BOOK REVIEW

Salmon: Biology, Ecological Impacts and Economic Importance

Editors: Patrick T.K. Woo, Donald J. Noakes (University of Guelph Guelph, Ontario, Canada and others)

The new book published by NOVA Publishers, USA, "Salmon: Biology, Ecological Impacts and Economic Importance" is a collection of scientific reviews in diverse fields of salmonid ecology, morphology, genetics, fisheries, aquaculture, and economic importance of salmon. Twenty-eight authors from seven "salmon-dependent" (a word from Chapter 14 that caught my fancy) countries represent 15 chapters filled with both well-known and new information on considered issues. The well-made book cover features mature salmon migrating upstream bringing new life for future generations, nutrients for freshwater ecosystems, and prosperity for coastal communities. In a similar fashion, this picture symbolizes that assimilation of the book's information by the reader provides a baseline for new advances.

In the Preface, editors mentioned that they tried to provide a good mix of both basic and applied topics in the book to attract more attention to the volume's content. This objective is achieved and is particularly effective nowadays when potential readers search for information on the Internet using keywords and meta-tags. The book conveys some customized information, and by running through the contents of the book, general information may expand the reader's scope of interest. Several specific features will be of particular interest to readers. It covers matters related as to Atlantic salmon, "King of Fish" (Montgomery 2003), and Pacific salmon. Such an approach emphasizes the tight interconnections of problematic matters between salmon and climate change, habitat degradation, fisheries management, etc., in both Atlantic and Pacific environments.

Wild and hatchery salmon populations in the marine life period depend on feeding and survival conditions defined by a complex of physical and biocenological factors. They are sensitive to year-to-year variability in oceanic forcing that sometimes produces enormous fluctuations in abundance of salmon stocks throughout a species' range. These fluctuations occur due to salmon mortality in the early marine and oceanic phases that is significant, making it important to analyze the carrying capacity for pelagic fish through top-down and bottom-up controls. Although I do not share an opinion that "Pacific salmon … are among the most critically endangered wild fishes in their native ranges" (page 195) or "production potential of wild salmon has declined since the 1990s" (page 223), such polemic bitterness should attract readers' attention and increase public awareness of salmon stock conservation and their studies. Even though the productivity of wild salmon stocks is currently at a high level and providing recent annual harvest of about 1.1 million tons, this "era of prosperity" can be quickly replaced by years of low salmon abundance as occurred on a Pacific-wide scale in the 1940s.

In general, a starting point for the book is the recognition of regime shifts and the dynamics of climatic and oceanographic conditions. Almost all chapters in the book deal with this important problem of environmental conditions influencing different aspects of salmon nutrition, growth, metabolism, body shape and conditions, behavior, and finally genotype through natural selection. Several major reviews consider the future of salmonid fish production in relation to global warming, ecosystem health, and

habitat degradation. Such links to global problems that are becoming ever more urgent give the book a timely relevance.

Although Atlantic salmon and the common Pacific salmon species have been studied for a long time in periods of low and high stock abundance, there are many poorly studied matters in their biology and ecology that are partially covered by the book's chapters. Comparative studies of hatchery conditions and seed quality in chum salmon, metabolic rates and requirements of farmed salmon, and lipid composition of different phenotypic groups of Atlantic salmon provide an important background for future research on juvenile salmon survival mechanisms. Importance of disease as a critical factor in the decline of seed quality and fry survival in hatchery production is emphasized in the first two chapters. Together with studies on energy contents and physiological conditions of salmon at different life stages, it forms an advanced research area to improve natural mortality forecasts for wild and farmed salmon. There are many scientific facts and hypotheses that will add to popular discussions on wild and hatchery salmon stock interrelationships, environmental impact of salmon aquaculture, and trends in salmon fisheries over the coming years.

A brief introductory chapter by one of the editors, D. Noakes, aggregates the individual chapters into a unified whole. It provides an overview on salmonid fish diversity and basic information about captured and farmed salmonid fish production. A few focused specialists keep in mind the "balance sheet" that there is more than twice the amount of farmed salmon production compared to wild salmon harvest. It is important to notice, especially for Canada, that farmed fish contribute substantially to the economies of some coastal communities, which produce a larger value of high-demand seafood production. Pacific salmon capture fisheries are responsible for roughly 30% of the total salmonid production on the world food fish market that in large part is represented by less valuable pink and chum salmon. Therefore, fish farming is becoming more economically important than many traditional fisheries, which raises new economic and social questions in salmon-related matters and influences managerial decisions to ensure conservation and sustainability of salmonids. That is why, beyond the groups mentioned in the Preface, I recommend this book to a wide readership including economists, analysts, environmentalists, NGOs, and mass media.

Salmon aquaculture production grows quickly from year to year. Likely, that is a reason why some figures are outdated, including annual production of salmon farms in totals by species. The first source of discrepancy is the reference to different years. Thus, in Chapter 1, farmed salmon, trout, and char production raised in net pens is estimated as more than 2.3 million tons per annum with a lack of reference to a particular year. The value increases up to 2.5 million tons in Chapter 12 with the same authorship and to "almost 2.5 million tonnes" (as global production of farmed salmon) in 2012 in Chapter 15. Authors of Chapter 13 mistakenly refer to 2.5 million tons as the total salmon production that "could be caught or grown in 2014". This value is underestimated because, according to Chapter 14, global salmon production was 3.89 million tons in 2011. K. Criddle and I. Shimizu (Chapter 14) also list all main subtotals of this sum, including a second source of discrepancy. Influenced by the bulk of marine net pen production, people frequently lose sight of freshwater salmonid aquaculture that also provides large production. Rainbow trout freshwater and brackish water aquaculture in 72 countries produced about 480,000 tons in 2011 and almost 540,000 tons in 2012, while marine rainbow trout farming supplied 290,000 and 316,000 tons

in eight States (http://data.fao.org/). Together with Arctic char aquaculture production of 3,500-3,700 tons, this value is a difference between global production of farmed salmon (Chapter 15) and salmonid fish production raised in net pens (Chapters 1 and 12). It would be useful to clarify and standardize salmon aquaculture statistics through the volume together with usage of the term "tons" (Chapters 1, 8, 12-14) and "tonnes" (Chapters 7 and 15).

One more remark on the first chapter relates to the statement that the sub-family Salmoninae comprises more than 110 species. In the cited article (Crespi and Fulton 2004), authors deal with 30 species of salmonids and do not consider their total abundance. The FishBase Internet resource (http://www.fishbase.org/) counts 120 valid species of Salmoninae and seems to be the most appropriate reference for the statement (see Froese, R., and D. Pauly, eds. 2008. Salmonidae in FishBase). There are well-known phylogenetic and systematic problems concerning the sub-family Salmoninae. Different opinions exist about either the numbers of species in individual genera or the number and phylogeny of genera themselves (e.g., see review by Osinov, A.G., and V. S. Lebedev. 2004. Journal of Ichthyology, Vol. 44 (9): 690–715). In Chapter 3, brief "notes on the margin" devoted to intraspecific morphological variation of Atlantic salmon resulted in description of a new species or subspecies, but one would like more. It would be very advantageous to invite a detailed review on salmonid fish taxonomy in such a collection of scientific articles devoted to this subfamily. Now, the situation with taxonomy for many rare salmonid species can be described as was done for Salmo dentex and S. marmoratus on the fishermen's website. "Species is poorly studied and its status has remained unclear due to lack of samples for detailed analyses, hybridization with other trout lineages and diverse and multiple designations of the same trout in different areas" (http://www.troutsalmonchar.com/).

Chapters are distinguished from one another by volume as well as by scope. Some authors focus on their own in-house studies and present an extended summary of mostly their own writings per se (e.g., share of self-citation is more than 60% in Chapter 7). However, this is not bad, especially when important publications are not easily accessible by prospective readers. Based on published articles, the author suggested a new approach for future ecological studies for better understanding of fish production in natural ecosystems through advanced study of food digestion and utilization rates in changing environmental conditions. In Chapter 10, M. Kaeriyama and Y. Qin presented an historical overview of chum salmon hatchery program in Japan that is so extensive and ambitious that gave a reason to consider this large-scale experiment is a salmon domestication as recently as ten years ago. Authors conveyed information, arguments, and speculations regarding ecological and genetic interactions between wild and hatchery produced Pacific salmon and recommended measures to support sustainability of wild and hatchery stocks. In conclusion, they point to one important and timely question related to the issue: "How can we ensure fishery management adaptively responds to emerging new information on trends and status of naturally reproduced salmon?" Contrary to the common belief that almost all Pacific salmon in Japan originate in hatcheries, several studies examining the contribution of hatchery/wild fish by mass marking of hatchery fish have shown significant contribution of wild salmon to total stock abundance. Thus, K. Morita estimated the contribution of wild fish as ~26% for chum and ~80% for pink and masu

salmon (see NPAFC Newsletter No. 35). It is evident that the large-scale hatchery experiment in Japan slides into a new stage with a high-grade convergence of both naturally reproducing and hatchery stocks. In this relation, the authors' recommendation to separate wild and hatchery salmon populations looks belated.

Another sort of review is presented in chapters using literature surveys, when the author(s) summarizes a bulk of published sources and encourage readers to follow references for further details. Such reviews are presented on the intraspecific morphological heterogeneity of Atlantic salmon by A. Yurtseva (Chapter 3), salmonid nutritional and anti-nutritional factors (Chapter 9) by I. Forster and R. Hardy, and on behavior and genetics of salmon by D. Noakes (Chapter 10). In the first one, the author analysed morphological development under the influence of different driving factors (water velocity, temperature, selection pressure, feeding, etc.) and made conclusions separately for natural and aquaculture environments. Despite all the merits of this review, it should be noted that the wording "genetically identical cultured and wild Atlantic salmon parr" is inaccurate. Origination from the wild parents from the same rivers does not mean full genetic identity of progeny. In Chapter 10, salmon behaviour, including migration and navigation is considered as a result of genotype expression through adaptations to local conditions. This chapter has 237(!) papers cited and seven pages of introductory literature review—about 60% of the whole text, that emphasizes a comprehensive analysis of the subject matter. It is regrettable that authors of these three chapters did not select attractive figures and/or tables from the cited literature to illustrate the main points in their reviews. In comparison, Chapter 7 contains 20 figures and 2 tables that notably facilitate an understanding of the text.

As for other chapters, several of them provide brilliant snapshots of the current state of knowledge in specific scientific fields, and their conclusions sometimes reveal significant relevance to allied topics. In this relation, I would like to highlight an absence of water temperature effect (within the comfortable interval 4-8ºC) on the ATP content of chum salmon fry (Chapter 2). It is an important consideration in the method of otolith thermal marking, which is widely applied to Pacific salmon in hatcheries. The influence of fasting remains less clear. The author makes three contradictory conclusions: "Fasting for more than 3 days caused a decrease in ATP content in fry" (caption to the Figure 3), "fasting for more than 72 h resulted in ATP increase content of fry" (text below), and "data indicate that feeding and fasting have little or no impact on ATP content" (the next sentence on page 16). These statements need further clarification. A little discrepancy in statements also occurs regarding dietary supplementation: "iron citrate or cotton seed oil can improve seed quality" (Abstract) and "it is unclear whether dietary iron citrate supplementation improves seed quality" (page 17). Such diffident statements may confuse readers unfamiliar with the experimental details.

Chapter 4 is a little bit more specialized than others, both by topic and geographically. However, it also consists of one incorrect statement: "the alevins gained scale cover and became juveniles (page 48). In fact, salmon alevins first become fry and then gain scales. Authors of another specialized review (Chapter 13) attract readers' attention to the problem of non-waster salmon processing and the importance of

such prospective by-products as collagen and gelatin. It should be noted that advanced raw fish processing promises even more benefits. Recent technological studies reveal that salmon heads contain relatively high concentrations of hexosamines—amino sugars that are valuable biologically active compounds.

Chapter 8 by A. Bergheim and S. Fivelstad is another example of a comprehensive and well-organized review. It contains more than just basic information on recommended water quality criteria, oxygen consumption, carbon dioxide, and excretory production of Atlantic salmon fry, parr, smolt, and adult stages on Norwegian farms. The second part of the review emphasizes tests of optimal/sub-optimal/critical levels of oxygen, carbon dioxide, and ammonia connected to the metabolism of the fish stock in the pre-smolt stage in freshwater and after transfer to the marine environment. It includes brief descriptions of flow-through farms and recirculating systems with an emphasis on critically important and poorly studied points. Therefore, this review can be used as a guide for new aquaculture farmers (together with data on the effects of dietary supplementation on chum salmon fry from Chapter 2) as a background for future research.

The most extensive (by volume) review on the economic importance of wild Pacific Salmon appear at the end of book (Chapter 14). It contains up-to-date information on this topic for two geographically distinct regions: Japan and Alaska. Recent events are described, like the catastrophic tsunami of 2011 in eastern Japan, obtaining the MSC certificate by the Japanese domestic salmon fishery in the Kitami region of the Okhotsk Sea coast of Hokkaido, and presented data series are updated until 2013. It is cheerful to read about the significance of the Convention for the Conservation of Anadromous stocks in the North Pacific Ocean for salmon stock conservation and rational exploitation. Some information given is rare in English-language sources, particularly on the brand-labeled chum salmon on Japanese domestic market, its high value, and, therefore, the importance of marine fisheries for juvenile and immature salmon, etc. It should be noted only that correspondence of subsection “Importance of the Okhotsk Sea…” to the economic importance of wild Pacific Salmon remained somewhat unclear. Observations on ice cover dynamics and hatchery release timing are undoubtedly interesting, but go slightly beyond the general topic of review.

The sections on evolution of Pacific salmon fisheries management in Alaska were presented in Chapter 14 in an informative manner. Pacific salmon is one of the most important groups of fish in the world’s fishery. Their portion of the world capture fishery harvest is gradually increasing and recently reached 0.98% in 2011. The author cites the statement that the increase of production of pink and chum salmon is primarily a result of enhanced artificial production for these two species (Ruggerone et al. 2010). I do not completely agree, particularly for pink salmon whose stock dynamics is mostly driven by favorable environmental conditions. Moreover, salmon importance is not limited by the bulk or monetary value of catch. Beside commercial fishery profit, the chapter emphasizes that coastal communities benefit from sport and subsistence fishing and tourism. Interesting observations are made regarding the importance of fishing in linking interregional connections. Pacific salmon have a broad significance for the dietary, social, and cultural needs of coastal societies around the North Pacific and factually have become cultural icons across the North Pacific Rim.

In conclusion, I would like to say that the book makes a positive general impression. It provides vast information and leaves enough space to differentiate one's own views from those of authors. Undoubtedly, this book will improve readers' knowledge and develop understandings on the importance of salmonid fishes in a complex of interrelated and interdependent aspects of human activities.

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