Shark Research

Emerging Technologies and Applications for the Field and Laboratory

EDITED BY

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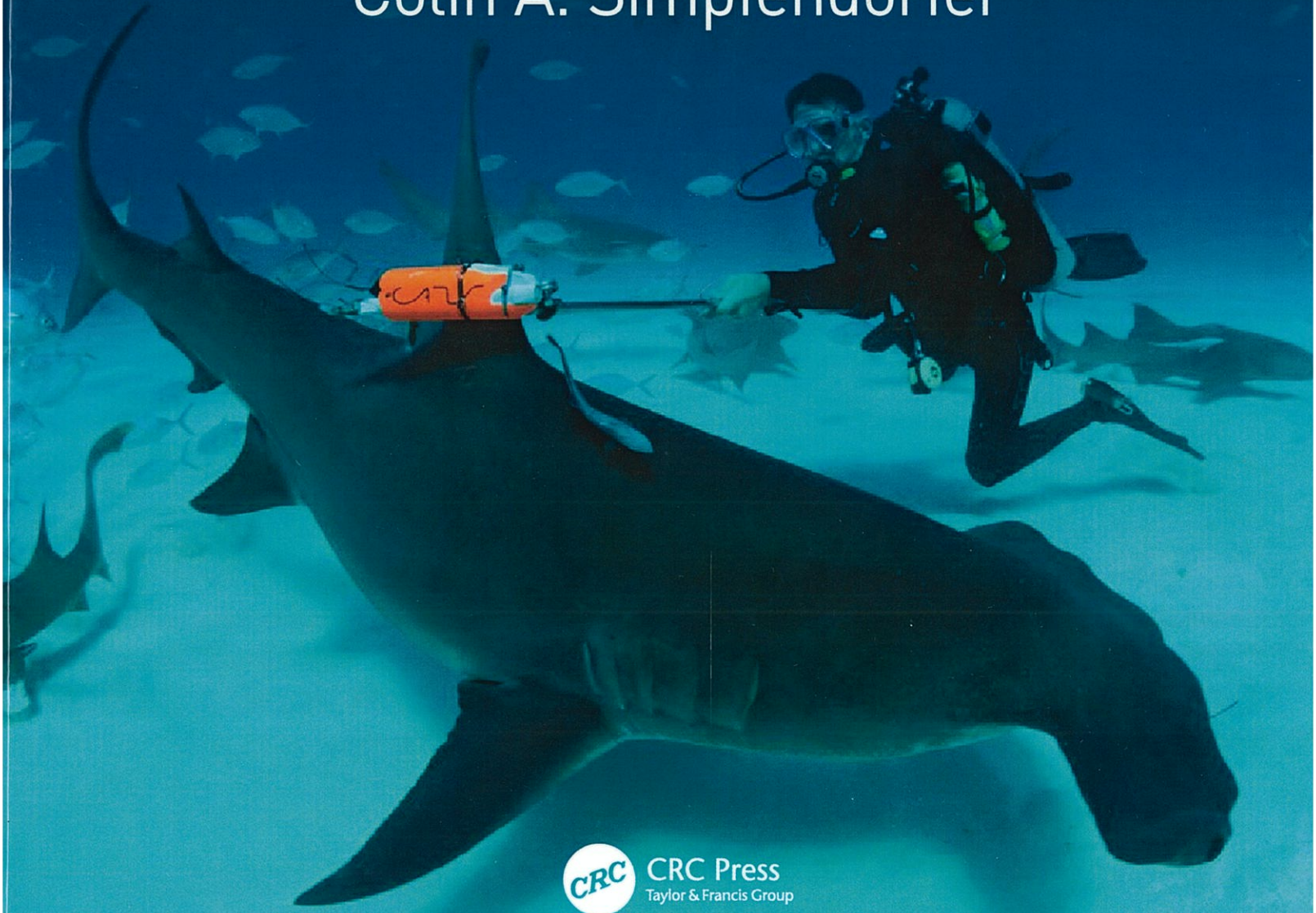

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Preface

The remarkable pace of advancements in technology, particularly in the last two decades, has contributed to the development of a toolbox that greatly enhances the range of investigations into the biology and life history of elasmobranchs. In our preface to *The Biology of Sharks and Their Relatives* in 2004, Jack Musick, Mike Heithaus, and I hinted at the potential impact of these advances when we noted that

> ... virtually every area of research associated with these animals has been strongly impacted by the revolutionary growth in technology, and the questions we can now ask are very different than those reported in [Perry] Gilbert's work not so long ago. A careful reading of the chapters we have presented in this work will show conclusions based on emergent technologies that have revealed some long-hidden secrets of these animals. Modern immunological and genetic techniques, satellite telemetry and archival tagging, modern phylogenetic analysis, GIS, and bomb dating are just a few of the techniques and procedures that have become a part of our investigative lexicon.

Even then we did not anticipate the magnitude of expansion that was to occur in the 15 years since that volume was produced and the improvements that would occur to existing methods. Now, biologists, field biologists and laboratory biologists alike, are faced with a bewildering array of techniques and instruments with which to investigate almost every aspect of elasmobranch biology. From traditional studies of comparative morphology to satellite tracking and the almost limitless uses of DNA for examining species relatedness and assessing variability within and between populations, the questions that can be asked and the data that can be obtained for analysis are providing new insights and understanding of this ancient line of aquatic vertebrates.

The dilemma facing investigators, with such an extensive array of tools and techniques, is which investigative approach is most appropriate for a particular line of inquiry. Knowing how to use technology also assumes that the right choices are made with regard to selecting instruments and methodologies that will provide answers that are relevant to a particular line of inquiry. This applies not only to the technology or approach that is applied but also to the analytical methods with which the collected data are analyzed. Increases in computer power and statistical methods have progressed at rates similar to those of the technology applied to study these animals. One example of this is network analysis (Chapter 18), which until recently had not been applied to sharks or rays but is now a fundamental tool in the analysis of data across a number of data collection techniques.

When we began this project, our goal was straightforward: We intended to feature chapters presenting the various techniques and applications we identified as being among the most useful approaches to broadening the ways we could better investigate and understand the biology and life history attributes of elasmobranch species. Although some technologies, such as acoustic tracking, have been present for many years, miniaturization, data storage, and battery technology, as well as advanced approaches to analysis of increasingly large volumes of data, have helped to improve upon these tried and tested techniques and long-accepted approaches. Outlining these changes was as important as introducing newer, more novel investigative approaches. We were also fully aware that no single volume could hope to present every possible technique, instrument, or technological advancement. Perhaps later volumes will expand on our initial attempts.

Each chapter is designed to identify the types of studies that are appropriate for the use of the various technologies presented within each chapter, the kinds of results that can be expected from their use, and what information the studies reveal that advances our understanding of elasmobranch biology. Most certainly these techniques are equally applicable to studies of other marine groups, as well.

Of equal importance, we also believed that each chapter should include a discussion of where such techniques are inappropriate, not likely to succeed, or are otherwise probably not applicable to the study of elasmobranch biology. Choosing an inappropriate study methodology simply leads to wasted time and dashed expectations. We hoped that our treatments would prevent investigators from making such mistakes or having unrealistic expectations. In that sense, the chapters serve as a rudimentary "how to," at least with respect to making more informed choices about a particular approach to address questions of biological interest. We expected that such information would prove useful to students just beginning their formal studies of elasmobranch biology while also serving as a guide for more seasoned scientists seeking to apply new techniques to ongoing studies. Our hope is that we have succeeded in serving both groups.

Our authors are a diverse group, all of whom have strong records of scholarship and all of whom have served as pioneers and leaders in applying these technologies to their own investigations. They thus provide a knowledge base from practical experience that we expect to serve as a valuable resource for our readers. We hope the information and "advice" we have assembled will accomplish that goal.

Editors

Jeffrey C. Carrier, PhD, is professor emeritus of biology at Albion College, Michigan, where he was a faculty member from 1979 to 2010. He earned a bachelor of science degree in biology in 1970 from the University of Miami and completed a doctorate in biology from the University of Miami in 1974. While at Albion College, Dr. Carrier received multiple awards for teaching and scholarship and held endowed professorships in biology. His primary research interests center on various aspects of the physiology and ecology of nurse sharks in the Florida Keys. His most recent work investigated the reproductive biology and mating behaviors of this species in a long-term study from an isolated region of the Florida Keys. Dr. Carrier's projects with acoustic telemetry, animal-borne video, ultrasound and endoscopy, and baited remote underwater video systems drive his interest in applications of technology to the study of the biology of sharks and their relatives. Dr. Carrier has been a long-time member of the American Elasmobranch Society, the American Society of Ichthyologists and Herpetologists, Sigma Xi, the Society for Animal Behavior, and the Council on Undergraduate Research. He served multiple terms as president of the American Elasmobranch Society and received several distinguished service awards from the society. He holds an appointment as an adjunct research scientist with Mote Marine Laboratory's Center for Shark Research. In addition to his publications in the scientific literature, he has written and edited five previously published books on sharks and their biology.

Michael R. Heithaus, PhD, is a professor in the department of biological sciences and dean of the College of Arts, Sciences and Education at Florida International University (FIU) in Miami, Florida, where he has been a faculty member since 2003. He received his bachelor of arts degree in biology from Oberlin College, Ohio, in 1995 and his doctorate from Simon Fraser University, Burnaby British Columbia, in 2001. He was a postdoctoral scientist and staff scientist at the Center for Shark Research and also served as a research fellow at the National Geographic Society's Remote Imaging Department. At FIU, Dr. Heithaus served as the director of the Marine Sciences Program before becoming the director of the School of Environment, Arts, and Society. Dr. Heithaus is a behavioral and community ecologist. His main research interests are in understanding the ecological roles and importance of large predators, especially their potential to impact community structure through nonconsumptive effects. His work also explores the factors influencing behavioral decisions, especially of large marine taxa, including marine mammals, sharks and rays, and sea turtles, and the importance of individual variation in behavior in shaping ecological interactions. Dr. Heithaus is the co-lead of the Global FinPrint project, a worldwide survey of elasmobranchs on coral reefs. His lab is engaged in marine conservation and research projects around the world, including ongoing long-term projects in Shark Bay, Australia, and the coastal Everglades of southwest Florida.

Colin A. Simpfendorfer, PhD, is a professor in the College of Science and Engineering at James Cook University, Queensland, Australia, and currently serves as the associate dean for Research. He has also worked at the Center for Shark Research at Mote Marine Laboratory, Sarasota, Florida, and the Shark Fisheries Section of the Western Australian Department of Fisheries, Perth, Australia. He received his bachelor of science degree in marine biology and zoology in 1986 and doctorate in fisheries science in 1993, both from James Cook University. He has spent his career studying the life history, ecology, status, and conservation of sharks and rays with the principle aim of providing scientific information for improving their management. He regularly provides scientific advice to governments, nongovernmental organizations, and industry. He has been at the forefront of applying new technology and approaches to sharks and rays, including early work on the analysis of acoustic telemetry data, using eDNA as a means of surveying for critically endangered sawfish, and he is a principle investigator for the Global FinPrint project, surveying sharks and rays on coral reefs globally. Dr. Simpfendorfer is an author of over 200 peer-reviewed scientific papers on sharks and rays and has trained more than 30 master of science and doctoral students, some of whom have authored or co-authored chapters in this book. He is currently the co-chair of the IUCN Shark Specialist Group, which works to improve the conservation status of this important group of ocean predators by assessing their status, developing conservation plans, and delivering quality scientific information to decision makers. He also serves on Australia's national Threatened Species Scientific Committee.

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