
Stream Ecology

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Stream Ecology

Structure and Function of Running Waters

Third Edition

 Springer

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Cover photo: Students conducting macroinvertebrate sampling in the Guare River, Venezuela

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Dedicated to our families, and to colleagues, students, and all those whose efforts advance our understanding of flowing waters to protect them for future generations

Preface to the Third Edition

The underlying science of stream ecology has undergone dramatic advances since the first edition over 20 years ago. The subject matter of other disciplines increasingly must be addressed, including hydrology, geomorphology, an array of topics in the earth sciences and biogeochemistry, along with advances in socioeconomic studies. The published literature is enormous, spread across many different professional journals. We cannot do justice to all of these advances, but hopefully, we have provided an entry point for readers new to the field. Some of the material will be challenging to some readers, depending on background. Each chapter has a summary that clarifies the main ideas covered, and it may be helpful to view that first, to keep the main ideas in focus.

This Third Edition of *Stream Ecology* will be used primarily in electronic form, as an e-book, and viewers will have the opportunity to acquire individual chapters rather than the entire book. Recognizing that readers may not have the opportunity to refer back and forth among different chapters, we have made an effort to ensure that each chapter can stand alone. The result is a moderate amount of repetition, which we hope will serve either as a useful explanation or reminder, ensuring that each chapter's narrative is accessible without depending upon significant cross-referencing to other chapters.

We are grateful to many individuals who have discussed ideas and shared references with us in preparation of this Third Edition of *Stream Ecology*. We especially thank a number of colleagues who read and improved earlier versions of chapters, including Sebastian Birk, Alex Flecker, Hal Halvorson, Nick Hudson, Susan Jackson, Peter McIntyre, Thomas Parr, LeRoy Poff, Amber Ulseth, and Ellen Wohl. We also appreciate the generosity of colleagues who shared or helped us acquire photographs, including Francesco Comiti, Carolyn Cummins, Chris Dutton, Jeff Duda, John Gussman, Angus McIntosh, Jeremy Monroe, Luca Messina, Jim O'Connor, Julian Olden, Amanda Subalusky, and John Warrick. We are especially grateful to Jesús Montoya for his excellent work in figure preparation. We appreciate the support of our editors Judith Terpos and Nel van der Werf during the preparation of this edition, and the efficient work of their production team.

Although the material in this third edition is substantially modified and updated, it nonetheless includes material from previous editions. We acknowledge our debt to many wonderful colleagues, who provided helpful guidance to previous editions of *Stream Ecology*.

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Preface to the Second Edition

The diversity of running water environments is enormous. When one considers torrential mountain brooks, large rivers of lowlands, and great rivers whose basins occupy subcontinents, it is apparent how location-specific environmental factors contribute to the sense of uniqueness and diversity of running waters. At the same time, however, our improved understanding of ecological, biogeochemical, hydrological, and geomorphological processes provides insight into the structural and functional characteristics of river systems that brings a unifying framework to this field of study. Inputs and transformations of energy and materials are important in all river systems, regional species richness and local species interactions influence the structure of all riverine communities, and the interaction of physical and biological forces is important to virtually every question that is asked. It seems that the processes acting in running waters are general, but the settings often are unique.

We believe that it helps the reader, when some pattern or result is described, to have some image of what kind of stream or river is under investigation, and also where it is located. Stream ecology, like all ecology, depends greatly on context: place, environmental conditions, season, species. The text includes frequent use of descriptors like “small woodland stream”, “open pastureland stream”, or “large lowland river”, and we believe that readers will find these useful clues to the patterns and processes that are reported. For most studies within North America we have included further regional description, but have done so less frequently for studies from elsewhere around the globe. We apologize to our international readers for this pragmatic choice, and we have made every effort to include examples and literature from outside of North America.

Some locations have established themselves as leading centers of study due to the work of many researchers carried out over decades. The Hubbard Brook Experimental Forest in New Hampshire, Coweeta Hydrologic Laboratory in North Carolina, and some individual streams including Walker Branch in Tennessee, Sycamore Creek in Arizona, Río Las Marias in Venezuela, and the Taieri and Whatawhata in New Zealand, are locations that appear frequently in the pages that follow. Knowing what these places are like, and how they may or may not be typical, in our view justifies the frequent use of place names and brief descriptions. The names of organisms also appear frequently and may at first overwhelm the reader. It may be easiest to pay them little attention until they gradually become familiar. Ultimately it is difficult to really comprehend the outcome of a study without some appreciation for the organisms that were present.

As is true for every area of ecology in present time, the study of streams and rivers cannot be addressed exclusive of the role of human activities, nor can we ignore the urgency of the need for conservation. This is a two-way street. Ecologists who study streams without considering how past or present human modifications of the stream or its valley might have contributed to their observations do so at the risk of incomplete understanding. Conservation efforts that lack an adequate scientific basis are less likely to succeed. One trend that seems safe to forecast in stream ecology is toward a greater emphasis on understanding human impacts. Fortunately, signs of this trend are already apparent.

We have organized the flow of topics in a way that is most logical to us, but no doubt some readers will prefer to cover topics in whatever order they find most useful. For this reason, we have strived to explain enough in each chapter that it is comprehensible on its own. This leads to a certain amount of intentional repetition, which we hope will provide clarification or a reminder that will benefit the reader's understanding.

We are extremely grateful to the many colleagues who shared ideas, provided references, and reviewed chapters in draft form. Space doesn't permit us to thank everyone who answered a query with a helpful explanation and suggestions for source material; however we do wish to acknowledge the individuals who carefully read and improved our chapters. Any remaining shortcomings or errors are the authors' responsibility, but hopefully these are few, thanks to the efforts of: Robin Abell, Brian Allan, Fred Benfield, Barb Downes, David Dudgeon, Kurt Fausch, Stuart Findlay, Alex Flecker, Art Gold, Sujay Kaushal, Matt Kondolf, Angus McIntosh, Peter McIntyre, Rich Merritt, Judy Meyer, Pat Mulholland, Bobbi Peckarsky, LeRoy Poff, Brian Roberts, Doug Shields, Al Steinman, Jan Stevenson, Jen Tank, Paul Webb, Jack Webster, Kevin Wehrly, and Kirk Winemiller. All were generous with their time and their knowledge, and we are in their debt.

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Other individuals provided invaluable assistance with important aspects of manuscript production. Mary Henja and Jamie Steffes did extensive proof reading and arranged all the figure permissions. Haymara Alvarez, Susana Martinez and Dana Infante assisted with production of figures, and Jesus Montoya did a superb job of taking figures made in many different styles and re-drafting them to a common style and high quality. Funding for MMC release time and travel to Michigan was provided by Dirección de Desarrollo Profesional de Universidad Simon Bolivar, and the Horace H Rackham School of Graduate Studies of the University of Michigan. We also wish to thank our editors at Springer, Suzanne Mekking and Martine van Bezooijen, and our prior editor Anna Besse-Lototskaya, for their support, encouragement, and patience. It has been a pleasure to work with them all.

Lastly, our deepest thanks go to our families for their love and support, and we must admit for a good deal of tolerance as well, during the writing of this book. It has been an enjoyable experience for both of us, and we hope that the current edition will serve as a useful guide for the next generation of stream ecologists.

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Krista A. Capps is an Assistant Professor in the Odum School of Ecology and the Savannah River Ecology Laboratory at the University of Georgia. Her research is dedicated to understanding how anthropogenic activities alter community structure and ecosystem processes in temperate and tropical freshwater ecosystems. She attempts to view her research through a social-ecological lens, acknowledging the powerful impacts that public policy and economic considerations can have on the quality and quantity of freshwater resources, the abundance and diversity of aquatic organisms, and the function of freshwater ecosystems.