Levings, 18 salmonid species are known to use estuaries; in addition to being emblematic species of cultural and economic interest, the diversity and distribution of salmonids in estuaries also make them a suitable candidate species for studying estuarine biology. Indeed, the underlying theme of Levings's book is using salmonids as a case study for a broader understanding of estuaries themselves. In fact, the book makes an excellent reference on estuary habitat in general (albeit temperate estuaries). Hopefully, the specificity of the subject does not deter anybody from picking up the book because there is much to be learned about both fish ecology and physical oceanography/limnology from this book, which will interest many readers, even those without any specific affinity for salmonids.

Salmonids of native and wild origin lead the book around the world, even into the Southern Hemisphere where they have been widely introduced (e.g., Argentina, Chile, New Zealand, Keregulen) to explore the chemical, physical, and biological characteristics of estuaries "from a salmonid's eye view". In this sense, it is an excellent general text on estuaries marrying the biotic and abiotic environments.

As focal species, salmonids have broad appeal to both scientists and the public. This work is best suited, however, to those with an interest leaning towards the scientific realm given the extensive detail and careful citation of works within. Nonetheless, there is also frequent definition of terms throughout the book (e.g., ecological indicators, p. 207; marine protected areas, p. 225), ensuring accessibility of the entire text for readers of varied interests, including both natural history enthusiasts and scientists from other disciplines (e.g., physical oceanographers or limnologists).

It is clear that Levings's long career dedicated to researching estuarine biology contributes greatly to the detail contained within the book, with consideration given to nearly every possible biotic and abiotic factor within the estuary that might be encountered by salmonids, including predation, competition, pollution, salinity, and temperature. There is significant use of published literature on salmonids in estuaries used as support throughout the book. However, there is also consideration given to areas lacking sufficient research about which the author provides some speculation based on his experience and understanding of salmonids in fresh or salt water. The data-deficient topics the book identifies, such as effective methodology for restoration of estuaries and the potential for designating estuaries as protected areas, call for further research,

potentially making it an important reference for early career salmonid researchers or others developing research agendas on the topic.

The conclusion is nicely bookended with reference to one of the author's own 1984 works reviewing the science of estuaries, calling for a test of the hypothesis that juvenile salmonids are not dependent upon estuaries (p. 284). Although the scope of the book extends well beyond this specific hypothesis, it is evident that the years have been kind to that particular question, advancing the overall state of research on salmonids. There has clearly been a considerable shift in focus towards research in estuaries during Levings's career, and readers will see firsthand by noting the recency of most literature cited in the book. The state of the research is still only in its early-mid phase with much more to learn and apply about estuaries to ensure their conservation. Evidently, this book represents a sort of mid-term review rather than a final examination of the subject, a reference that will hopefully direct further research towards estuaries. Indeed, Levings offers readers some inspiration should they be developing their own research agenda and interested in exploring estuaries, including studying cumulative effects of impacts on salmonids making the transition through estuaries and developing more comparative studies among estuaries. The book will hopefully instigate another push towards the study and protection of estuaries as these sensitive habitats clearly need greater focus to ensure the conservation of many species and particularly salmonids.

ROBERT J. LENNOX

Fish Ecology and Conservation Physiology Laboratory, Department of Biology, Carleton University, Ottawa, ON, Canada