

Place Matters

Geospatial Tools for Marine Science,
Conservation, and Management
in the Pacific Northwest

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Foreword

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A map is the greatest of all epic poems. Its lines and colors show the realization of great dreams.

Gilbert Grosvenor, Editor, National Geographic, 1903 –1954

Two centuries ago, much of the northwestern American continent and most of the adjacent sea were unknown to all but the relatively small number of people whose ancestors had made their way across unexplored, uncharted wilderness ages before. Knowledge of what lay beyond the nearshore waters was earned the hard way, as scraps of information from ships' logs were pieced together to gain insight into currents, the location of islands and reefs, and the configuration of the shoreline. Ocean depths were determined by dropping weighted lines over the side, recording their length, and on a chart placing numbers that were somewhere in the vicinity of their actual location. Notes on vegetation and occurrence of wildlife were based on trudging the terrain and having face-to-face encounters with creatures along the way. Despite the daunting difficulties, explorers Meriwether Lewis and William Clark were inspired by the dream of mapping North America, and they succeeded in developing the first comprehensive image of hills and valleys, mountains and rivers that included much of the Pacific Northwest.

Imagine the amazement of Lewis and Clark if they could see this book of wondrously detailed information about places they struggled to comprehend, one data point at a time.

Early in the twentieth century, U.S. President Theodore Roosevelt took a personal interest in making sure that large tracts of the Pacific Northwest were protected as national parks, a safeguard for the nation's natural, historic and cultural heritage against rapid, often destructive exploitation. Similar actions were taken in Canada, resulting in great expanses of land and wildlife remaining in a relatively natural state. In a few decades, rivers were diverted and dammed, forests leveled, and cities developed, in a geological moment forever altering the distillation of thousands of millennia.

Imagine Roosevelt's astonishment if he could see changes over land and seascapes since his time, and how precious the protected areas have become, now engulfed by largely tamed terrain.

Throughout the 1900s, swift changes were also occurring in the sea, both through natural shifts in the shoreline and in the depths beyond, and through human activities. Offshore, fishing fleets ploughed the ocean floor with trawls and sophisticated new technologies were being applied to find, catch and market fish and other ocean wildlife on an unprecedented scale. Even so, from the surface much seemed unchanged. In 1951, Rachel Carson wrote in *The Sea Around Us*, her celebrated tribute to the ocean, that man “ . . . has returned to his mother sea only on her own terms. He cannot control or change the ocean as, in his brief tenancy on earth, he has subdued and plundered the continents.”

At that time people would not have been familiar with terms such as “geospatial” or “integrated database” and it would take time for them to grasp the capabilities of modern computers, cameras, satellites and sophisticated sensors, but they probably would be quick to comprehend the profound value of these technologies.

Imagine Carson’s delight if she could read this book and discover how much has been discovered about the ocean in half a century – and her dismay about the enormity of what has been lost.

In 50 years, more has been learned about the ocean than during all preceding history, largely owing to new technologies our predecessors could barely imagine. At last, even on cloudy days and foggy nights, with global positioning systems, there is no excuse for not knowing where in the world you are, land or sea. Satellites sweep the Earth making precise navigation routinely possible for one and all. Comprehensive knowledge of sea surface temperature and currents, biological productivity, wind speed and direction, salinity and even the configuration of the seafloor thousands of feet under the ocean’s surface are gathered by satellites hundreds of miles in the sky.

Most wondrous of all, through geographic information systems (GIS) and related technologies, it is now possible to see our place in the world with new eyes, and to comprehend previously elusive connections among the ocean, atmosphere, land and living things. Linkages are revealed, causes and effects determined, and changes over time evaluated using computer analysis coupled with liberal doses of good, common sense. While less than 5% of the ocean below the surface has been seen directly, let alone explored, we nonetheless now comprehend that the ocean is the great blue engine that drives the way the world works, harbors 97% of the water, shapes climate, weather, planetary chemistry and temperature, generates most of the oxygen in the atmosphere, absorbs much of the carbon dioxide, and provides living space for about 97% of life on Earth.

We also now know that the ocean is not limitless in its capacity to accept noxious wastes, nor can it forever yield endless quantities of

wildlife. In 50 years, populations of tuna, swordfish, sharks and other large fish have been reduced by ninety percent. More than a hundred dead zones have developed in coastal regions, worldwide. Coral reefs, kelp forests, seagrass meadows, natural coastal marshes and wetland ecosystems have sharply declined, and even deepwater systems, hosting ancient sponges, corals, and long-lived fish and other sea creatures, are feeling the harsh bite of fishing gear deployed from hundreds or thousands of feet above.

Even in the relatively untrammelled Pacific Northwest, pollution from upstream sources is inexorably altering the chemistry of downstream waters. The land and its living fabric of forests, waters, and wildlife, and the surrounding, living ocean that have made possible the prosperity of people for thousands of years, are now at risk. For the first time, enough data exist to be able see where we have come from, and realistically project where we might be going if we do this thing or that. We can, with good reason, wonder and worry what the consequences to the ocean, to the land, to wildlife, and to ourselves will be if we continue “business as usual.”

Imagine the wrath of generations to come if, knowing what we know, we choose to allow the last 10% of the big fish to be consumed, or choose not to act to protect what remains of the healthy coral reefs, shallow and deep; the kelp stands, and the great blue heart of the living ocean beyond the coasts.

Better yet, imagine the joy of those who look at this book a century or two from now and recognize the wisdom, the strength, and the power of the knowledge articulated here.

The key is to not only admire the good, thoughtful scientific analyses embodied here, but to heed the underlying messages. Johann Wolfgang von Goethe observed many years ago that “It is simply not enough to understand, but to act.” It is not too late to halt the present avalanche of troubling trends and secure an enduring place for ourselves within the natural systems that sustain us. We can, if we will.

Place matters. . . .

Preface

The technologically sophisticated, spatially integrated database information management and display system known as the geographic information system or GIS, has been heralded as “the telescope, the microscope, the computer, and the Xerox machine of regional analysis and synthesis of spatial data” (Ron Abler, Executive Director, Association of American Geographers, 1988). Marine GIS has been touted as an application holding great potential for mapping and interpreting the ocean environment in unprecedented detail, from the seafloor to the sea surface, and from the nearshore, to the shoreline, the estuary and landward. This book is about how marine GIS is contributing to our understanding of the shores and ocean of the Pacific Northwest (i.e., northern California, Oregon, Washington, British Columbia, Yukon Territory, and Alaska, with some treatment given to southern California as well). With access to a plethora of data made easier by the Internet and the World Wide Web, and with improved, cheaper computer hardware and software, GIS is now functionally available to large segments of the population. This not only increases the utility of GIS for basic science and exploration of the marine environment, but also creates new opportunities for participatory management and cooperative research in the marine realm. The Pacific Northwest is emerging as a veritable hotbed of marine GIS research and development, with practitioners expanding the increasingly crucial technical role of GIS for ocean research, and its application to a variety of ocean science, policy and management issues.

This book is based on a special symposium that was held at the Annual Meeting and Science Innovation Exposition of the American Association for the Advancement of Science (AAAS), February 2004 in Seattle, Washington. For the first time, this prominent meeting, which attracts more science and science policy leaders than any other single meeting in the United States, sponsored a marine science track entitled “Living Oceans and Coastlines,” consisting of twelve special symposia on research frontiers in coral reef studies, fisheries, marine mammals and marine birds, aquaculture, ecosystem-based marine management, design and assessment of marine protected areas, and general marine policy. The symposium “Place Matters: Geospatial Tools for Marine Science, Conservation, and Management” was one of two that specifically addressed issues of geospatial data and analysis in the oceans. In the symposium, scientists and practitioners from academic institutions, government agencies, and environmental organizations showcased how they are using marine GIS to handle and exploit present and future data streams from observatories, experiments, numerical models, and other sources, yielding insights into oceanographic,

ecological, and socioeconomic conditions of the marine environment in the Pacific Northwest. The authors of chapters in this book were either participants in the AAAS symposium, or were invited to contribute their work on closely related projects elsewhere along the West Coast in order to round out the geographic range and policy applications of the selections combined here. The book is divided into three major sections: the first section is conceptual, laying out selected methods and models for conservation-based marine GIS; the second section describes working examples of marine GIS tools and large-scale implementations; while the third section focuses on the use of GIS by various environmental advocacy and local citizens' organizations. An epilogue includes a brief summary of consensus findings, but, more importantly, covers some of the most pressing theoretical challenges in marine and coastal GIS, and provides some insight into future trends in data access and exchange, representation, and modeling of marine data. We acknowledge with gratitude the comments of two anonymous reviewers, which significantly improved the entire book manuscript, as well as the support and patience of the editorial staff at Oregon State University Press.

With the emergence of area-based management of fisheries and marine ecosystems, and the importance and prominence of marine and other environmental issues in the Pacific Northwest, this book should be of particular interest to a variety of scientific and lay readers. The accompanying Web site (<http://www.ecotrust.org/placematters>) includes some of the actual GIS tools, maps, and datasets that were developed or used by chapter authors, the Power Point files of the presentations given at the AAAS session, and some additional Web-based resources. All of these should be particularly helpful for use in high school or university classrooms, or professional workshops. GIS databases and tools are indeed on the leading edge of science, and help integrate various scientific disciplines and data sources to address management questions. With the ability to overlay biological, geological, and socioeconomic information, GIS tools bring together an interdisciplinary scientific audience, as well as managers, conservationists and other constituencies interested in the end products. Both in substance and practice, the use of GIS is pushing the community of researchers and practitioners towards increased collaboration, infrastructure and technical innovations, and creative meshing in hard-hitting policy arenas.

This is an exciting time, as scientists, managers and conservation organizations—often in collaboration with each other—are making advances in the way that data are collected, documented, used, shared, and saved. We hope that this book, and the accompanying materials on the companion Web site (<http://www.ecotrust.org/placematters>), help to either show the way, or to add inspiration and ideas to current efforts.

We wish to thank two anonymous referees for their careful and thoughtful reviews of all the chapters, which significantly improved the book's manuscript.

A final note on nomenclature: Usage of terms and units of measurement are kept consistent within each chapter, but may vary across chapters. Typically, authors working in more academic settings use metric units, while researchers working in management contexts use the imperial units of nautical charts and agency datasets. Similarly, people working in fishing communities tend to adopt the term "fishermen" used by both fishing men and women to refer to themselves, rather than "fisher."

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