

Brief Contents

Chapter 1	Introduction to Marine Environmental Science and Oceanography	1	Chapter 8	Seafloor and Deep-Sea Ecosystems: Resource Harvest and Habitat Protection	255
Chapter 2	Marine Biology, Ecology, and Conservation	31	Chapter 9	Marine Endangered Species: Conservation, Protection, and Recovery	289
Chapter 3	Conservation of Intertidal and Coastal Ecosystems	75	Chapter 10	Conservation of Cetaceans	323
Chapter 4	The Estuary and Marsh: Habitat Impacts and Environmental Protection.	117	Chapter 11	Marine Fisheries: Overharvest and Conservation	349
Chapter 5	Tropical Coral Reefs: Environmental Impacts and Recovery	159	Chapter 12	Ocean Conservation Laws, Agreements, and Organizations	399
Chapter 6	Nearshore Ecosystems: Community Ecology and Habitat Protection	195	Index		431
Chapter 7	The Open Ocean: Anthropogenic Inputs and Environmental Impacts	225	Credits		448

Contents

Preface ix

About the Author xii

Chapter 1 Introduction to Marine Environmental Science and Oceanography 1

1.1 Geological Oceanography	1
Seafloor Spreading	1
Seafloor Regions	2
1.2 Oceanic and Coastal Regions	6
Sea Coast	6
Rocky Coasts	6
Reefs	8
Islands	9
The Ocean Water Column	11
1.3 Water Movements: Wave, Tides, Currents	12
Wind Waves	12
Tsunami	13
Tides	14
Circulation Patterns	15
1.4 Sea-Level Changes	19
Global Sea-Level Changes	19
Local Sea-Level Changes	23
1.5 Ocean Chemistry	23
Seawater, Salts, and Trace Elements	23
Dissolved Gases	24
Chemicals of Life	25
Study Guide	29
Topics for Review	29
Conservation Exercises	29
Further Reading	30

Box 1-1 Conservation Concern:

Global Warming and the Ocean 20

Box 1-2 Conservation Controversy:

Fertilizing the Ocean 27

Chapter 2 Marine Biology, Ecology, and Conservation 31

2.1 The Conservation Ethic and Biodiversity	31
2.2 Classification and Biology of Marine Organisms	35
Marine Microorganisms	35
Marine Fungi	38
Marine Plants	38
Marine Invertebrates	40
Marine Vertebrates	52
2.3 Marine Ecology Concepts	66
Population Ecology	66
Community and Ecosystem Ecology	68
Study Guide	72
Topics for Review	72
Conservation Exercises	73

Further Reading 73

Box 2-1 Conservation Brief:
What's in a Name? 33

Chapter 3 Conservation of Intertidal and Coastal Ecosystems 75

3.1 Dune and Beach Ecosystems	76
The Dune Ecosystem	76
Dune Impacts	78
Dune Conservation	79
The Beach Ecosystem	81
Beach Impacts	87
Beach Pollution	93
Impacts of Recreational Use of Beaches	95
Beach Harvest Impacts	96
3.2 Intertidal Mudflats	99
3.3 The Rocky Intertidal Zone	101
The Rocky Intertidal Ecosystem	101
Human Impacts on the Rocky Intertidal Ecosystem	105
Rocky Intertidal Protection	112
3.4 Global Climate Change and Intertidal Ecosystems	112
Study Guide	114
Topics for Review	114
Conservation Exercises	114
Further Reading	115

Box 3-1 Conservation Success Stories:

California and Netherland Dunes 82

Box 3-2 Conservation Focus:

Who Owns the Beach? 88

Box 3-3 Learning from History:

Torrey Canyon, Exxon Valdez, and Deepwater Horizon 108

Chapter 4 The Estuary and Marsh: Habitat Impacts and Environmental Protection 117

4.1 The Estuary	117
Estuary Types	117
Physical Characteristics	117
Biological Importance	118
Environmental Impacts	120
Fisheries Conservation	122
4.2 Salt Marsh Ecosystems	126
Salt Marsh Development	126
Salt Marsh Ecology	126
Salt Marsh Destruction	130
Impoundments	132
Pollution	133
Impacts of River Channelization	133
Salt Marsh Restoration Methods	134
4.3 Mangrove Ecosystems	136
Mangrove Distribution	136
Mangrove Reproduction and Growth	139

The Mangrove Ecosystem	140
Mangrove Community Diversity	140
Mangroves as a Buffer and Filter	144
Natural Impacts on Mangroves	144
Human Impacts on Mangrove Ecosystems	145
Social Impacts of Mangrove Loss	149
Mangrove Protection Methods	150
Regional Mangrove Status	151
Mangrove Conservation Prognosis	152
4.4 Global Climate Change and Marsh Ecosystems	153
4.5 The Future of Estuary and Marsh Conservation	154
Study Guide	155
Topics for Review	155
Conservation Exercises	156
Further Reading	156

Box 4-1 Current Issue:

Eels from the Estuary 123

Box 4-2 Learning from History:

Oysters from Chesapeake Bay 127

Box 4-3 Research Brief:

Geese and Snails, Top-Down Killers of the Marsh 131

Box 4-4 Conservation Focus:

Belizean Reef Mangroves 138

Chapter 5 Tropical Coral Reefs: Environmental Impacts and Recovery 159

5.1 The Tropical Coral Reef	160
Biodiversity	160
Reef-Building Organisms	160
Conditions for Reef Growth	161
5.2 Reef Community Interactions	162
Primary Producers	163
Filter Feeders	163
Grazers	163
Predators	165
5.3 Environmental Impacts on Corals	166
Bleaching	166
El Niño	166
Climate Change and Coral Loss	170
Coral Diseases	171
Excessive Nutrients and Organic Matter	172
Sedimentation	173
Toxic Pollutants	173
Combined Impacts	174
5.4 Harvest Impacts	175
Sea Urchin Harvest	175
Organisms as Curios	175
Traditional Medicine	175
Bioprospecting on Reefs	177
Sponge Harvest	178
Conch Harvest	178
Lobster Harvest	179
Destructive Fishing Methods	179
Live Fish Markets	181
Ecosystem Impacts of Fish Harvest	183
5.5 Development and Tourism Impacts	183
Coastal Development	183
Boat Groundings	183
Development for Tourism	184
Snorkeling and Diving	185

5.6 Approaches to Coral Reef Conservation	185
Assessment and Monitoring	185
Education	186
Marine Protected Areas	186
Reef Restoration	187
Education and Community Action	190
5.7 Overview and Future of Coral Reef Conservation	190
Study Guide	191
Topics for Review	191
Conservation Exercises	192
Further Reading	192

Box 5-1 Current Issue:

Attack of the Lionfish 167

Box 5-2 Research Brief:

Historical Ecology of Reefs 176

Box 5-3 Research Brief:

Contrasting Fish Communities on Hawaiian Reefs 188

Chapter 6 Nearshore Ecosystems: Community Ecology and Habitat Protection 195

6.1 Soft Bottom Ecosystems	195
Anthropogenic Impacts on Soft-Bottom Ecosystems	196
Coastal Hypoxia and Dead Zones	197
6.2 Seagrass Ecosystems	199
Seagrasses	199
Seagrass Growth and Reproduction	200
The Seagrass Community	201
Seagrass Interactions with Other Ecosystems	203
Human Benefits	204
Anthropogenic Impacts on Seagrasses	204
Seagrass Protection and Recovery	208
Seagrass Restoration	210
6.3 Rocky Bottom Ecosystems	210
6.4 Kelp Ecosystems	214
Kelps	214
Kelp Communities	216
Impacts to the Kelp Ecosystem	217
Kelp Protection and Recovery	218
6.5 Climate Change and Nearshore Ecosystems	221
Study Guide	222
Topics for Review	222
Conservation Exercises	222
Further Reading	222

Box 6-1 Conservation Efforts:

The Wadden Sea and Chincoteague Bay 207

Box 6-2 Conservation Controversy:

Artificial Reefs 212

Box 6-3 Learning from History:

Phase Shifts in Kelp Ecosystems 219

Chapter 7 The Open Ocean: Anthropogenic Inputs and Environmental Impacts 223

7.1 The Photic Zone	223
Oceanic Epipelagic Ecosystems	226
7.2 Open Ocean Pollution	223
Metals	234
Persistent Organic Pollutants	238

Harmful Plankton Blooms	241
Plastics in the Open Ocean	248
7.3 Climate Change and the Ocean Pelagic	249
Study Guide	252
Topics for Review	252
Conservation Exercises	252
Further Reading	253

<i>Box 7-1 Conservation Success Story:</i>	
Protecting the Creatures of the Sargassum	231
<i>Box 7-2 Learning from History:</i>	
Mercury Scares and Seafood Consumption	236
<i>Box 7-3 Consume with Caution:</i>	
Ciguatera Poisoning	244
<i>Box 7-4 Conservation Controversy:</i>	
Are Red Tides Natural or Man Made?	246

Chapter 8	Seafloor and Deep-Sea Ecosystems: Resource Harvest and Habitat Protection	255
8.1	Continental Shelf and Slope Ecosystems	255
8.2	Seamount Ecosystems	256
8.3	Deep-Sea Ecosystems	259
	The Mesopelagic Zone	259
	The Deep-Sea Pelagic	261
	The Deep Seafloor	261
	Vent and Seep Ecosystems	263
8.4	Impacts of Deep Sea-Fisheries	267
	Fish Harvest	267
	Crab Harvest	269
	Bottom Trawling	270
8.5	Habitat Impacts on the Deep Seafloor	273
	Offshore Oil and Gas Drilling	273
	Impacts of Surface Fisheries on Deep-Sea Ecosystems	275
	Seafloor Mining	276
	Ocean Pollution and Dumping	279
	Climate Change and the Deep Sea	283
8.6	Deep-Sea Conservation Measures	284
	Study Guide	285
	Topics for Review	285
	Conservation Exercises	286
	Further Reading	286

<i>Box 8-1 Conservation Concern:</i>	
Deep-Water Coral Reefs	271

Chapter 9	Marine Endangered Species: Conservation, Protection, and Recovery	289
9.1	Legal Protection	289
	National Endangered Species Legislation	290
	International Agreements	292
9.2	Endangered Species Case Histories	293
	Marine Invertebrates	293
	Seabirds	294
	Penguins	296
	Sea Turtles	299
	Endangered Fishes	303
	Sirenians: Sea Cows and Manatees	305
	Pinnipeds	306

9.3	Future Prospects for Endangered Species Conservation	319
	Study Guide	320
	Topics for Review	320
	Conservation Exercises	320
	Further Reading	321

<i>Box 9-1 Assessing Impacts on Endangered Species:</i>	
Counting Fishery Bycatch	297
<i>Box 9-2 Turtles, Trawls, and TEDs</i>	
301	
<i>Box 9-3 Learning from History:</i>	
Northern Fur Seals	308
<i>Box 9-4 Animal Welfare, Hunter Rights, and Conservation:</i>	
Clashes Over the Harp Seal	315

Chapter 10	Conservation of Cetaceans	323
10.1	Legal Protections of Cetaceans	323
10.2	Cetacean Harvest	325
	Historic Use of Whales	325
	The Great Whales and Commercial Whaling	326
	Whale Recovery	332
	Takings of Dolphins and Porpoises	334
10.3	Unintended Anthropogenic Harm to Cetaceans	335
	Pollution	335
	Climate Change	338
	Ship Collisions	339
10.4	Captive Cetaceans and Animal Rights	342
10.5	Cetacean Conservation Solutions	343
	Study Guide	345
	Topics for Review	345
	Conservation Exercises	346
	Further Reading	346

<i>Box 10-1 Whaling:</i>	
The Ongoing Debate	329
<i>Box 10-2 Are the Great Whales Important Prey for Killer Whales?</i>	
334	
<i>Box 10-3 Noise Pollution and the Mysteries of Cetacean Strandings</i>	
336	
<i>Box 10-4 Right Whales in the Wrong Place</i>	
340	
<i>Box 10-5 Freeing Willy</i>	
344	

Chapter 11	Marine Fisheries: Overharvest and Conservation	349
11.1	Fisheries Characterization	349
11.2	Fisheries Harvest Methods	353
	Dredging	354
	Spears and Harpoons	354
	Hook-and-Line Gears	355
	Traps and Weirs	358
	Net Fishing	359
11.3	Marine Fisheries Overharvest	365
11.4	Managing Fisheries for Sustainability	370
	Harvest Quotas	370
	Ecosystem-Based Management	372
	Aquaculture as a Solution to Overharvest	373
11.5	Conservation of Fishery Populations	375
	Coastal Pelagic Fisheries	376
	Groundfish Fisheries	381

Highly Migratory Predators	386
Shark Harvest and Conservation	391
11.6 Climate Change and Fisheries	394
Study Guide	395
Topics for Review	395
Conservation Exercises	395
Further Reading	396
<i>Box 11-1 Fishing Down the Food Web</i>	368
<i>Box 11-2 Unpredictability in Pelagic Ecosystems</i>	369
<i>Box 11-3 Learning from History:</i>	
<i>Boom and Bust of Atlantic Cod Fisheries</i>	381
<i>Box 11-4 Conservation Controversy:</i>	
<i>The World's Most Valued Fish</i>	387

Chapter 12 Ocean Conservation Laws, Agreements, and Organizations . . . 399

12.1. Tragedy of the Commons and Marine Resources	399
12.2. Marine Conservation Laws and Agreements	401
Marine Species Protections	402
Ocean Commons: International Agreements	403
Coastal Ocean Commons Laws: Case Studies	407
Global Environmental Agreements	419

12.3 Marine Environmental and Conservation Organizations	421
Government Organizations	421
International Organizations	422
Non-Governmental Organizations	425
12.4 The Future of the Ocean Commons	426
Study Guide	428
Conservation Exercises	428
Further Reading	428

<i>Box 12-1 Case History:</i>	
<i>Establishing U.S. Marine Fisheries Management Principles</i>	409
<i>Box 12-2 Case Study:</i>	
<i>Conflicts Between Trade Laws and Conservation</i>	420
<i>Box 12-3 Conservation Concern:</i>	
<i>What Seafood Should I Eat?</i>	427

Index 431

Credits 448