Preface

The southern California salt marshes and my many collaborators are the reasons for this book. We uncovered many secrets that can be observed and studied further. If you learn how we uncovered so many secrets about salt marshes, you can add to that knowledge, as well as apply similar approaches to uncovering secrets in other kinds of ecosystems. All it takes is an inquisitive mind and encouragement that you can contribute new knowledge through careful observation and testing. You too can contribute sound science.

The salt marshes of southern California are unique, and visitors who want to learn their secrets need background information from this region. Nearly every textbook that mentions our Nation's salt marshes emphasizes those along the Atlantic and Gulf of Mexico Coasts. Also, much of the earliest knowledge about US salt marshes was developed in Georgia. While Georgia's latitude is similar to that of southern California, the salt marshes are very different. The following comparison chart shows why we should not generalize from GA to southern California.

	Southern California	Georgia
Coastal landscape and watershed	Narrow coastal shelf, small area for salt marshes. Coastal upwelling provides nutrients to coastal waters. Nearby mountains lead to small, separated watersheds.	Broad coastal plain, large watersheds, large riverine influence, extensive salt marsh plains.
Climate and river influence	Mediterranean-type climate, moderate temperatures year-round. Rarely humid. Minimal rainfall (10"/yr), most in cool months, Nov. - March. Salt marshes linked to large watersheds experience major river flooding, but only rarely.	Temperate climate. Considerable rainfall. Major influence of river waters, which dilute salinities at the coast. Estuaries have regions of low to seawater salinity. Cold winters, warm humid summers.
Tidal regime	Semidiurnal mixed tides, 2 unequal low tides and 2 unequal high tides per day. Upper marsh tends to dry with only 1 higher tide per day. Daytime low tides in summer lead to hypersaline marsh plain soils.	Semidiurnal tides, 2 equal low tides and 2 equal high tides per day. Upper marsh is wetted by 2 high tides/day. Marsh soils are less saline with river influence.
Native vegetation	Hypersaline marsh plain supports mostly succulents; Pacfic cordgrass (*Spartina foliosa*) occupies a narrow fringe along channels that have daily tidal influence and less hypersaline soil. Cordgrass and succulent canopies are usually <1m tall; sunlight penetrates to the soil.	Smooth cordgrass (*Spartina alterniflora*) occupies vast marsh plains. It does not tolerate extreme hypersalinity. It usually grows >1m tall, produces dense stems that form a dense canopy that absorbs most of the sunlight. Soil surface is darker.
Epibenthos (above the soil)	Bluegreen algae and diatoms thrive on the marsh soil year-round, often growing up the stems of vascular plants. Green algae are abundant in spring (March) when daytime tidal amplitudes are minimal.	Darkness under the dense cordgrass limits algal growth. Two daily high tides add "shade" and scour surface algae, especially diatoms that are loosely attached to the substrate.

How to use this book

Everyone—feel free to download and print sections for your own use, especially when visiting a salt marsh in southern California. Some artwork is copyrighted and not to be reproduced for profit. A few photos, especially aerial shots, are quite old and I'm uncertain about their origin. Other photos that lack a credit are ones I took over the years; if you'd like to use them for another purpose, I'd appreciate credit. Please email me (jbzedler@wisc.edu) so I can verify that I took the photo, and let me know where the photo will appear. I like knowing how our research is being used!

This book complements the Middle and High School Curriculum and *Tijuana Estuary High School Teacher's Guide – Grades 6-12* (http://trnerr.org/high-school-curriculum/), as well as Estuaries 101 Curriculum, which is NOAA's on-line science curriculum from the National Estuarine Research Reserve System (http://estuaries.noaa.gov/Teachers/HighSchool.aspx).

Suggestion for teachers and tour leaders—ask students to list things that we don't know about the salt marsh that we should know to conserve and restore it. See if they can modify the approaches we used in the past to meet the needs of the future.

Suggestion for Adaptive Managers—ask students and visitors to help design experiments that can be conducted in future restoration modules at wetlands throughout southern California. Workshops might be in order to brainstorm and capitalize on opportunities to "learn while restoring."

Suggestion for all. Read more about salt marshes! Here's how to look up references mentioned in the text and listed in chapter twenty. CSU and UC libraries should have the journals in which research papers have been published.

A sample reference: Morzaria-Luna, H. N., and J. B. Zedler. 2014. Competitive interactions between two salt marsh halophytes across stress gradients. *Wetlands* 34:31-42.

Authors are: H. N. Morzaria-Luna and Joy B. Zedler.

Year published: 2014 (Note: the work is often older than the year when it gets published)

Title of the paper: "Competitive….gradients."

Journal (or book) where the paper is published: *Wetlands*. This is a peer-reviewed journal, so professionals have evaluated and approved the work, usually after the author(s) made changes required by a journal editor.

Volume and pages: "34:31-42" stands for volume 34, pages 31- 42.

Why I wrote this book

I wrote this book to engage the next generation in understanding how salt marshes look and perform. I appreciate the tremendous learning capacity of today's youth and the shortage of stories about environmental science. There aren't many books about plants and vegetation besides textbooks. I aimed to make plants and ecosystems understandable. I want to show the next generation ways to learn why nature is the way it is and to predict how it might change in decades to come.

I also wrote this book to highlight the research of several, but certainly not all, of my collaborators. Twelve students earned Ph.D. degrees and 65 earned M.S. degrees under my wings. Many more carried out undergraduate projects or took my classes and asked questions that made me think. A few conducted research with me after obtaining a Ph.D. or M.S. degree, and some continued to collaborate long afterward as a postdoctoral or post-MS fellow. Brief biographies of collaborators mentioned in this e-book appear in chapter twenty-one. Thank you for all your contributions to southern California salt marsh ecology. You are an awesome group of people!

I wrote the book to help fulfill the missions of many funding sources. To deserve research funding year after year requires several steps, namely, to 1. identify knowledge gaps, 2. figure out how to fill them, 3. write compelling proposals with reasonable budgets, 4. administer the funds responsibly, meeting objectives even when budgets have been cut, 5. identify the best research assistants and collaborators, 6. facilitate creative work, 7. publish the findings in a timely manner, 8. share new knowledge with a broad range of "users," and 9. give more than was promised. This e-book clearly satisfies #9. I made time to write for a younger audience after completing and publishing the scientific work for academic peers, and guidebooks for agencies and restoration practitioners.

I wrote this book to support the efforts of many nongovernmental organizations who have acquired, protected, managed, and restored southern California coastal wetlands. Special thanks go to the Southwest Wetlands Interpretative Association; the Friends of Famosa Slough, Los Peñasquitos Lagoon Foundation, the Ballona Institute, and Los Cerritos Wetlands Land Trust. I know there are more citizen groups, and I appreciate all your efforts to conserve salt marshes!

Thanks for funding our research

The most important sources of research support came from the following: Two academic homes, San Diego State University (SDSU; 1969-1998, and professor emerita thereafter) and University of Wisconsin-Madison (UW; 1998-present). SDSU hosted the Pacific Estuarine Research Laboratory (PERL), which I established in 1986, and which John Callaway, Sharook Madon, and Janelle West guided after I moved to UW in 1998. SDSU designated Tijuana Estuary as an Auxiliary Field Station for its ability to support research. Beginning in 1998, UW helped attract graduate students to continue salt marsh research.

Funding conveyed by Earth Island Institute supported research to restore Southern California coastal wetlands, much of which is described in this book.

Who is the Earth Island Institute? Quoting their website: "a non-profit, public interest, membership organization that supports people who are creating solutions to protect our shared planet…..For 25 years, Earth Island Institute has been a hub for grassroots campaigns dedicated to conserving, preserving, and restoring the ecosystems on which our civilization depends." David R. Brower (1912-2000) founded Earth Island Institute in 1982 to be an umbrella organization for ecosystem conservation, preservation and restoration. Consistent with that goal, the Earth Island Institute and dozens of other environmental groups are now housed in the David Brower Center in Berkeley, California. Among the institute's objectives are: "Educating the diverse youth and communities of Southern California, supporting locally based restoration efforts, bringing back the long buried creeks and streams, connecting the waters of the mountains to the sea, allowing fish safe passage upstream, and restoring our fragile coastal habitats." This e-book (and my entire career in restoration ecology) speaks to that mission.

Funding from the California Sea Grant Program in conjunction with the California State Resources Agency supported peer-reviewed projects and Sea Grant Trainees. Sea Grant aims to solve problems and disseminate knowledge. Our work complemented efforts of Dr. Chris Onuf at UC-Santa Barbara, with results that led to stronger science and broader regional perspectives.

CalTrans funded PERL to monitor of their salt marsh mitigation project in San Diego Bay. Salt marshes were restored and constructed to provide habitat for three endangered species; US Fish and Wildlife Service (FWS) established specific criteria for each species; PERL determined which criteria were met; FWS judged whether efforts were in compliance with those criteria.

The National Oceanic and Atmospheric Administration's National Estuarine Research Reserve System of the Office of Ocean and Coastal Resource Management (Sanctuaries and Reserves Division) provided funding for graduate research fellowships.

The California State Coastal Conservancy organized and implemented plans for salt marsh restoration in Tijuana Estuary, including the Tidal Linage and Model Marsh. They were leaders in adaptive restoration—the restoration of sites as large field experiments. Thank you! Many coastal wetlands that have been restored or planned for restoration have received guidance from the State Coastal Conservancy.

Two ambitious restoration experiments were supported by the National Science Foundation. The experimental restoration of the Tidal Linkage tested the effect of biodiversity on ecosystem functioning and the Model Marsh experiment tested many facets of topographic heterogeneity theory. Both projects benefited from NSF Research Assistantships. Construction costs came from multiple sources, including FWS.

The US Geological Service established an office of its Biological Research Division in San Diego, which supported experimentation on a federally endangered plant and other salt marsh halophytes at the PERL greenhouse.

Thanks for supporting this document

Dr. Paul Zedler (plant ecologist and Associate Director of UW's Nelson Institute of Environmental Studies) and our daughters, Dr. Sarah (a modeler in physical oceanography) and Dr. Emily (a modeler in fluid dynamics and engineering), encouraged the project. The possibility that our grandchildren, Dana and Rick, might read it someday kept me writing.

Former students and collaborators reviewed sections of the document and helped me remember details. Read their bios to learn where they landed after uncovering secrets about southern California salt marshes! Perhaps they will inspire you as they have inspired me.

Jeff Crooks and the Tijuana River National Estuarine Research Reserve generously agreed to post downloadable files on their web site, making the document available globally. Thank you!

Regrets for not including every story

In recording my memories of 40+ years of salt marsh research, there were more stories than I could transfer to the keyboard. I am grateful for the work and people who are not included. Dean Donald Short facilitated the work of PERL at SDSU; university staff handled grants; departmental faculty served on thesis committees; hourly workers helped in a million ways; resource agency staff protected salt marshes; nongovernmental organizations and citizens supported salt marsh conservation. All were building blocks that helped the Pacific Estuarine Research Lab provide science-based information. To all, a huge

thank you!