

MANAGING OCEAN ENVIRONMENTS IN A CHANGING CLIMATE

Sustainability and Economic
Perspectives

Edited By

KEVIN J. NOONE

USSIF RASHID SUMAILA

ROBERT J. DIAZ



ELSEVIER

AMSTERDAM • BOSTON • HEIDELBERG • LONDON • NEW YORK • OXFORD
PARIS • SAN DIEGO • SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO

FOUNDATION FOR THE SEA
o:keanos

Contents

Contributors ix

Preface xi

1. Valuing the Ocean: An Introduction

KEVIN J. NOONE, USSIF RASHID SUMAILA AND ROBERT J. DIAZ

- Purpose and Scope of the Book 2
- Differential Analysis for Future Scenarios 3
 - Expert Survey Approach 9
- The Matrix: Values, Threats, and Knowledge 9
 - Knowledge for Decision Support 12

2. Ocean Acidification

CAROL TURLEY

- Cause and Chemistry 15
- Time and Space Scales 17
- Future Ocean Acidification Scenarios 21
- Potential Future Effects on Physiological Processes and Behavior 25
- Impacts on Communities, Food Webs, and Ecosystems 32
- Conclusions 35

3. Ocean Warming

KEVIN J. NOONE AND ROBERT J. DIAZ

- Introduction 45
- Physical Consequences of Ocean Warming 46
- Biological Consequences of Ocean Warming 57
- Summary and Take-Home Messages 62

4. Hypoxia

ROBERT J. DIAZ, HANNA ERIKSSON-HÄGG AND RUTGER ROSENBERG

- Key Messages 67
- Introduction 68
- The Heart of the Problem 71
- Global Patterns in Hypoxia 73

<i>OMZs and Open Ocean Decline in Oxygen</i>	78
<i>Environmental Consequences of Hypoxia</i>	81
<i>Economic Consequences of Hypoxia</i>	85
<i>Global Change and Hypoxia</i>	87
<i>Restoration and the Future of Hypoxia</i>	90

5. Sea-Level Rise

KEVIN J. NOONE

<i>Introduction</i>	97
<i>Causes of Sea-Level Rise</i>	97
<i>Observations of Sea-Level Rise</i>	109
<i>Sea Level Rise in the Future</i>	111
<i>Impacts of Sea-Level Rise</i>	115

6. Marine Pollution

DAN WILHELMSSON, RICHARD C. THOMPSON, KATRIN HOLMSTRÖM, OLOF LINDÉN
AND HANNA ERIKSSON-HÄGG

<i>Introduction</i>	127
<i>Chemical Pollution—POPs and Metals/Toxic Chemicals</i>	129
<i>Oil Pollution</i>	135
<i>Solid Substances</i>	143
<i>Radioactive Waste</i>	150
<i>Noise</i>	152
<i>Present and Forecasted Impacts of Pollution on Global Marine Ecosystems</i>	157

7. The Potential Economic Costs of the Overuse of Marine Fish Stocks

USSIF RASHID SUMAILA, WILLIAM W.L. CHEUNG AND A.D. ROGERS

<i>Fish and Fisheries Are Important to People</i>	171
<i>Evidence of Overuse of Fish Stocks</i>	173
<i>Climate Change Will Exacerbate the Problem of Overuse of Fish Stocks</i>	179
<i>Global Economic Loss due to Overfishing</i>	181
<i>Estimated Economic Losses</i>	184
<i>Conclusion</i>	186

8. Impacts of Multiple Stressors

JULIE HALL, ROBERT J. DIAZ, NICOLAS GRUBER AND DAN WILHELMSSON

<i>Introduction</i>	193
<i>Global-Scale Stressors</i>	195
<i>Local- and Regional-Scale Stressors</i>	200
<i>Feedbacks and Synergistic Effects</i>	203
<i>Concluding Remarks</i>	215

9. Tipping Points, Uncertainty, and Precaution: Preparing for Surprise

KEVIN J. NOONE AND FRANK ACKERMAN

Introduction	223
Why Buy Insurance?	226
Making Decisions in the Dark	228
Peering into the Future	231
Shell Game	231
Pentagon Planning	233
Safe Standards and Planetary Boundaries	235

10. Valuing the Ocean Environment

FRANK ACKERMAN

Introduction	243
What Is Not Included	244
Classic Studies of the Value of Ocean Environments	247
Fisheries and Climate Change	252
Tourism and Climate Change	254
Costs of SLR	257
Stormy Weather	259
Shrinking the Ocean Carbon Sink	262
Valuing the Damages	265
Scenario Definitions	266
Fisheries	267
Sea-Level Rise	267
Storms	268
Tourism	268
Ocean Carbon Sink	269

11. Managing Multiple Human Stressors in the Ocean: A Case Study in the Pacific Ocean

WILLIAM W.L. CHEUNG AND USSIF RASHID SUMAILA

Introduction	277
Pattern of Biodiversity and Marine Living Resources	278
Key Human Pressures in the Pacific Ocean	282
Challenges to Sustainable Management of Fisheries Resources in the Pacific Ocean	283
Climate Change	287
Sustainable Management of the Pacific Ocean	294

12. Paths to Sustainable Ocean Resources

KATERYNA M. WOWK

Introduction	301
Implications of Major Threats and Policy Recommendations	303
Multiple Stressors: Putting the Pieces Together	323
Implications of Valuing Ocean Damages and Planning for Surprise	329
Pacific Region Case Study—Implications for Regional Ocean Governance	334
The Next Era of Global Ocean Governance: Paths to Sustainability	336
Concluding Recommendations	340
Index	349