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# Freshwater Ecology

Second Edition

*Walter K. Dodds and Matt R. Whiles*



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# Freshwater Ecology

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# Preface

## **FOR THE STUDENT**

This book was written for you. We obtained as much student input as possible by having student reviewers assess the text and the approach used in it. The idea for the text was based on teaching students who were not satisfied with the existing texts. Teaching aquatic ecology and limnology has made it clear to us that most students enter ecological sciences for practical reasons. They often are concerned about conservation of resources from a classical perspective (e.g., fisheries program) or from an environmental issue perspective. Most existing texts limit the applied aspects of aquatic ecology to a section at the end.

The aim of this text is to incorporate discussion of the issues as they arise when the basic materials are being covered. This allows you to see the applications of difficult topics immediately and, we hope, provides additional impetus for doing the work required to gain an understanding. We also attempted to use the broadest possible approach to freshwater ecosystems; scale and linkages among systems are important in ecology. Most students in ecological courses had some interest in the natural world as children. They spent time exploring under rocks in streams, fishing, camping, hiking, or swimming, which stimulated a love of nature. This book is an attempt to translate this basic affinity for aquatic ecosystems into an appreciation of the scientific aspects of the same world. It is not always easy to write a text for students. Instructors usually choose a text, giving the students little choice. Thus, some authors write for their colleagues, not for students. We tried to avoid such pressures and attempted to tailor the approach to you. We hope you will learn from the materials presented here and that they will adequately supplement your instructor's approach. When you find errors, please let us know. This will improve any future editions. Above all, please appreciate the tremendous luxury of being a student and learning. You are truly fortunate to have this opportunity and we are grateful for the time you take with this text.

## **FOR THE INSTRUCTOR**

We hope this book will make your job a little easier. The chapters are short, mostly self-contained units to allow the text to conform to a wide variety of

organizational schemes that may be used to teach about freshwaters. This will also allow you to avoid sections that are outside the scope of the course you are teaching. However, environmental applications are integrated into the text because we do not view the basic science and applications as clearly separate. We attempt to create instructional synergism by combining applied and basic aspects of aquatic ecology. Describing applications tends to stimulate student interest in mastering difficult scientific concepts. A variety of pedagogical approaches are used in an attempt to engage student interest and facilitate learning. These include sidebars, biography boxes, and method boxes. In the second edition we have also added advanced sections for areas where you might want the students to get a little more in depth but in areas that we often skip in our own lectures for a first class in freshwater ecology. We also include an appendix on experimental design in ecological science and a glossary because we have found many advanced undergraduates have little exposure to the practical side of how science is done. It is always difficult to know what to include and where to go into detail. Detailed examples are supplied to enforce general ideas. The choices of examples, perhaps not always the best overall, are the best we could find while preparing the text. Suggestions for improvements in this and any other areas of the text are encouraged and appreciated, and instructors using the first edition did just that. We apologize for any errors.

Why did we write this? In our experience, teaching limnology/freshwater ecology is more work than teaching other courses because of the breadth of subject, differential preparation of students, and associated laboratories but always seems to be the most fun. Of course it is fun; it is the best subject! We hope this book facilitates your efforts to transmit what is so great about the study of freshwater ecology.

## **WHY DID WE WRITE A SECOND EDITION?**

Asking students to buy a new text rather than used requires a good reason to produce a new edition. In the near decade from the writing of the first edition, many new advances have occurred, and new topics have gained prominence with respect to environmental effects and hot areas of research interest. A second author (Matt R. Whiles) was added to broaden the perspective. In our attempt to cover these new areas we have added about 500 new and updated references, 50 new figures, 30 updated figures, color plates, two new chapters, and expanded the length of the text by roughly 40%. Particularly, we included more emphasis on wetlands and reservoirs than in the previous edition. Numerous errors were found in the first edition by dedicated students in Walter K. Dodds's classes (with a potential award of test points for each unique error) and instructors across the country who adopted the first edition. We have hopefully corrected these without introducing too many new ones.

# Acknowledgments

We thank Dolly Gudder, who was involved in all aspects of the writing and compilation of this book, including proofing the entire text, drafting and correcting all the figures from the first edition, library research, writing the first draft of the index, and obtaining permissions. We are forever in her debt. Alan Covich provided extensive conceptual guidance and proofread the text; his input was essential to producing this work. Eileen Schofield-Barkley provided excellent editorial comments on all chapters. The fall of 1998 Kansas State University limnology class proofed Chapters 1 through 8 and 11 through 18. The Kansas State University limnology classes proofread all chapters (especially Michelle Let) and graciously field tested the text in draft form. The L.A.B. Aquatic Journal Club, Chuck Crumly, Susan Hendricks, Stuart Findlay, Steve Hamilton, Nancy Hinman, Jim Garvey, Chris Guy, and Al Steinman provided suggestions on the first edition. Early helpful reviews on book concepts were provided by James Cotner, David Culver, Jeremy Jones, Peter Morin, Steven Mossberg, Stuart Fisher, Robert Wetzel, and F. M. Williams. The anonymous reviews (obtained by the publisher) are also greatly appreciated, including those who completed a detailed survey on the prospect of a second edition. Many of the good bits and none of the mistakes are attributable to these reviewers. We appreciate the support of the Kansas State University Division of Biology, the Kansas Agricultural Experiment Station, and Southern Illinois University at Carbondale. This is publication 10-207-B from the Kansas Agricultural Experiment Station.

Thanks for corrections from the Freshwater Ecology classes at Kansas State University with particular thanks to Katie Bertrand and Andrea Severson. Thanks to Lydia Zeglin for help on describing molecular methods. Excellent suggestions for corrections of the first edition also came from Robert Humston, David Rogowski, John Havel, Sergi Thomas, Daniel Welsh, Erika Iyengar, Matt McLammany, Jack Webster, and Robert Humston. Kabita Ghimire produced the global distribution maps of freshwater habitats. Keith Gido, James Whitney, and Joe Gerken helped clarify Chapter 23. Thanks to Erika Martin, Joshua Perkin, and Kyle Winders for detailed review of the entire draft manuscript from the



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Walter K. Dodds thanks his teachers over the years who guided him so well down the academic path: Ms. Waln, Steve Seavey, John Priscu, and especially Dick Castenholz and Eric Wickstrom. His students (Chris, Eric, Ken, Michelle, Mel, Randy, Nicole, Bob, Jon, Kym, Jessica, Justin, Alyssa, Kyle, Alex, and all the others) have kept asking the questions that fuel imagination. Walter's parents initiated his fascination for nature, and the encouragement of his siblings and in-laws kept him going. Dolly made it all possible.

Matt R. Whiles thanks F. E. Anderson, L. L. Battaglia, J. E. Garvey, J. W. Grubaugh, R. O. Hall, A. D. Huryn, K. R. Lips, R. Lira, and S. D. Peterson for valuable input and advice on this work. His early mentors, M. E. Gurtz, C. M. Tate, G. R. Marzolf, and J. B. Wallace provided guidance at critical points of his life and helped him realize that he could actually make a career out of his interests in ecology. His parents, Jim and Jane, and his sister, Wendy, tolerated and even supported his somewhat odd boyhood interests and laid the foundation for all of this. His wife, S. G. Baer, provided endless support, encouragement, and advice, and his recent and current graduate students (Amanda, Catherine, Checo, Dan, David, Eric, Jodi, Kaleb, Kim, Natalie, Therese) provided inspiration and tolerated him throughout this process.

Our children, Hannah, Joey, Sadie, and Rowland, put it all in perspective; the next generation is the reason this text includes environmental applications. We both deeply appreciate the support and love of our families.

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