

CONTENTS

Introduction: Global Warming and Polar Ecosystems <i>Carlos M. Duarte</i>	13
1. The Impact of Increasing Ultraviolet Radiation on the Polar Oceans <i>Susana Agustí</i>	23
1.1. Ultraviolet radiation and the terrestrial ozone layer	25
1.2. Atmospheric pollution and ozone decline	26
1.2.1. An ozone hole over Antarctica	28
1.2.2. The current situation: predictions and global warming	29
1.3. Increased UV radiation over the polar regions	32
1.4. Damage induced by UV radiation and protection mechanisms	34
1.4.1. Avoiding exposure to UV radiation: plankton migrations	35
1.4.2. Protection and repair systems	36
1.4.2.1. Protective cellular structures or “parasols”	36
1.4.2.2. “Sun filter” production	37
1.4.2.3. Antioxidants	38
1.4.2.4. Repair systems	38
1.5. Impact of increasing UV radiation on the polar oceans	39
Acknowledgements	43
References	43
2. Are Declining Antarctic Krill Stocks a Result of Global Warming or of the Decimation of the Whales? <i>Victor Smetacek</i>	45
2.1. Introduction	48
2.2. Iron limitation of productivity	50
2.3. Diatoms, euphausiids and blue whales	53
2.3.1. Diatoms	53
2.3.2. Antarctic krill	55
2.3.3. Blue whales	58
2.4. Distribution of <i>Euphasia superba</i>	60
2.5. Krill stock size	61
2.6. Evidence for the decline of krill biomass	66

2.7. Ecosystem conditioning by the “food chain of the giants”	71
2.8. Testing the hypothesis	76
2.9. Conclusions	77
Acknowledgements	78
References	79
3. The Impact of Climate Change on Antarctic Megafauna	
<i>Jaume Forcada</i>	83
3.1. Introduction	86
3.2. The Antarctic marine ecosystem and the importance of krill for the megafauna	88
3.3. Antarctic megafauna: life history, ice adaptation and critical habitats ...	91
3.3.1. Life history variability and ice adaptation	93
3.3.1.1. Seabirds	93
3.3.1.2. Marine mammals	96
3.3.2. Ice adaptation and critical habitats	104
3.4. The consequences of interacting anthropogenic effects for Antarctic megafauna	106
3.5. Is global warming a real problem for the Antarctic megafauna?	108
3.6. Is it possible to predict the future?	108
References	109
4. Impacts of Global Warming on Arctic Pelagic Ecosystems and Processes	
<i>Paul Wassmann</i>	111
4.1. Introduction	114
4.2. A few facts about the worlds last <i>terra incognita</i> : the Arctic Ocean ..	116
4.3. Primary production and carbon budgets in the Arctic Ocean	119
4.4. Engirdling the Arctic Ocean: marginal ice zones and flaw lead polynyas	124
4.5. Pelagic-benthic coupling and phasing in the open water-SIZ-MYI complex: some basic considerations	126
4.6. Physical-biological forcing of Arctic shelves: past, present, future	132
4.7. Arctic marine research: a pressing need for international cooperation	135
Acknowledgements	135
References	136
5. Effects of Global Warming on Arctic Sea-Floor Communities and its Consequences for Higher Trophic Levels	
<i>Paul E. Renaud, Michael L. Carroll and William G. Ambrose Jr.</i>	139
5.1. Introduction	141
5.2. Why study benthos?	141
5.3. The scope of this chapter	145

5.4. Climate change and climate variability in the Arctic	145
5.4.1. A period of climate change	145
5.4.2. Temporal patterns of environmental variability	147
5.4.3. Spatial patterns of environmental variability	148
5.5. Insights from paleoceanography and historical case studies	149
5.5.1. Case Study 1: proxy studies of climate change over the past 3 million years	150
5.5.2. Case Study 2: human impacts and the structure of ecosystems	151
5.5.3. Case Study 3: the 1920s and 1930s warming period	152
5.5.4. Case Study 4: regime shift in the Bering Sea	154
5.6. Impacts on the ecology of arctic communities	156
5.6.1. Biodiversity and community structure	156
5.6.2. Carbon cycling	160
5.6.3. Reproduction	161
5.6.4. Trophic interactions	162
5.7. Research recommendations	164
5.8. Conclusions	166
Acknowledgements	167
References	168
List of Photographs	179
List of Illustrations	181
Index	183
About the Authors	187





