

Fish & Fisheries Series 39

Andrew M. Muir  
Charles C. Krueger  
Michael J. Hansen  
Stephen C. Riley *Editors*

The Lake Charr  
*Salvelinus*  
*namaycush*:  
Biology, Ecology,  
Distribution, and  
Management

 Springer

# **Fish & Fisheries Series**

Volume 39

## **Series Editor**

David L. G. Noakes, Fisheries & Wildlife Department, Oregon State University,  
Corvallis, USA

The volumes in the Fish & Fisheries series will cover topics ranging from the biology of individual species or groups of fishes, to broader concepts in fisheries science, conservation and management. The series is directed to professionals and researchers in fish biology, senior undergraduate and postgraduate students, and those concerned with commercial production or harvest of fishes.

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**With deep regrets we are informing our Readers that Prof. David Noakes, Editor in Chief of the journal *Environmental Biology of Fishes* and Series Editor of the *Fish and Fisheries* book series has suddenly passed away.**

**David's professional expertise and prompt advice has always been highly regarded and will be very much missed by all at Springer, who have known and worked with him.**

David L.G. Noakes  
Fisheries & Wildlife Department  
Oregon State University  
Corvallis, USA

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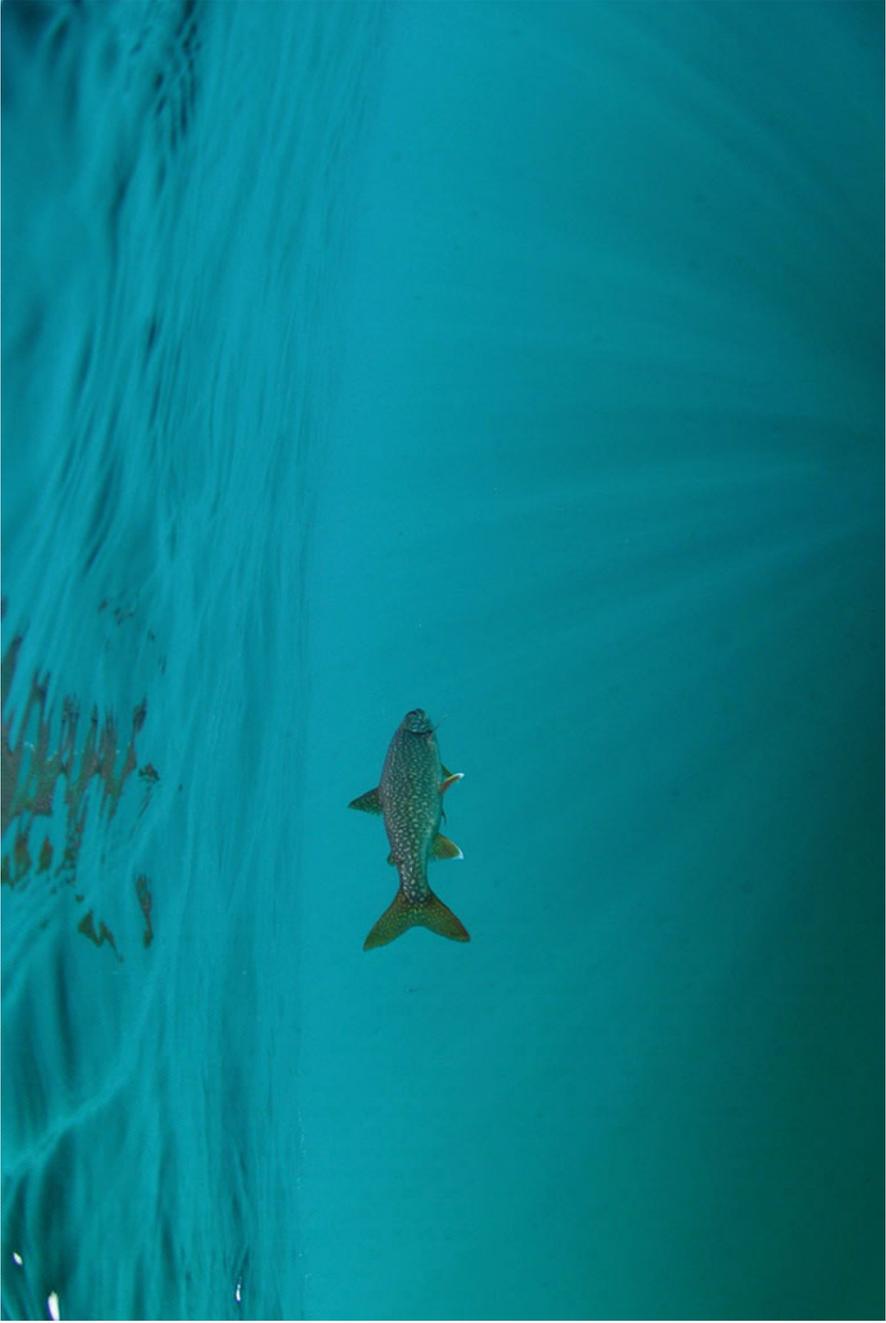
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A lake charr *Salvelinus namaycush* (photo by P. Vecsei—Tlicho Government, Northwest Territories, Canada)

*In fond memory of Dr. David L.G. Noakes, the progenitor of this volume. A remarkable man—husband and father, friend, mentor, professor, and inspiration to us all. We will miss you dearly. Charrs/Chars.*



# Foreword

This volume is a major international accomplishment. Of course, you might expect me to claim this, since I am a coauthor of one of the chapters and of the Introduction. I do take some small credit for that, but the major contributions by a large number of research colleagues are much more important. Full disclosure, I have been involved in research and practical matters with *Salvelinus namaycush* for a number of years, and many of those activities were through contacts with the Great Lakes Fishery Commission (GLFC). In many ways, the GLFC has taken the lead in organizing and producing this volume. I know many of the authors in this volume personally and professionally. I was involved in the organization of the International Charr Symposium held in Duluth, Minnesota (June 2018). That meeting provided much of the basis and impetus for this volume. To my regret I did not attend that Symposium because I was in a different meeting (EEEEF, Montreal, Quebec) at exactly the same time.

My claim of international accomplishment for this volume might appear to be yet another example of North American hubris – almost all the authors in this volume are from either the USA or Canada. But the international accomplishment is reflected in both the fact that the Charr Symposium was held in Duluth, Minnesota, and the recognition by international scientists of the significance of *S. namaycush* and the accumulated information on the species.

The International Charr Symposium series originated with a conference on *Salvelinus alpinus* hosted by Lionel Johnson in Winnipeg, Manitoba, in 1981. It has continued from that time, hosted on a voluntary basis by colleagues around the Northern Hemisphere and has usually emphasized *S. alpinus*, even in the name of the Symposium.

One of my Icelandic colleagues is typical of Icelanders in that she has traveled extensively (including study for her doctoral degree in the UK) and collaborated with scientists in a number of countries. However, it was not until she attended the Duluth Charr Symposium that she appreciated the extent of the North American activities with charr. She had not realized that Lake Superior has almost the same surface area as the entire country of Iceland! *S. namaycush* is a dominant species in

Lake Superior, and it is distributed widely in thousands of other lakes across its native range in North America. That includes the other Laurentian Great Lakes, as well as Great Bear Lake and Great Slave Lake, and numerous smaller water bodies. The contrast is not just a North American “Bigger is better” comment; it provides a perspective for both North Americans and those from elsewhere on this volume.

A continuing theme for every Charr Symposium has been the extreme diversity within the genus, mostly focused on *S. alpinus*. For example, Icelanders take great pride in the extraordinary genetic, morphological, and ecological diversity of *S. alpinus* in their lakes and rivers, with the classic example of four quite distinct forms in a single lake, Thingvallavatn (surface area 84 km<sup>2</sup>). All evidence points to that, and other Icelandic lakes, as evidence of the process of sympatric speciation. If four distinct forms develop within one lake much smaller than Lake Superior (surface area 82,000 km<sup>2</sup>), what can we expect in *S. namaycush* distributed over so many lakes, including truly Great Lakes in North America? The contributions in this volume quite appropriately address that question. Everything from paleoecology to genetic diversity of *S. namaycush* is covered in detail by authorities on a considerable range of subject areas. This is a landmark accomplishment that will be welcomed by international colleagues who have been largely unaware of the wealth of information on this species, for two different reasons. Traditionally much of the literature on *S. namaycush* has been in North American journals, and was mostly directed to questions of management, harvest, and traditional fisheries concerns about a species identified by the common name lake trout. At the same time, most of the people working on *S. namaycush* in North America have not usually considered the International Charr Symposia as a primary meeting venue.

The Duluth Charr Symposium accomplished a great deal, first to draw attention to the ecological and evolutionary significance of *S. namaycush*, and also to provide a very different perspective for North American colleagues. In a different way, this volume is an example of the importance of scientific names in science and the limitations of common names. There is a tradition of using common names of fish species, even in the primary scientific literature. We are all familiar with the standard format: provide both the scientific and common name of each species when first mentioned in the text and thereafter use only the common name. Why default to common names in the scientific literature? And use only English common names—not French, German, Norwegian, or Japanese and certainly none of the names from indigenous peoples who have lived with the fish throughout history. What is gained for science by referring to *Oncorhynchus mykiss*, *S. namaycush*, *Salmo trutta*, and *Salvelinus confluentus* as “trout”?

Yes, I am a coauthor on papers that refer to Icelandic *S. alpinus* by their common Icelandic names or by functional terms used to identify them by their trophic specializations. Those and other studies of *S. alpinus* have emphasized what we recognize as the important distinction between the pattern and the process of evolution. The process is clearly what is important and interesting. The pattern, which is the scientific or common names assigned to particular individuals or groups of individuals, is a necessary convenience but should be understood as only the equivalent of a digital image at one point in time of an active, ongoing ecological and

evolutionary process. It is conventional to think in terms of geological time, and such time spans far exceed our ongoing studies and taxonomic discussions. However, the geological evidence from the Icelandic examples of *S. alpinus* suggests that very significant evolutionary changes can take place in only a few thousand years. *S. namaycush* has had at least as much geological time and a much greater and more complex ecological theater in North America in which to develop its evolutionary play. Now we have the details of paleoecology, habitat diversity, and genetic information summarized here to consider this question.

It is fair to ask what should we now expect from the wealth of information about *S. namaycush* in this volume. First and foremost, there will be renewed attention to and analyses of ecological and genetic diversity, prompted by the obvious comparisons to congeneric species. There will be an appreciation of the research potential for this species, given its huge native geographic range and associated life history complexity. The information in this volume already clearly shows that *S. namaycush* is at least as complex and diverse as *S. alpinus*. There are some obvious and important questions. Why (and how) do these fish live to such great ages and grow to such a large size? Why are they relatively intolerant of saltwater and thus restricted to continental North America? The species has very considerable potential for experimental laboratory studies as well as field research. It is produced in large numbers in conventional hatcheries, is harvested as a major commercial and recreational species, and is important for Tribes and First Nations, so it provides a remarkable challenge for those concerned with management, conservation, and restoration. This volume is a major testament to this remarkable species.

Fisheries & Wildlife Department,  
Oregon State University,  
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David L. G. Noakes

# Lake Charr *Salvelinus namaycush* Illustrations

Lean-like (Grey; Piscivore)

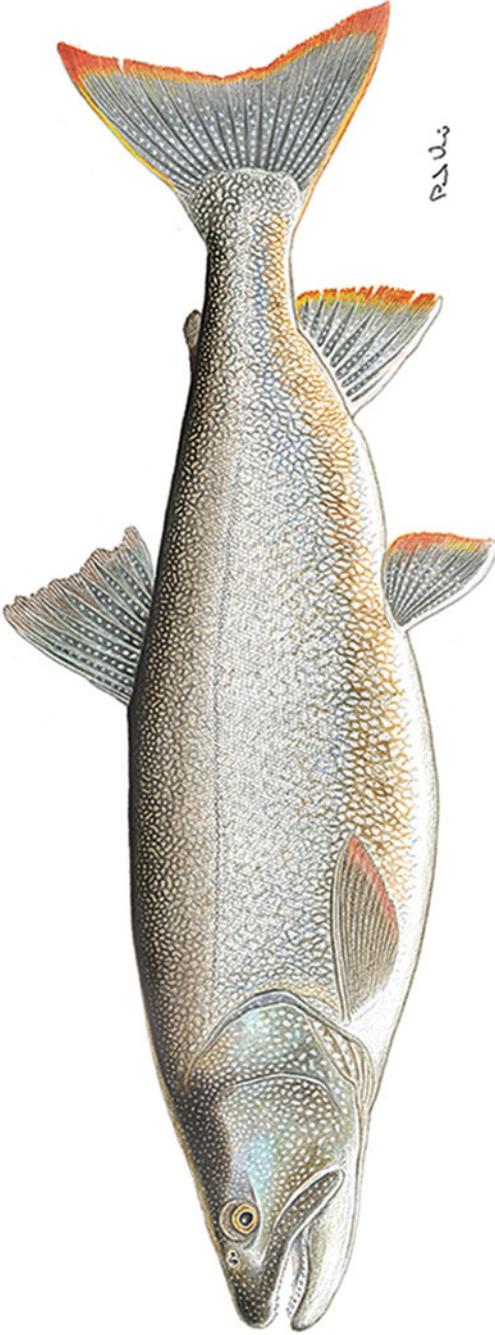
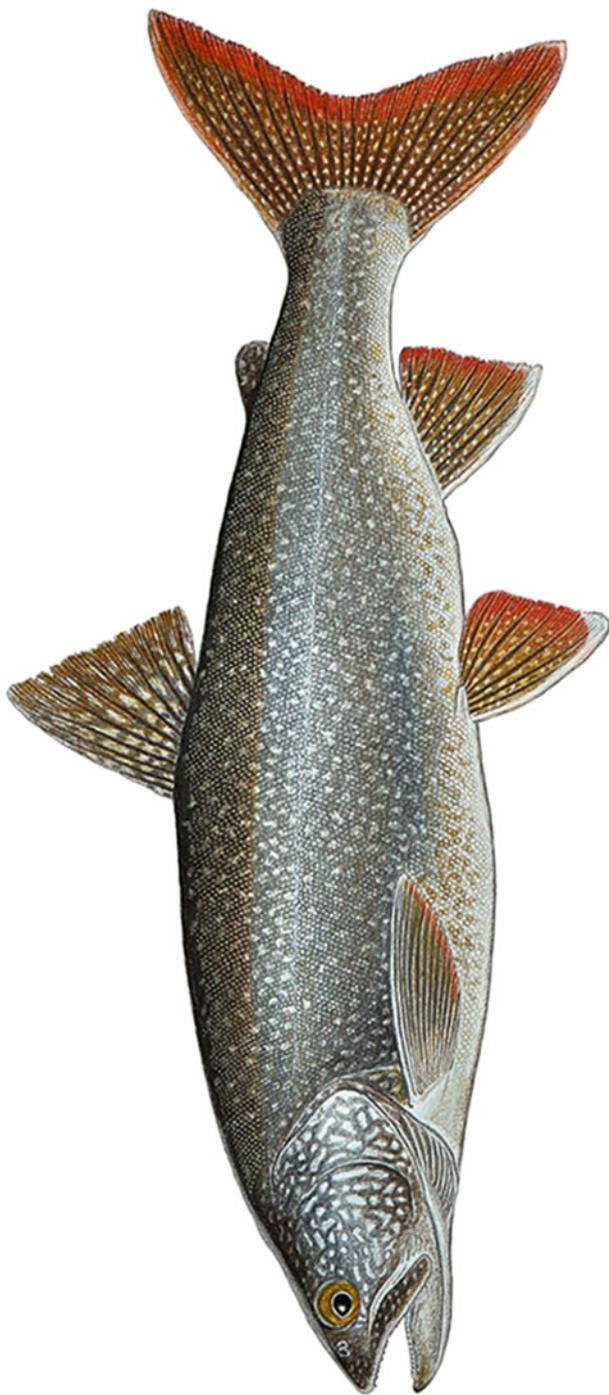


Plate 1 NoBeans Island, Smith Arm, Great Bear Lake, NT, Canada, 1141 mm TL

**Lean-like**



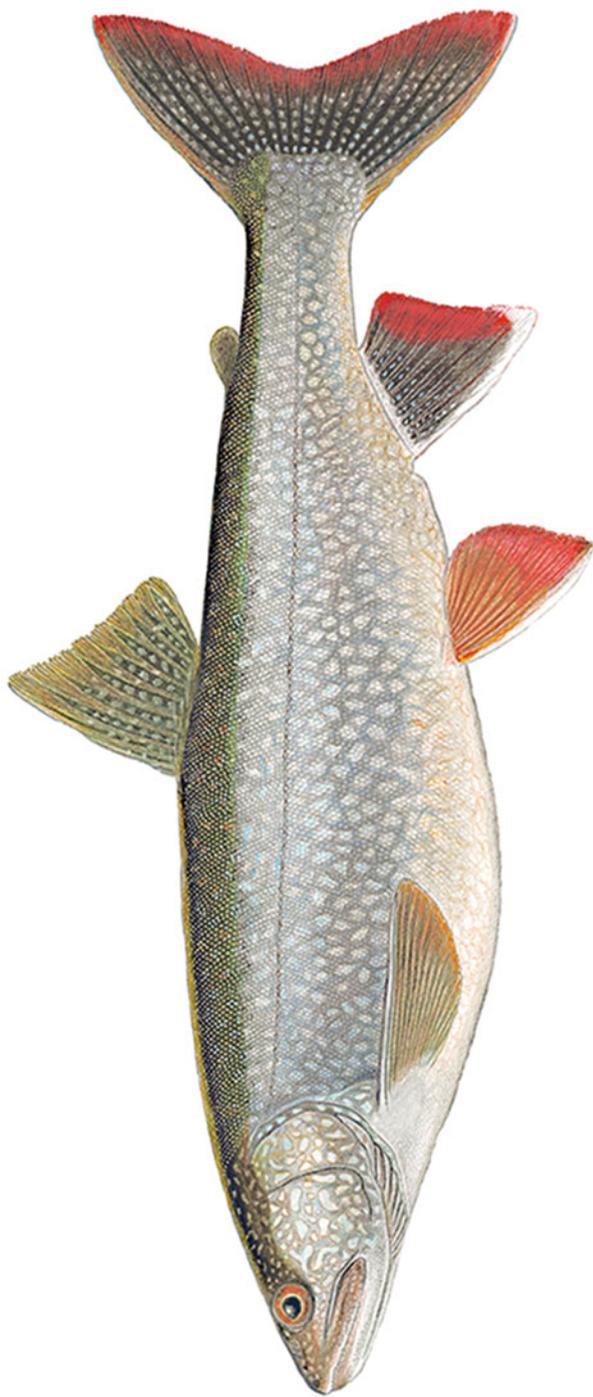
**Plate 2** First Bay, Dease Arm, Great Bear Lake, NT, Canada, 675 mm TL

**Lean-like**



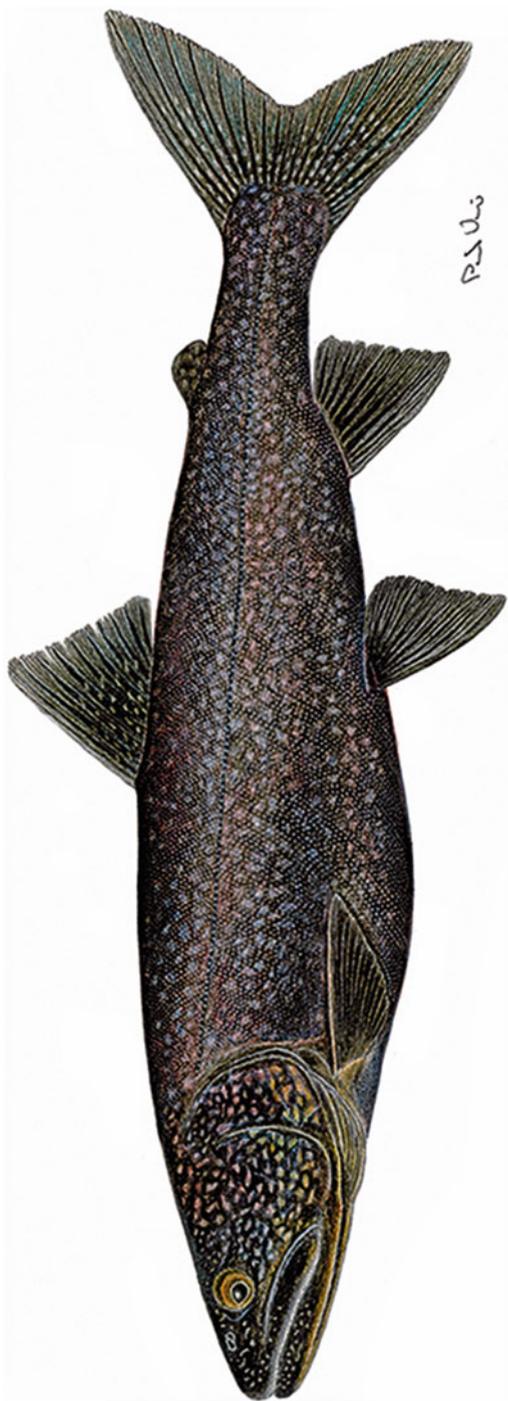
**Plate 3** East Arm, Great Slave Lake, NT, Canada, 782 mm TL

**Lean**



**Plate 4** Rock of Ages, Isle Royale, Lake Superior, MI, USA, 508 mm TL

**Lean-like**



**Plate 5** Lake Mistassini, QC, Canada, 504 mm TL

Lean



Plate 6 Rush Lake, MI, USA, 459 mm TL

**Humper**



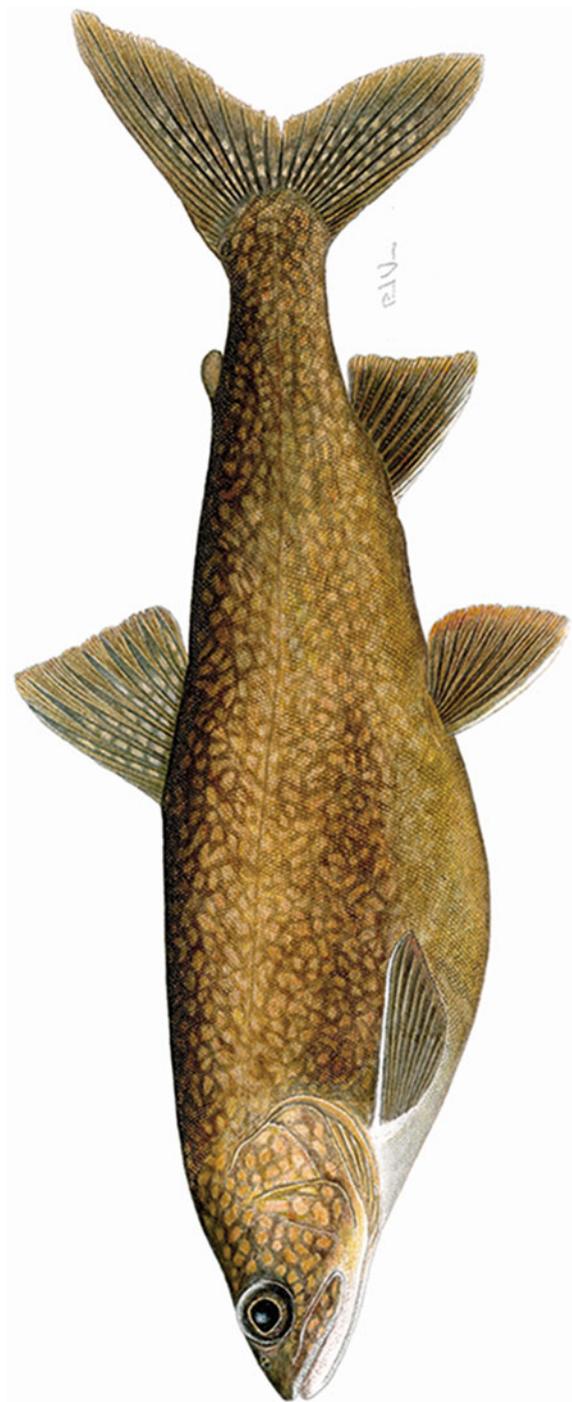
**Plate 7** Klondike Reef, Lake Superior, MI, USA, 441 mm TL

**Humper-like**



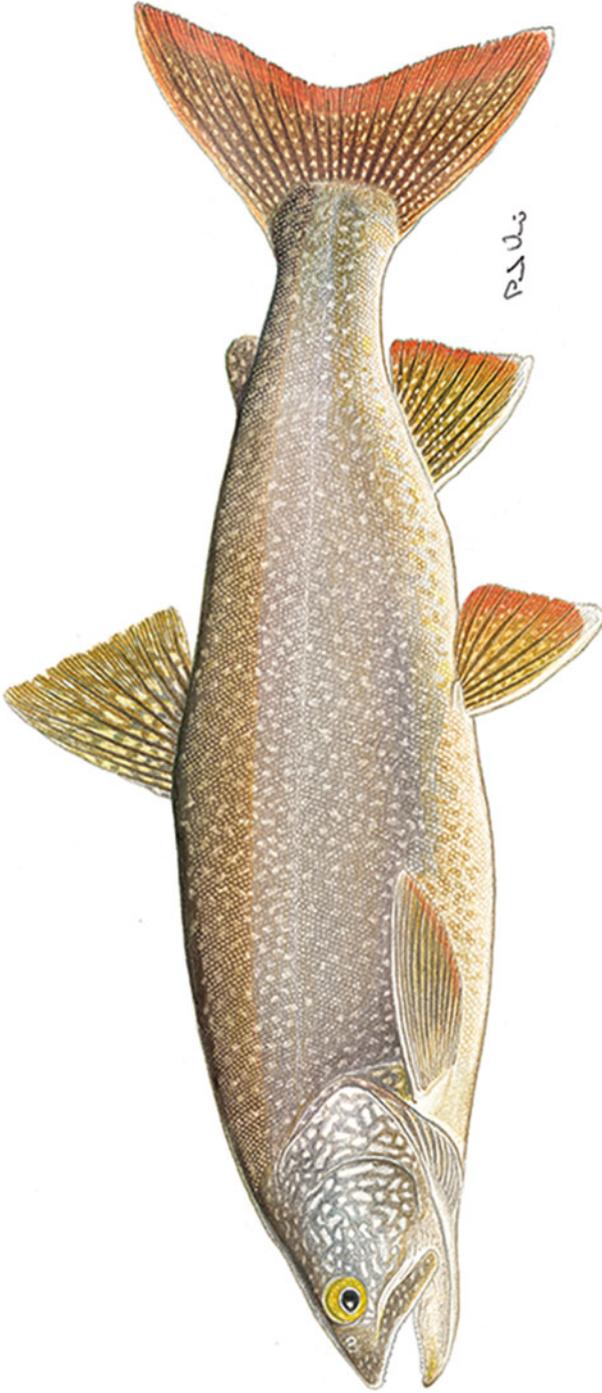
**Plate 8** Lake Mistassini, QC, Canada, 406 mm TL

**Humper-like (Huronicus)**



**Plate 9** Rush Lake, MI, USA, 380 mm TL

**Humper-like**



**Plate 10** Skilak Lake, AK, USA, 360 mm TL

Siscowet-like

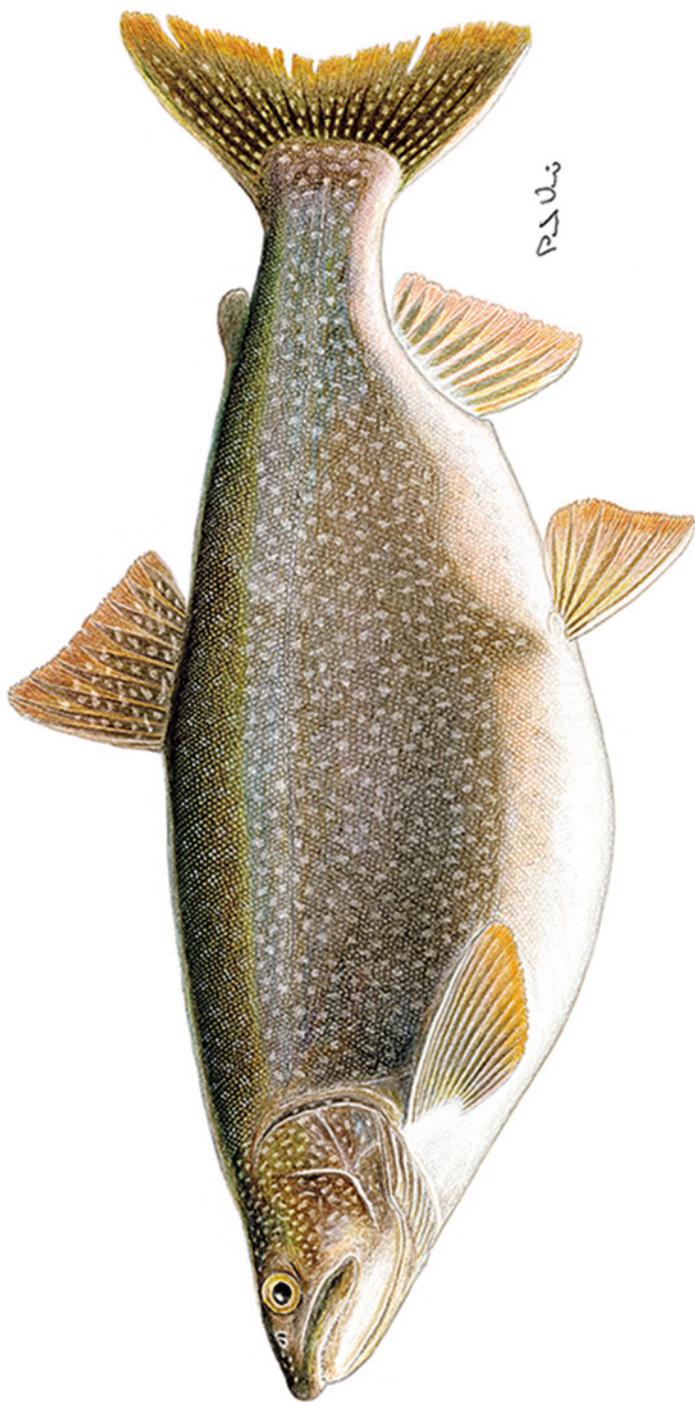


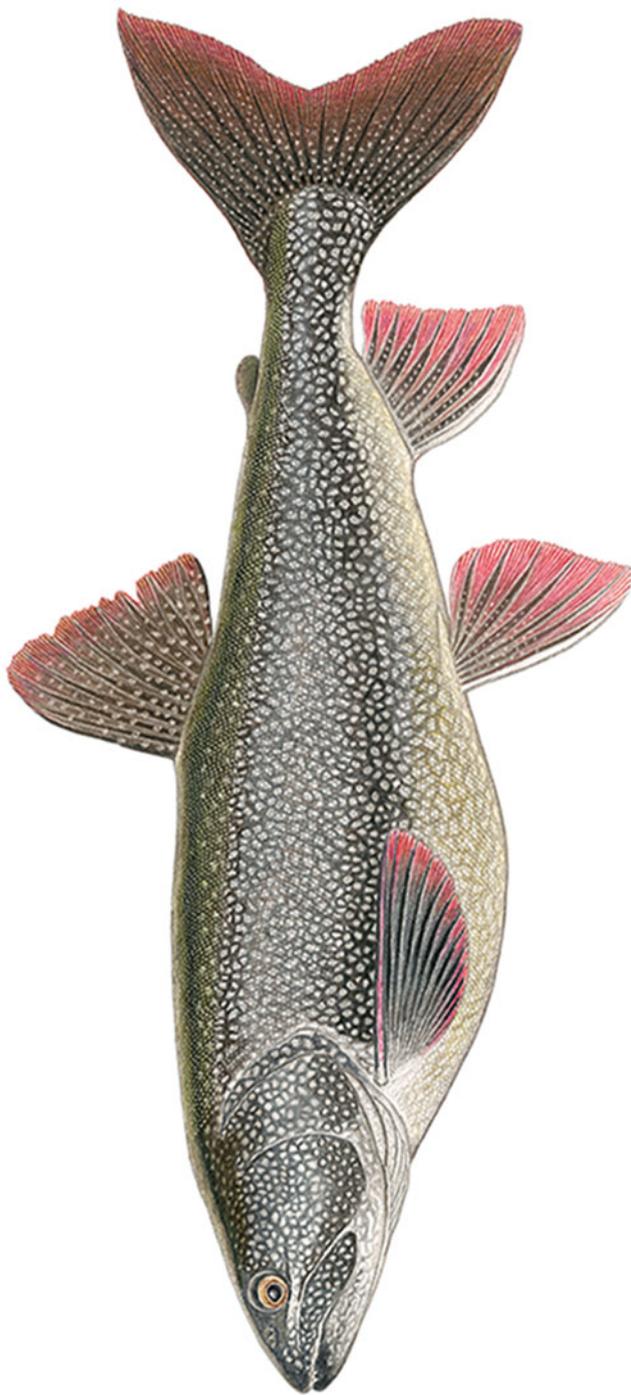
Plate 11 East Arm, Great Slave Lake, NT, Canada, 782 mm TL

**Siscowet**



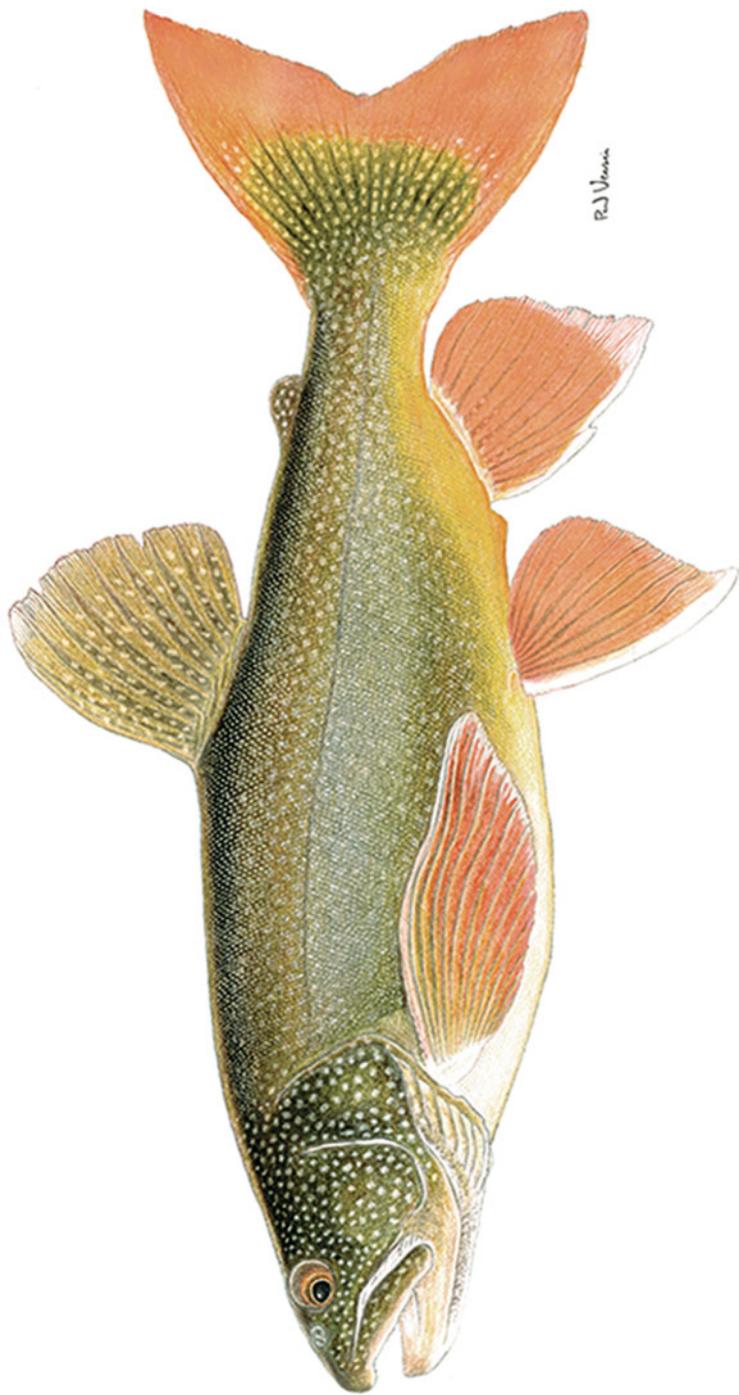
**Plate 12** Lighthouse, Isle Royale, Lake Superior, MI, USA, 602 mm TL

**Redfin**



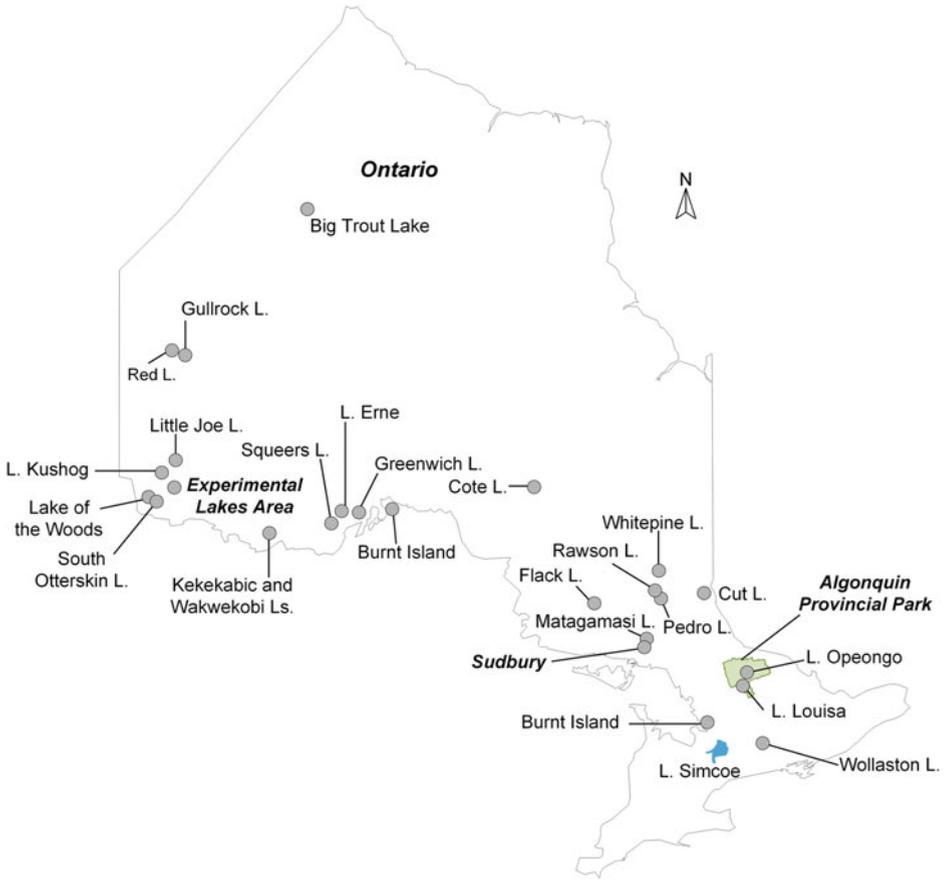
**Plate 13** Superior Shoal, Lake Superior, ON, Canada, 867 mm TL

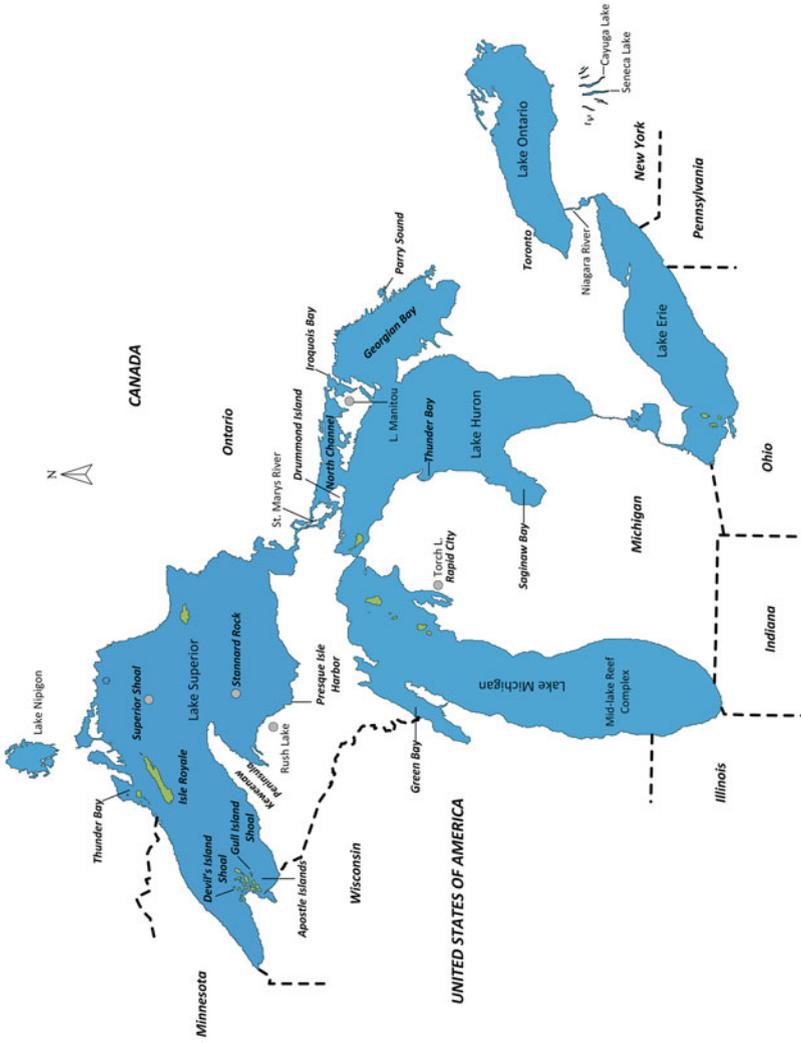
**Butterfly (Insectivore)**



**Plate 14** Shipwreck (PigPen), Dease Arm, Great Bear Lake, NT, Canada, 675 mm TL







# Acknowledgments

We thank David Noakes, Oregon State University, for reaching out and encouraging us to take on this project. We are grateful to Alexandrine Cheronet (Senior Editor) and Judith Terpos (Assistant Editor), Springer Nature, for offering us the opportunity to publish a modern synthesis about the lake charr *Salvelinus namaycush* and to Eva Loerinczi (Publishing Editor) and Bharat Sabnani (Production Coordinator) for helping us get the project over the goal line.

We are indebted to the many expert authors who contributed to this volume; without them and their vast experiential knowledge, the book would not have been possible. Several authors also presented their chapters at the 9th International Charr Symposium, July 2018 Duluth, Minnesota (*Hydrobiologia* (2019) 840:1–398). Our synthesis of modern knowledge on the lake charr's ecology builds off the many pioneers in the field beginning with Louis Agassiz's report of the 1848 expedition to Lake Superior through to Martin and Olver's 1980 synthesis of the lake charr's ecology. These pioneering natural historians paved the way for generations of lake charr biologists.

Color illustrations of lake charr were done by Paul Vecsei–Tlicho Government, Northwest Territories, Canada. Illustrations were created from enhanced high-resolution digital images of live or freshly caught fish. Printed color images were placed on a light table, and body outlines were transferred to cotton archival two-ply vellum (Strathmore™ Artist Papers). Anatomical features (meristic and morphometric variables) were drawn to scale on these outlines. A combination of graphite and polychromos color pencils (Faber-Castell) finished with multiple wash layers of watercolor pencil brought the illustrations to life.

Special thanks to the chapter reviewers: Mike Allen–University of Florida/IFAS, Paul Blanchfield–Fisheries and Oceans Canada, Randy Eshenroder–Great Lakes Fishery Commission, Colin Gallagher–Fisheries and Oceans Canada, John Gunn–Laurentian University, Christopher Guy–USGS Montana Cooperative Fishery Research Unit, Chris Harvey–Northwest Fisheries Science Center, Arne Jacobs–

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