

Invitation to

# Oceanography

Web Enhanced Edition

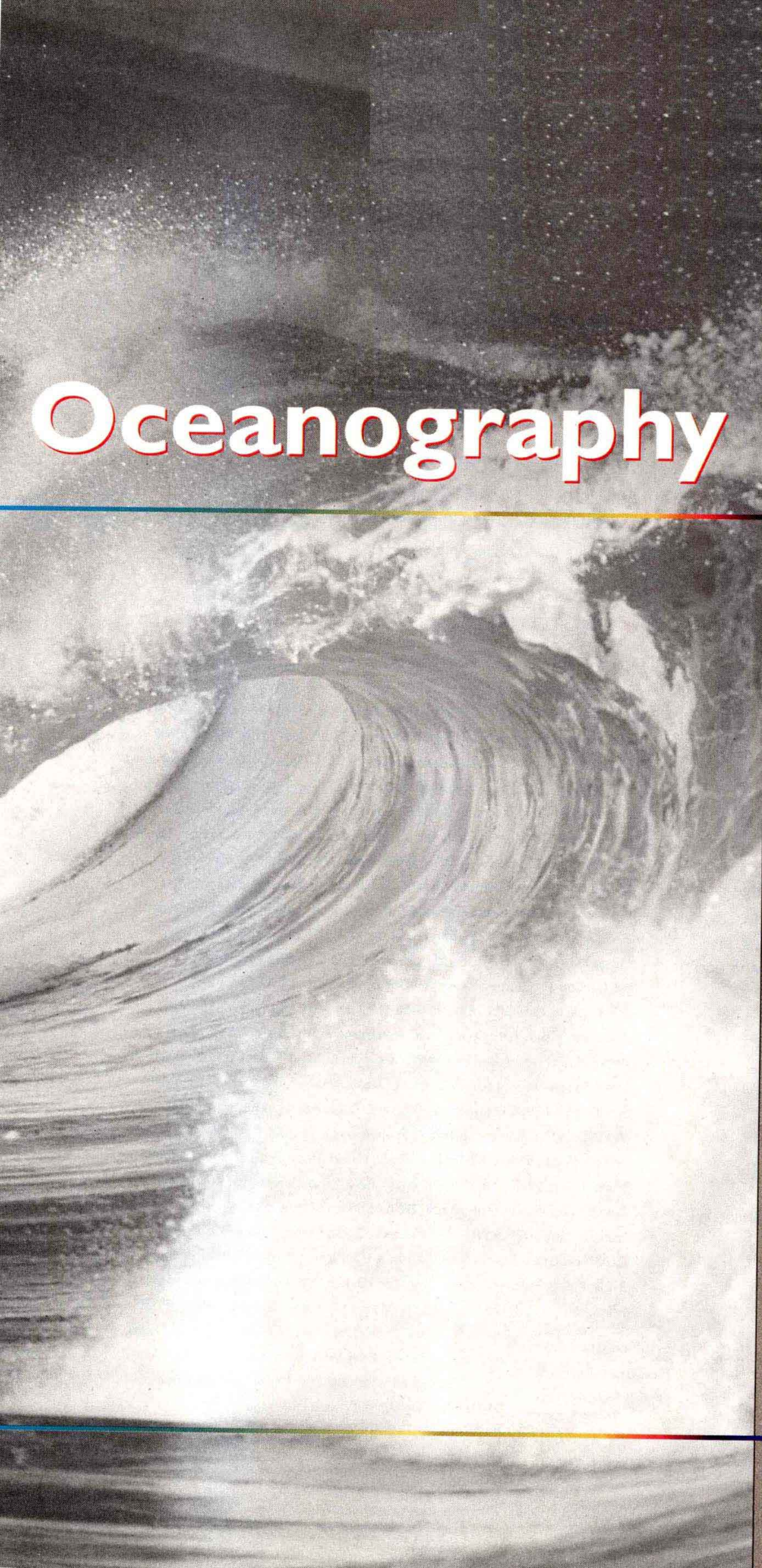
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OceanLink



Paul R. Pinet





# Oceanography

Web Enhanced Edition

Paul R. Pinet  
COLGATE UNIVERSITY



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## ■ DEDICATION

*Marita E. Hyman*

A wise, passionate, caring partner who shares  
her life with me living on a special parcel of  
land on a large Earth in a vast universe.

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(Continued on page 508)

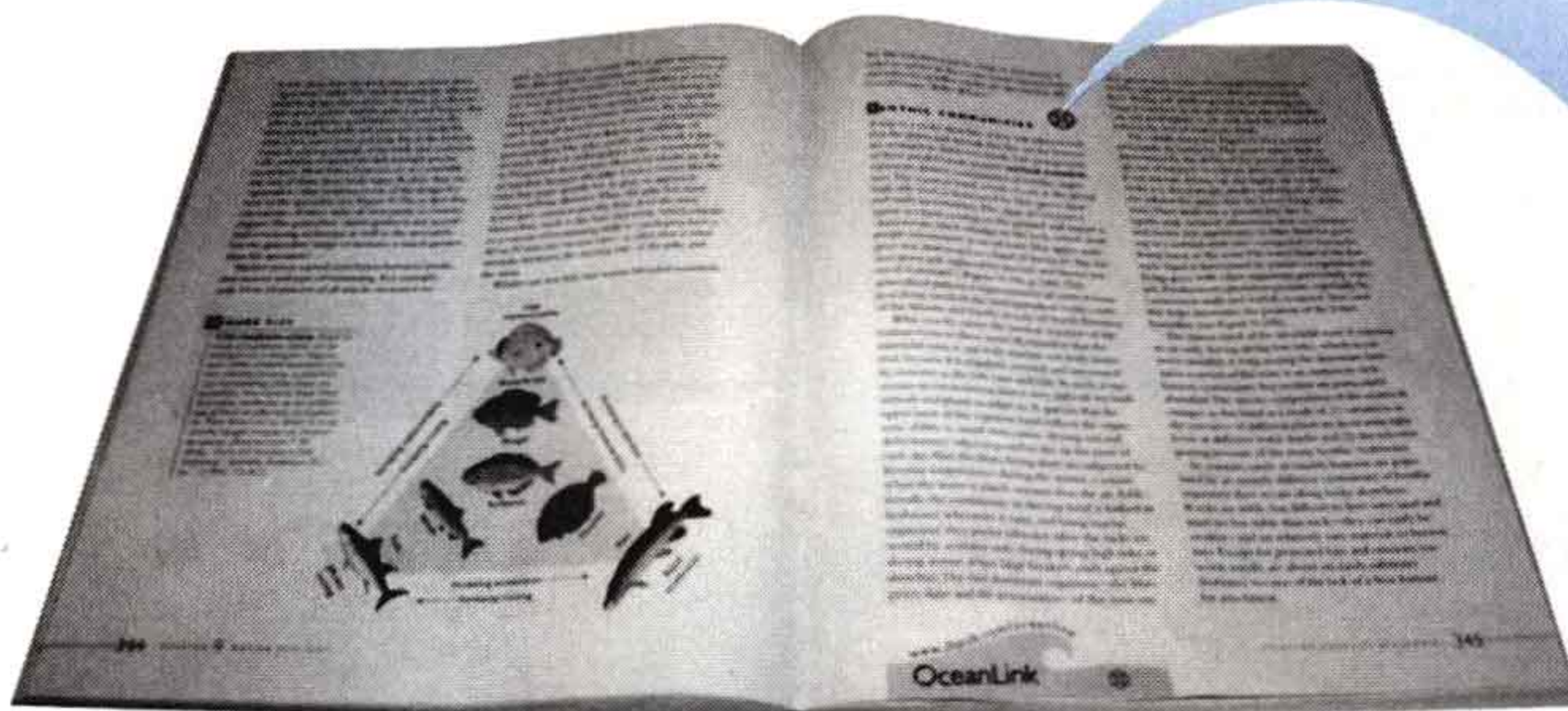




# OceanLink

## KEY TOPIC ICON

The distinctive Key Topic icon appears next to major topic headings to indicate that additional material is available through the OceanLink web site. OceanLink directs you to other sites that enhance and reinforce the material presented in the text. Soon you will be connected to a wealth of additional current and reliable information on the Web.



- The Key Topic icon identifies key topic headings that are matched to WWW sites you can visit through OceanLink.
- Select the appropriate chapter and page number that corresponds with the Key Topic icon.

Brief descriptions on Jones and Bartlett's OceanLink site place the links in context.

With a click of the mouse, OceanLink takes you to the best and most current sites on the Web.

Links Ch 1 F... - Microsoft Internet Explorer


Address: <http://www.jbpub.com/oceanlink/links/trameset-ch9-link1.htm>

**OceanLink Key Topics**  
Chapter 9: Marine Ecology  
Page 345: Benthic Communities

1. Vertical zonation is a universal characteristic of rocky shores that are affected by a significant tide. Also, they are readily accessible for viewing at low tide when this community is exposed to air. The Rocky Shores web site allows you to learn more about the principal inhabitants of rocky shore communities and their life habits, as well as the nature of the intense competition for living space in this intertidal zone.

Go to the [Rocky Shores web site](#).

## ROCKY SHORES



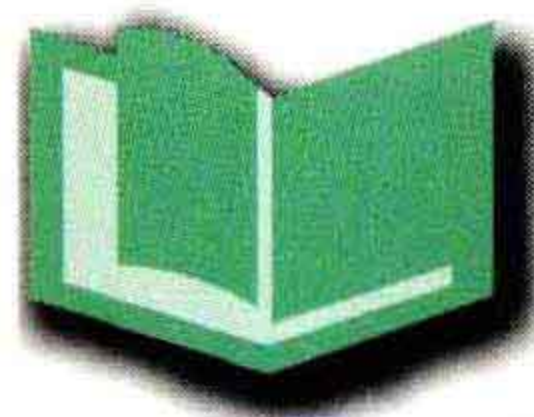
Photograph by Raymond Seed

In the study of community structure, larval recruitment, and physiology, rocky shores have proven to be the most versatile habitats, owing to their accessibility to observation and to the strong physiological gradient, ranging from fully marine to terrestrial habitats. The physiological gradient makes it relatively easy to see the interactions of physiological performance and interspecies interactions. Ecological processes such as competition and predation are strongly modulated by the time organisms are exposed to air and such effects cause vertical gradients in the importance of, for example, predation. Many carnivores can only move about and seize prey when covered with water, which limits the time that intense predation can occur in the high intertidal.

Our understanding of these environments has been informed especially by field experiments. Removal or addition of hypothetical predators and prey has been crucial in understanding ecological interactions. The experiments performed by Joseph Connell and Robert T. Paine and their followers set the standard for ecological field work both in the marine and other environments.

Opening picture: rs\_11.jpg at life.bio.surysb.edu

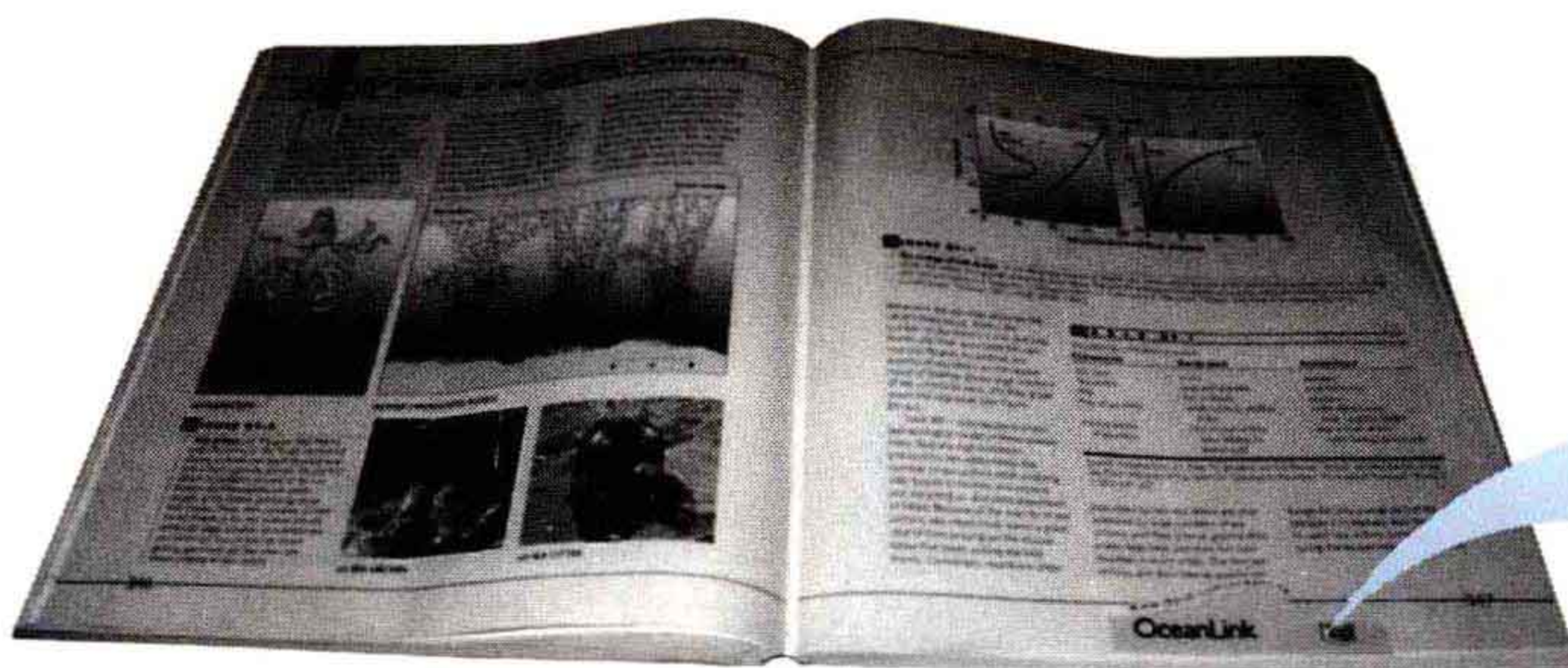




# OceanLink

## SCIENCE BOX ICONS

The distinctive Science Box icons appear in selected boxes to indicate that Jones and Bartlett's OceanLink is connected to web sites picked by the author for their additional coverage of the topic and their examples of science in use.



- The OceanLink Science Box icon identifies science topics that are matched to WWW sites you can visit from the home page.
- Select the appropriate chapter and page number that corresponds with the Science Box icon.

Brief descriptions on Jones and Bartlett's OceanLink site place the links in context.

### Biology Science Box: Ecology of the Giant Kelp Community

Your understanding of the ecological connections among kelp, sea urchins, and otters will be deepened by learning more about the behavior and ecological requirements of the animal members of the giant kelp community. The first web site discusses the living habits of sea otters; the second of sea urchins.

Go to [Jimmy's Sea Otter Page](#).  
Go to this site about [Sea Urchins](#).

OceanLink takes you to sites offering valuable extra information and/or the latest research news.

### Picture Galleries

[Gallery 1](#)  
[Gallery 2](#)  
[Gallery 3](#)

### About Sea Otters

[Introduction](#)  
[Sea Otter Books](#)  
[What is a Sea Otter?](#)  
[Sea Otter Facts](#)  
[Sea Otter Facts #2](#)  
[Sea Otter Research](#)  
[Animal Bytes: Sea Otter](#)  
[Sea Otter Report](#)  
[April the Errant Otter](#)

### Sea Otter Links

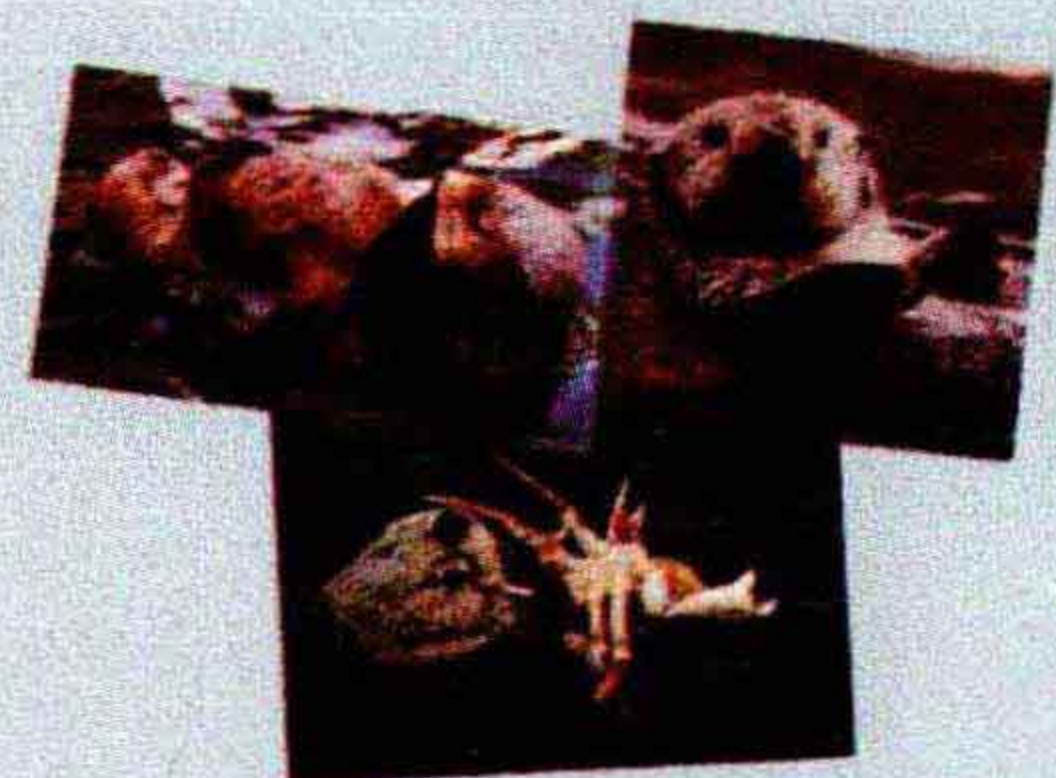
[Friends of the Sea Otter](#)  
[Monterey Bay Aquarium](#)  
[World Wildlife Fund Canada](#)  
[Marine Mammal Center](#)  
[Int'l Otter Survival Fund](#)  
[Mela's Otter Page](#)  
[Anthony Bemo's Otter Page](#)  
[BioInfo Animal Pictures](#)

1996 Visitors: 6364  
1997 Visitors: 22944  
(Up through 8/5/97)

Who am I?  
[Visit my home page.](#)

Jimmy Hu  
[jhu@earthlink.net](#)  
Created: 4/19/96  
Edited: 5/14/97  
Latest Pictures: 3/30/97

## Jimmy's Sea Otter Page



Hi there! You've come to the one stop otter shop. Here you can find everything you are looking for about sea otters. This site contains a collection of pictures, information on sea otters, and links to many other sea otter web sites.

If you are interested in reading about sea otters, I've written an [introduction to sea otters](#). I've also recently added a list of good [sea otter books](#), for those of you who are looking for more detailed information. If you just want to look at pictures, I have three pages devoted to them in the [picture gallery](#). Be sure to try the links to the other sea otter sites for more pictures and information.

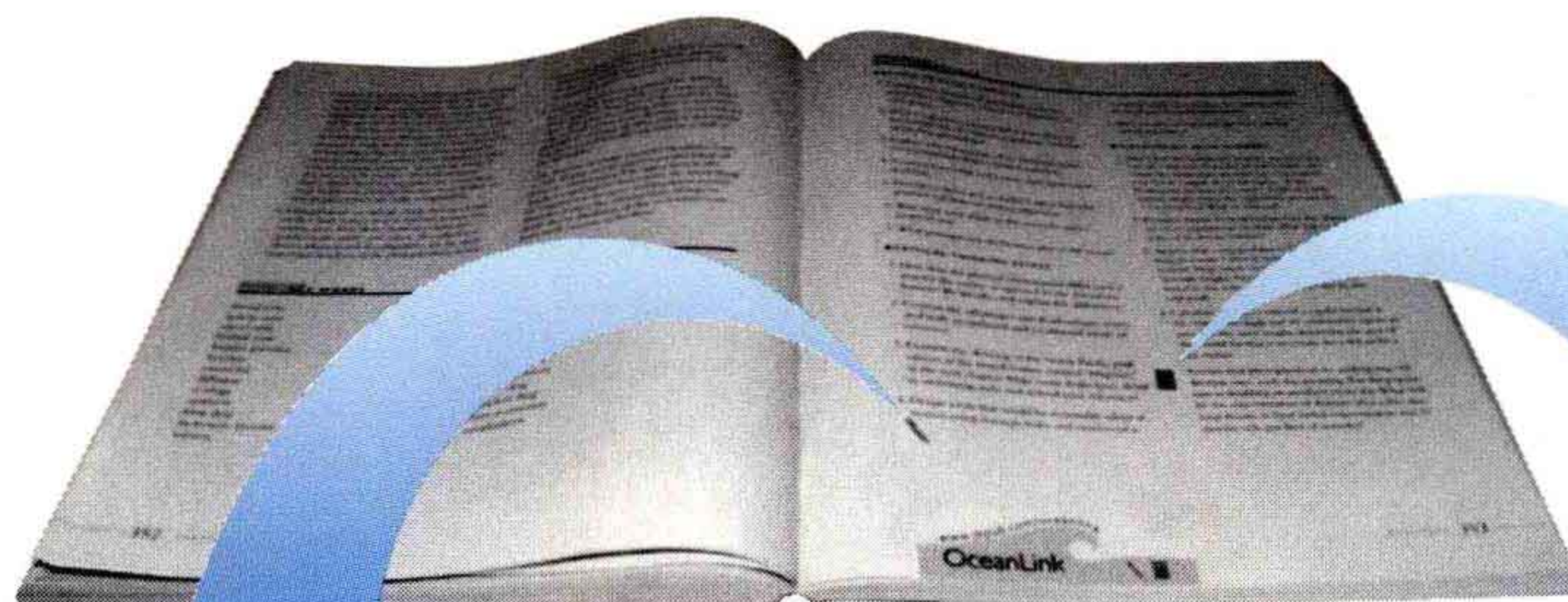




# OceanLink

## CRITICAL THINKING & MATH TUTOR ICONS

The Critical Thinking and Math Tutor icons identify selected end-of-chapter “Critical Thinking Essays” and “Discovering with Numbers” exercises for which additional resources and assistance are available on the Web. Your text author, Paul Pinet, encourages you to take your critical thinking a step further, and he patiently guides you through the mathematical problem solving process.



**OceanLink** Critical Thinking Exercises

**Critical Thinking Essay**  
Chapter 9: Marine Ecology, page 353, No. 4

Design a fish that would be reasonably adept at maneuvering through holes and crevices of a coral reef while also relying on a darting motion to catch prey. Explain your model.

The key design elements are summarized in Figures 9-21, 9-22, and 9-23.

**Topic** **Web Research Tip:** Another useful approach is to examine the body shapes and caudal fins of several fish species that inhabit coral reefs and compare these traits to the fishes' behavior. Examine the photos and the accompanying text for all the fish species shown on the web site below, and see whether you can 'pirate' some design ideas and incorporate them into your fish model.

**Do the Research** Here is the web site that will help you get started with this Essay:  
The [St. Petersburg Times Creature Feature page](#)  
You may wish to utilize a [search engine](#) to find even more information on this topic.

**Construct your Answer** Your response to this exercise should demonstrate a thorough consideration of the topic and all answers should be backed up with references to the research you have done to formulate your answer.  
Your instructor should indicate if you are to write your report and print it out or if you have the option of sending your assignment via e-mail.

**OceanLink Home**

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**Topic** is placed in clearer context; direct links and a search engine facilitate **Doing the Research**; and clear guidance is offered for **Constructing Your Answer**.

**OceanLink** Math Tutor

**Discovering With Numbers**

Chapter 9: Marine Ecology  
Page 353, Math Problem No. 5

This is a classic doubling-rate problem. If setting up the problem to solve is confusing to you, try thinking about it this way:

Imagine a piece of paper of a given thickness. If you fold it in half, you now have two thicknesses. If you fold those two thicknesses, you end up with four thicknesses. Another folding produces eight thicknesses. Take a piece of paper and actually fold it three times, noting the change in thickness. Can you see the trend: 1 thickness (no folding), 2 thicknesses (1 folding), 4 thicknesses (2 foldings), 8 thicknesses (3 foldings), each folding doubles the thickness of the paper. What thickness would five foldings give you? For problem 5, we start off with 10 diatom cells in a liter of water. One doubling of the diatom population the first day yields 20 diatoms (2 x 10 cells = 20 cells); another doubling on the second day yields 40 diatom cells (2 x 20 cells = 40 cells). Notice the trend: 10 cells, 20 cells, 40 cells. Now you should be able to calculate the concentration of diatoms in the liter of water after a five-day bloom, if the diatoms are doubling their numbers each day.

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Revised: August 18, 1997. [webmaster@jpub.com](#)

Math Tutor gently guides you through mathematical problem solving process with clues, but no answers.





# Preface

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**T**his book deals with the workings of the ocean, the dynamic processes that affect its water, sea floor, and abundant life forms. The approach used is a broad one, relying on basic concepts to explain the ocean's many mysteries. Anybody—whether sailor, surfer, beachcomber, or student—can learn about the processes and creatures of the oceans by reading this visually exciting book. No background in science is required to grasp the many important ideas that are relevant to the working of the oceans. Wherever appropriate, the underlying science is first explained clearly, and only then is it used to account for ocean processes. These overarching scientific concepts are summarized conveniently as “Key Concepts” at the end of every chapter. In order to help those unfamiliar with the practice of science, Chapter 1 provides an explanation of how scientists reason and draw conclusions about the natural world. In the glossary, important words are clearly defined and are accompanied by page numbers which refer you to the critical section of the book where the term in question was first introduced.

The figures and their accompanying captions do not merely illustrate, but also supplement the written text. The drawings have been beautifully and accurately rendered by a team of talented artists and illustrators in order to present in visual form ideas that are at times necessarily abstract. They should be studied carefully before advancing to the next section of the chapter, because they help provide concreteness to the ideas discussed. It has been the author's experience that those students who truly understand the “ins and outs” of the illustrations tend to have a solid

grasp of the chapters' main concepts. This will take a bit of time, but it is time well invested.

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## Web Enhancement

*Invitation to Oceanography: Web Enhanced Edition* provides you with web-integrated activities and direct links to World Wide Web resources. The starting point is *OceanLink*, Jones and Bartlett's own extensive oceanography home page. Students reach the *OceanLink* home page by entering the URL <http://www.jbpub.com/oceanlink> into a World Wide Web browser such as Netscape Navigator or Microsoft Internet Explorer.

The distinctive *OceanLink* Key Topics icon in the text identifies topics that are matched to useful WWW sites you can visit through *OceanLink*. Brief introductions place the link in context *before* you connect to the site. Jones and Bartlett constantly monitors the links to ensure that there will always be a working and appropriate site on-line.

The Science Boxes icon appears in the featured boxes. *OceanLink* is connected to web sites that provide additional coverage of the topic in the box and examples of science in use.

The *OceanLink* Critical Thinking icon next to selected end-of-chapter “Critical Thinking Essays” directs you to *OceanLink*, where useful links and additional help, including tips for researching your essay on the web, are available. The same is true for the “Discovering with Numbers” activities in the book. When you see a Math Tutor icon, it means that *OceanLink's* Math Tutor can help you work through the problem with clues, but it will not

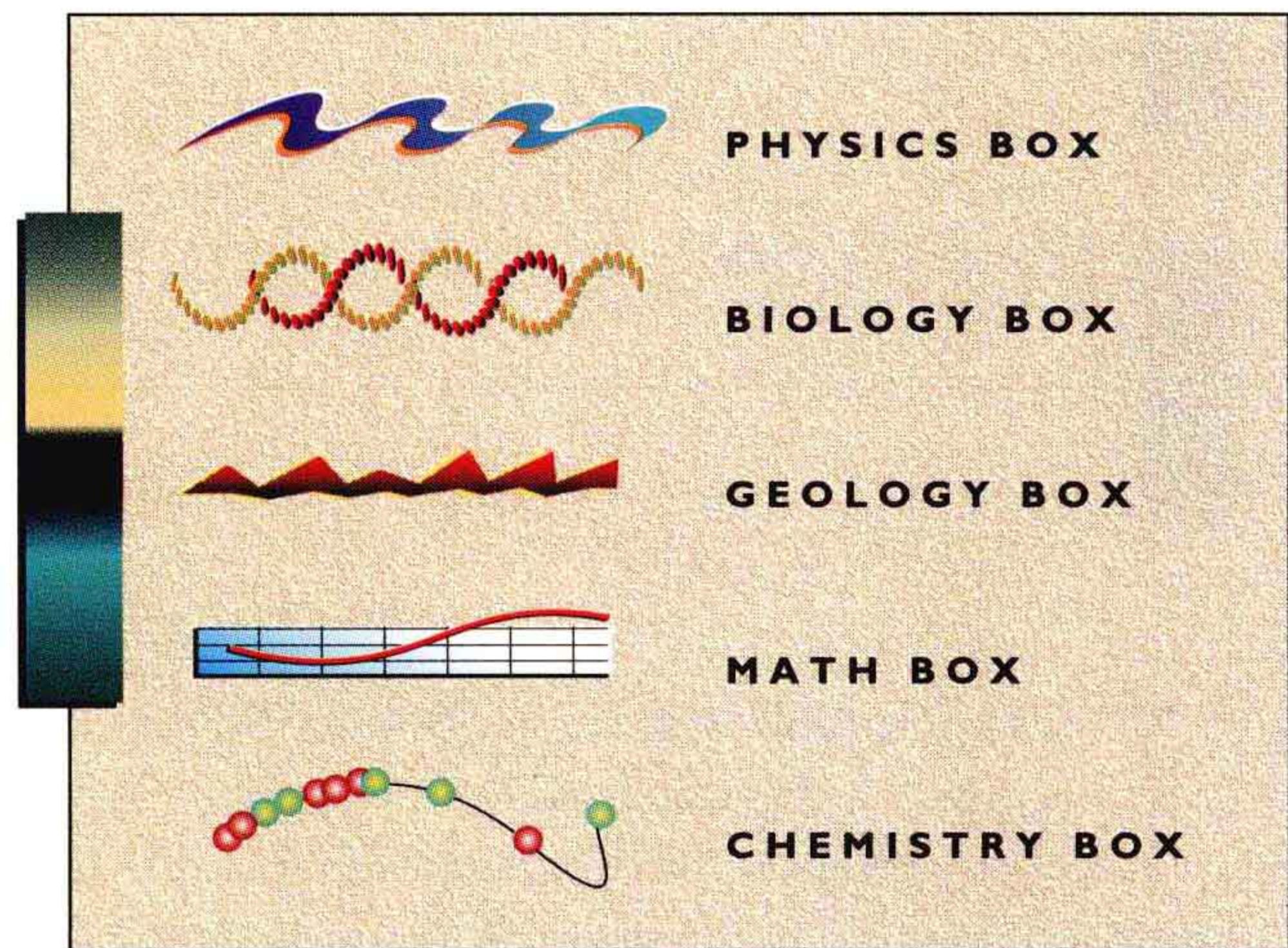


provide answers. In addition, *OceanLink* has an on-line glossary with key figures from the book.

### End of Chapter Features

Each chapter concludes with a series of questions arranged into three groupings. The first set, the **Review Questions**, are just that. They address the main notions developed in the chapter. The second set, the **Critical Thinking Essays**, require more thought, because you must synthesize ideas, sometimes drawing from concepts developed in previous chapters. In other words, verbatim answers might not be found anywhere in the book. However, you can develop an answer by thinking deeply about the question posed and applying common sense and logic to the information provided in the book. The final set of questions, **Discovering with Numbers**, deals with making straightforward calculations about ocean processes. They rely on basic mathematics, the kind that any high-school graduate has mastered. In order to assist you, math boxes that teach the art of computation are included in each chapter. Each box deals with a basic mathematical concept and provides a step-by-step solution to a specific problem. The trick to answering math questions is to understand conceptually what it is you are trying to solve. These math boxes will help you upgrade your math skills and develop self-assurance about reasoning with numbers. With the proper learning attitude, the math problems actually become fun to solve and provide special kinds of insights into ocean processes that only numerical calculations reveal.

**Featured boxes** abound in all of the chapters. They consist of four types, based on the principal subfields of oceanography: biology, chemistry, geology, and physics. Each is identified as such by a colorful and distinctive logo placed near the title of the box. The featured boxes serve several purposes. Some review common research techniques employed by oceanographers to investigate the seas. A number of them flesh out a concept merely outlined in the text. Others spotlight case histories whereby the oceanog-



raphy of a specific place is presented in concrete terms from the standpoint of an idea introduced in the text. Finally, a few featured boxes review a concept that is simply interesting in and of itself, and that otherwise could not be integrated easily into the main text of the chapter. They are like eating dessert after finishing the main course of a meal. Enjoy them! Here is a list of each box in the book and where they appear in their respective chapters.

■ CHAPTER 1:	
THE SCIENTIFIC PROCESS—PHYSICS BOX	16
UNDERWATER DIVING—PHYSICS BOX	21
EARTH SYSTEMS EDUCATION—PHYSICS BOX	24
CONVERSIONS—MATH	26
■ CHAPTER 2:	
PROBING THE SEA FLOOR—GEOLOGY	45
THE SAN ANDREAS FAULT—GEOLOGY	62
THE RED SEA—GEOLOGY	68
POWERS OF TEN—MATH	70
SEA-FLOOR SPREADING—MATH	71
■ CHAPTER 3:	
PROBING THE SEA FLOOR—GEOLOGY	80
THE 1929 GRAND BANKS EARTHQUAKE—GEOLOGY	88
THE DRYING UP OF THE MEDITERRANEAN SEA – GEOLOGY	106
SEDIMENTATION RATES—MATH	112
■ CHAPTER 4:	
PARTS PER THOUSAND—MATH	127
CHEMICAL TECHNIQUES—CHEMISTRY	128
DESALINATION—CHEMISTRY	149
OTHER PHYSICAL PROPERTIES OF WATER—CHEMISTRY	154
THE SEA-SURFACE MICROLAYER—CHEMISTRY	161
ORDER OF MAGNITUDE—MATH	164



■ CHAPTER 5:	
CURRENT MEASURING TECHNIQUES—PHYSICS	180
COUNTERCURRENTS AND UNDERCURRENTS—PHYSICS	193
UNDERWATER WEATHER AND WATERFALLS—PHYSICS	204
VOLUME TRANSPORT—MATH	212
■ CHAPTER 6:	
WAVE MEASURING TECHNIQUES—PHYSICS	220
TINY WAVES AND GIANT WAVES—PHYSICS	233
WAVE CELERITY—MATH	242
■ CHAPTER 7:	
CURRENTS THROUGH TIDAL INLETS—PHYSICS	258
TIDAL RHYTHMS IN ORGANISMS—BIOLOGY	266
TIDE CELERITY—MATH	269
DEPTH OF THE BAY OF FUNDY—MATH	270
■ CHAPTER 8:	
CAPE COD, MASSACHUSETTS—GEOLOGY	282
PADRE ISLAND, TEXAS—GEOLOGY	286
SAN DIEGO, CALIFORNIA—GEOLOGY	290
CHESAPEAKE BAY—BIOLOGY	298
OCEAN CITY AND ASSATEAGUE ISLAND, MARYLAND—GEOLOGY	306
SAND BUDGET STUDY—MATH	308
■ CHAPTER 9:	
SAMPLING THE BIOTA—BIOLOGY	326
MANATEES—BIOLOGY	329
KILLER WHALES—BIOLOGY	340
ECOLOGY OF GIANT KELP COMMUNITY—BIOLOGY	346
GRAPHS—MATH	350
■ CHAPTER 10:	
LARGE SHARKS—BIOLOGY	364
VOLCANIC VENT COMMUNITIES—BIOLOGY	368
SATELLITE OCEANOGRAPHY—BIOLOGY	378
MIGRANTS—BIOLOGY	384
WHAT CAUSES EL NIÑO?—PHYSICS	392
DOUBLING RATES—MATH	394
■ CHAPTER 11:	
SALT-MARSH EVOLUTION—GEOLOGY	407
PENGUINS—BIOLOGY	421
BOTTOM FEEDING BY WHALES—BIOLOGY	424
SARGASSUM GULFWEEED—BIOLOGY	427
SQUIDS—BIOLOGY	429
RESIDENCE TIME—MATH	434
■ CHAPTER 12:	
THE TORREY CANYON DISASTER—BIOLOGY	448
BIOREMEDIATION—BIOLOGY	454
THE EXXON VALDEZ OIL SPILL—BIOLOGY	457
STEADY STATE—MATH	467

Two chapters—“Coastal Processes” (Chapter 8) and “The Human Presence in the Ocean” (Chapter 12)—are particularly noteworthy. They deal with the

despoilment of the Earth’s precious marine environments. We are just beginning to sense the gravity of our collective impact on the oceans in general and on the shorelines in particular. Many of these coastal ecosystems—beaches, dunes, estuaries, salt marshes, mangrove swamps, lagoons, coral reefs—are being stressed well beyond their resiliency to absorb the damaging effect of our careless and abusive habits. However, the future looks promising, since more and more people are becoming ardent environmentalists, wanting to reverse the polluted and damaged state of the ocean’s many habitats. In fact, there is a great deal that you can personally do. Some of these activities are discussed in the final chapter of the book. Our collective individual actions have caused these massive, far-reaching problems; our collective individual actions can undo them as well.

Chapter 5—“Ocean Circulation” begins with a compact summary of climate processes and their effect on the movement of water in the ocean. Then, after describing ocean circulation, the chapter concludes with an up-to-date assessment of the likelihood of global warming in the future. This chapter is particularly important because it shows how interconnected the flow of air in the atmosphere and the flow of water in the oceans are, and how susceptible each is to human-induced activity.

A **reading list** is provided at the end of each chapter that includes both classical, but still relevant, references and more recent writings on the ocean’s dynamic processes and diverse habitats. Some are books; most are articles. They should prove valuable for delving deeper into an area of oceanography that intrigues you and for writing term papers. Also, the **appendices** at the end of the book provide important ancillary material, including conversion factors, a geologic time chart, and map-reading techniques.

It is the author’s hope that this book conveys his deep respect for Earth, especially its watery realm, and inspires the same in its readers. Perhaps a few, like the author, will even devote their lives to studying, protecting, and teaching about the oceans, increasingly enamored of their beauty, fragility, and complexity.





# Acknowledgments

---

**W**est Publishing Company published the first edition of this book. The valuable work and vision of the entire West staff is duly noted in the acknowledgments of the first edition. Since then, Jones and Bartlett Publishers have worked tirelessly to produce this new edition, the Web-enhanced version of *Invitation To Oceanography*. Brian McKean, the senior biology editor, has overseen the preparation of this edition. He is responsible for convincing me about the value of incorporating the internet idea into the book. His guidance, patience and energy, as well as his strong sense of aesthetics, are largely responsible for the successful and surprisingly painless completion of this project. Also, Judy Hauck, senior managing editor, Mary Hill, senior production editor, Dean DeChambeau, senior developmental editor, and Kathryn Twombly, project editor worked with me as a team in the truest professional manner. The final rendering of the book is the direct result of their combined efforts and clear-cut vision of how much more the book could be. I am indebted to all of them. Finally, there are the “nuts-and-bolts” people, Mike Campbell, director of internet technology and Andrea Wasik, web designer. Both are indispensable, knowledgeable professionals who endured my vast ignorance of computers and who held me firmly by the hand as they offered me a glimpse of the vast educational potential of this new technology. I have learned a great deal from the entire staff of Jones and Bartlett Publishers; I am privileged to be an author of one of their books.

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*West Chester University*

William Frazier  
*Columbus College*

Tom Garrison  
*Orange Coast College*

Jack C. Hall  
*University of North Carolina—Wilmington*





# Contents in Brief

---

<b>1</b>	<b>THE GROWTH OF OCEANOGRAPHY</b>	<b>2</b>
<b>2</b>	<b>THE ORIGIN OF OCEAN BASINS</b>	<b>31</b>
<b>3</b>	<b>MARINE SEDIMENTATION</b>	<b>77</b>
<b>4</b>	<b>THE PROPERTIES OF SEAWATER</b>	<b>117</b>
<b>5</b>	<b>OCEAN CIRCULATION</b>	<b>171</b>
<b>6</b>	<b>WAVES IN THE OCEAN</b>	<b>217</b>
<b>7</b>	<b>TIDES</b>	<b>247</b>
<b>8</b>	<b>THE DYNAMIC SHORELINE</b>	<b>275</b>
<b>9</b>	<b>MARINE ECOLOGY</b>	<b>315</b>
<b>10</b>	<b>BIOLOGICAL PRODUCTIVITY IN THE OCEAN</b>	<b>357</b>
<b>11</b>	<b>OCEAN HABITATS AND THEIR BIOTA</b>	<b>401</b>
<b>12</b>	<b>THE HUMAN PRESENCE IN THE OCEAN</b>	<b>439</b>





# Contents

## **1 THE GROWTH OF OCEANOGRAPHY**

<i>Preview</i>	3
<i>Oceanography: What Is It?</i>	4
<i>Historical Review of Oceanography</i>	5
Ocean Exploration	6
Early Scientific Investigations	14
Modern Oceanography	20



<i>Current and Future Oceanographic Research</i>	23
<i>Key Concepts</i>	27
<i>Questions</i>	27
<i>Selected Readings</i>	28
■ <b>FEATURED BOXES:</b>	
THE SCIENTIFIC PROCESS	16
UNDERWATER DIVING	21
EARTH SYSTEMS EDUCATION	24
■ <b>MATH BOX:</b>	
CONVERSIONS	26

## **2 ORIGIN OF OCEAN BASINS**

<i>Preview</i>	31
<i>The Earth's Structure</i>	33
The Earth's Interior Spheres	33
The Earth's Exterior Envelopes	35
<i>The Physiography of the Ocean Floor</i>	35
Bathymetric Provinces	35
<i>Geologic Differences Between Continents and Ocean basins</i>	40
The Earth's Topography and Bathymetry	40
Mass Balance and Isostasy	42
<i>Continental Drift</i>	47
<i>Sea-Floor Spreading</i>	48
The Geomagnetic Field	51
Spreading Ocean Ridges	54
<i>Global Plate Tectonics</i>	56
Subduction Zones	56
Plate-Tectonic Model	59
The Opening and Closing of Ocean Basins	65
A Summary of Global Plate Tectonics	67
<i>Key Concepts</i>	72
<i>Key Words</i>	73
<i>Questions</i>	73
<i>Selected Readings</i>	74
■ <b>FEATURED BOXES:</b>	
PROBING THE SEA FLOOR	45
THE SAN ANDREAS FAULT	62
THE RED SEA	68
■ <b>MATH BOXES:</b>	
POWERS OF TEN	70
SEA-FLOOR SPREADING RATES	71



### 3 MARINE SEDIMENTATION

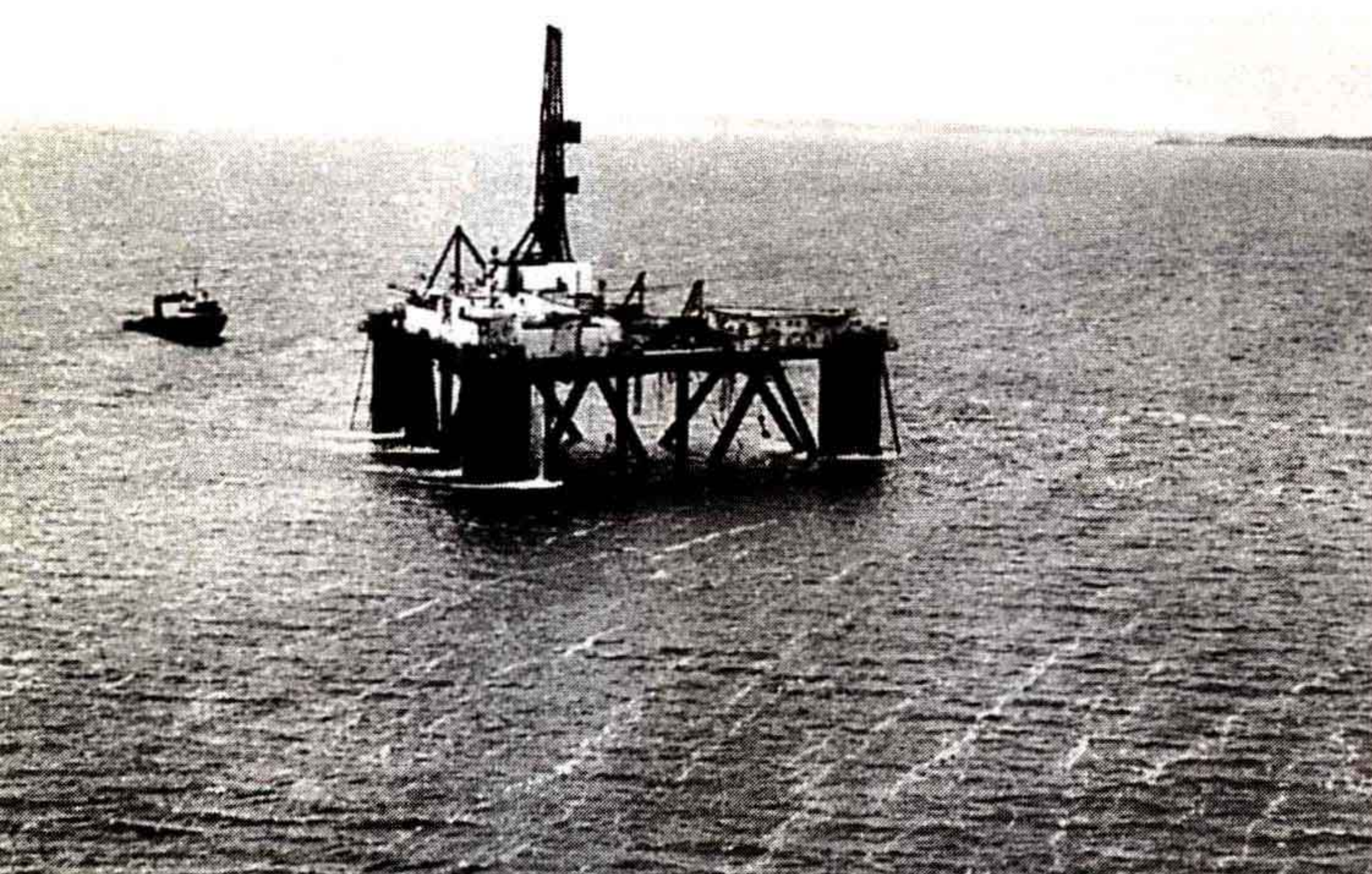
77

<i>Preview</i>	77
<i>Sediment in the Sea</i>	78
Classification of Marine Sediment	79
Factors That Control Sedimentation	79
<i>Sedimentation in the Ocean</i>	83
Shelf Sedimentation	83
Deep-Sea Sedimentation	94
<i>Key Concepts</i>	113
<i>Key Words</i>	114
<i>Questions</i>	114
<i>Selected Readings</i>	115
■ FEATURED BOXES:	
PROBING THE SEA FLOOR	80
THE 1929 GRAND BANKS EARTHQUAKE	88
THE DRYING UP OF THE MEDITERRANEAN SEA	106
■ MATH BOX:	
SEDIMENTATION RATES	112

### 4 THE PROPERTIES OF SEAWATER

117

<i>Preview</i>	117
<i>Basic Chemical Notions</i>	118
<i>Basic Physical Notions</i>	120
<i>The Water Molecule</i>	121
The Solutes of Seawater	125



<i>Salinity</i>	131
Principle of Constant Proportion	131
Factors That Regulate the Salinity of Seawater	132
Effects of Salinity on the Properties of Water	136
<i>Chemical and Physical Structure of the Oceans</i>	137
Temperature	137
Salinity	140
Density	142
<i>Gases in Seawater</i>	144
Oxygen	147
Carbon Dioxide	148
<i>The Ocean as a Physical Chemical System</i>	153
Reservoirs of Water	158
The Global Water Cycle	159
The Ocean as a Biogeochemical System	160
<i>Key Concepts</i>	165
<i>Key Words</i>	166
<i>Questions</i>	166
<i>Selected Readings</i>	168

■ FEATURED BOXES:	
CHEMICAL TECHNIQUES	128
DESALINATION	149
OTHER PHYSICAL PROPERTIES OF WATER	154
THE SEA-SURFACE MICROLAYER	161
■ MATH BOXES:	
PARTS PER THOUSAND	127
ORDER OF MAGNITUDE	164

### 5 OCEAN CIRCULATION

171

<i>Preview</i>	171
<i>Atmospheric Processes</i>	172
Air Pressure	172
Coriolis Deflection	173
General Wind Circulation	176
<i>Surface Ocean Currents</i>	178
The Wind-Driven Currents of the Sea Surface	179
Types of Surface Flows	184
A Model of Geostrophic Flow	188
Refinement of the Geostrophic-Flow Model	190
<i>Deep-Ocean Circulation</i>	195
Water Masses and Density-Driven Water Flow	195
A General Model of Thermohaline Circulation	196
<i>Water Flow in Semi-Enclosed Seaways</i>	201
<i>Global Climatic Change</i>	209
<i>Key Concepts</i>	213



Key Words	214
Questions	214
Selected Readings	215
■ FEATURED BOXES:	
CURRENT MEASURING TECHNIQUES	180
COUNTERCURRENTS AND UNDERCURRENTS	193
UNDERWATER WEATHER AND WATERFALLS	204
■ MATH BOX:	
VOLUME TRANSPORT	212

## **6 WAVES IN THE OCEAN 217**

Preview	217
Properties of Ocean Waves	218
Wind Generation of Waves	220



Wave Motions	223
The Motion of Water Particles Beneath Waves	223
Motion of the Wave Form	225
The Life History of Ocean Waves	226
Growth of Waves in the Fetch Area	226
Storm Waves Outside the Generating Area	227
Waves in Shallow Water	229
Shoreline Under Storm Conditions	232
Standing Waves	236
Other Types of Progressive Waves	238
Internal Waves	238
Tsunamis	240
Key Concepts	243

Key Words	243
Questions	244
Selected Readings	245
■ FEATURED BOXES:	
WAVE MEASURING TECHNIQUES	220
TINY WAVES AND GIANT WAVES	233
■ MATH BOX:	
WAVE CELERITY	242

## **7 TIDES 247**

Preview	247
Tidal Characteristics	248
Origin of the Tides	251
Equilibrium Model of the Tides	253
Dynamic Model of the Tides	256
Tides in Small and Elongated Basins	263
Tidal Currents	265
Power from the Tides	266
Key Concepts	271
Key Words	271
Questions	271
Selected Readings	272
■ FEATURED BOXES:	
CURRENTS THROUGH TIDAL INLETS	258
TIDAL RHYTHMS IN ORGANISMS	266
■ MATH BOXES:	
TIDE CELERITY	269
DEPTH OF THE BAY OF FUNDY	270

## **8 THE DYNAMIC SHORELINE 275**

Preview	275
Coastal Water Movement	276
Shoaling Waves	276
Circulation in the Surf Zone	277
Beaches	279
Sand Budgets	279
Beach Profiles	279
Barrier Islands	283
Barrier-Island Landscape	283
Origin of Barrier Islands	284



<i>Storm Effects</i>	288	Kingdom Fungi	322
<i>Cliffed Coasts</i>	289	Kingdom Metaphytae	322
<i>Estuaries</i>	292	Kingdom Metazoa	322
Origin of Estuaries	292	<i>Basic Ecology</i>	325
Circulation and Sedimentation in Estuaries	294	Temperature	328
Salt-Wedge Estuaries	294	Salinity	331
Partially Mixed Estuaries	296	Hydrostatic Pressure	334
Well-Mixed Estuaries	296	<i>Selected Adaptive Strategies</i>	335
<i>Deltas</i>	301	Life Cycles of Plankton	335
<i>Impact of People on the Coastline</i>	303	Functional Morphology of Fishes (Nekton)	340
<i>Key Concepts</i>	309	Benthic Communities	345
<i>Key Words</i>	310	<i>Key Concepts</i>	351
<i>Questions</i>	310	<i>Key Words</i>	352
<i>Selected Readings</i>	311	<i>Questions</i>	353
■ FEATURED BOXES:		<i>Selected Readings</i>	354
CAPE COD, MASSACHUSETTS	282	■ FEATURED BOXES:	
PADRE ISLAND, TEXAS	286	SAMPLING THE BIOTA	326
SAN DIEGO COUNTY, CALIFORNIA	290	MANATEES	329
CHESAPEAKE BAY	298	KILLER WHALES	340
OCEAN CITY AND ASSATEAGUE ISLAND, MARYLAND	306	ECOLOGY OF THE GIANT KELP COMMUNITY	346
■ MATH BOX:		■ MATH BOX:	
SAND BUDGET STUDY	308	GRAPHS	350

## 9 MARINE ECOLOGY 315

<i>Review</i>	315
<i>Ocean Habitats</i>	316
<i>Classification Of Organisms</i>	318
Kingdom Monera	319
Kingdom Protista	321



## 10 BIOLOGICAL PRODUCTIVITY IN THE OCEAN 357

<i>Preview</i>	357
<i>Food Webs and Trophic Dynamics</i>	358
Energy and Trophic Dynamics	360
Plants as Primary Producers	360
Animals as Consumers	362
Bacteria as Decomposers	365
Food Chains and Energy Transfer	367
<i>General Marine Productivity</i>	371
Primary Production in the Ocean	372
Variations in Productivity	375
<i>Global Patterns of Productivity</i>	379
Spatial Variations	379
Estimates of Plant and Fish Production	383
<i>Biological Productivity of Upwelling Water</i>	389
<i>Key Concepts</i>	396
<i>Key Words</i>	397
<i>Questions</i>	397



<i>Selected Readings</i>	398
■ FEATURED BOXES:	
LARGE SHARKS	364
VOLCANIC VENT COMMUNITIES	368
SATELLITE OCEANOGRAPHY	378
MIGRANTS	384
WHAT CAUSES EL NIÑO?	392
■ MATH BOX:	
DOUBLING RATES	394

## **II OCEAN HABITATS AND THEIR BIOTA 401**

<i>Preview</i>	401
<i>Biology of Coastal Habitats</i>	402
Estuaries	402
Salt Marshes	403
Mangrove Swamps	410
<i>Coral Reefs</i>	411
Biology of Corals	411
Ecology of Coral Reefs	413
Geology of Coral Reefs	417



<i>Biology of the Continental Shelf</i>	418
Neritic Zone	419
Sublittoral Zone	420
<i>Biology of the Open Ocean and the Deep Sea</i>	423
The Oceanic Realm	423
The Deep-Sea Bottom	430
<i>Key Concepts</i>	434
<i>Key Words</i>	435
<i>Questions</i>	436
<i>Selected Readings</i>	437

■ FEATURED BOXES:	
SALT-MARSH EVOLUTION	407
PENGUINS	421
BOTTOM FEEDING BY WHALES	424
SARGASSUM GULFWEED	427
SQUIDS	429
■ MATH BOX:	
RESIDENCE TIME	434

## **12 THE HUMAN PRESENCE IN THE OCEAN 439**

<i>Preview</i>	439
<i>Pollution: What Is It?</i>	440
<i>Hydrocarbons in the Sea</i>	442
<i>Municipal and Industrial Effluent</i>	447
Sewage	451
Metals	453
Artificial Biocides	456
<i>Coastal Development</i>	458
<i>Ocean Dredging and Mining</i>	460
Dredging	460
Ocean Mining	462
<i>The Ocean's Future</i>	463
<i>Key Concepts</i>	468
<i>Key Words</i>	469
<i>Questions</i>	469
<i>Selected Readings</i>	470

■ FEATURED BOXES:	
THE TORREY CANYON DISASTER	448
BIOREMEDIATION	454
THE EXXON VALDEZ OIL SPILL	457
■ MATH BOX:	
STEADY STATE	467

## **APPENDICES**

<i>I - Properties of the Earth</i>	473
<i>II - Conversion Factors</i>	474
<i>III - Geologic Time</i>	475
<i>IV - Maps and Topographic Profiles</i>	476
Contour Maps	477
Topographic Profiles	479
Oceanographic Profiles	479





# Invitation to Oceanography