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BOOK REVIEW

The inescapable influence of sea ice - a fundamental Earth ecosystem

Sea Ice, 3rd edition, by David N. Thomas (editor), 2017
Wiley-Blackwell, 664 pp., £150 (hardback) , ISBN: 9781118778357

The most striking first impression of this third edition of *Sea Ice* is its scope and breadth. The editorial team has clearly made a significant effort to bring together a group of expert contributors to comprehensively cover the broadest possible range of topics related to sea ice. This edition is considerably expanded from the previous, with twelve new chapters, many of which focus on interactions with biological communities and ecosystems.

For the first half of the book there is a strong narrative, starting with a useful introductory chapter, then progressing cogently from physical characteristics, to atmospheric and oceanographic interactions, to the importance of remotely sensed data, temporal changes, the role of sea ice in Earth System Models and several detailed and comprehensive chapters on the relationship of sea ice to biological life (including microbes, primary producers and micro- and macro-grazers). In the second half the narrative is less structured; each chapter stands alone, and the shifting focus is only a distraction if reading the book from cover to cover. The subject matter in the second half includes nutrients, gases, contaminants, biogeochemical models, indigenous use and the role of sea ice as a habitat for marine mammals and birds.

The book is quite technical in places. Given much of the subject matter (particularly with regard to the physical sciences) this is impossible to avoid. Nevertheless, it is generally well-written in a manner accessible to a broad readership. A good example of this is the chapter by Sturm and Massom on the importance of snow in sea ice dynamics. The complexities of the relationship between sea ice and snow, expressively described by the authors as "...exquisite timing, a dance ... between snow and sea ice" are provided in comprehensive

and readable detail, from the shapes of snowflakes and how they deform, to the ecological and biogeochemical properties of the snow-ice interaction. Many of these aspects are explored further in later chapters of the book, but this is an excellent summary and will likely be of considerable interest to life scientists.

A timely overview by Spreen and Kern of the importance of remotely sensed sea ice data in providing insights into extent, movements and more recently, thickness, is also a key chapter for biologists and ecologists. Here, the fundamental role that these data have played in improving our broader understanding of the global implication of climate change is clearly outlined and reinforced. Likewise the chapters on temporal changes in sea ice rise to the challenge of summarising complex, and often confounding data, with excellent overviews of the unequivocal Arctic trends (Meier) and a clear explanation of the nuances in the strong regional differences in Antarctic sea ice trends (Stemmerjohn and Maksym). Both of these chapters include well-referenced sections on the uncertainties and limitations of these predictions.

As a habitat, sea ice represents one of the largest ecosystems on the planet and at its peak, across the polar regions, it can cover approximately 26-31 million km² each year. Its importance as a habitat, and the role that it plays in supporting the biota of the region, is well documented in the eight chapters focussed primarily on biological interactions. From microbes to mammals, these chapters comprehensively cover a myriad of dynamic and complex interactions that occur between biological life and sea-ice and revisit, in detail, many of the important links touched on in earlier chapters on the physical characteristics.

The relationship between sea ice and primary producers is well-known as one of the most

important underpinning polar food webs. The dynamics of these interactions are well documented in the chapter by Arrigo on primary producers. Biogeographically, differences between the Arctic and Antarctic are highlighted, and unlike most of the other biological chapters, species specific distributional data are provided, including temporal and spatial variation. At the other end of the biological spectrum, the importance of sea ice to polar mammals and seabirds is covered across several chapters that are simply structured as species-by-species accounts. These sections highlight similarities across the poles – with sea ice providing a dependable source of food for a multitude of species or as habitat that provides critical breeding grounds for seals, polar bears and seabirds. The importance of polynyas (areas of unfrozen sea water surrounded by ice) for many species are also reinforced in these sections.

Most chapters are essentially reviews, and on the whole are well-researched, comprehensively referenced and extremely well illustrated by clear and informative figures. The coverage is impressive and there are few gaps. One area that might have been given more attention is the important role that sea ice plays in regulating the benthic environment, especially in coastal Antarctic areas (e.g. Clark et al. 2013). From a biogeographical perspective, there are relatively few species-specific data on differences in assemblages both between and within the Arctic and Antarctic regions. Nevertheless, as a one-stop-shop for sea ice related biological information, *Sea Ice* should be commended for the level of detail that is included.

Almost all chapters finish up with an outlook on the future. These are extremely useful sections, and most share a common theme – high levels of uncertainty and general lack of confidence in predicting future scenarios. This is not surprising given the complex and dynamic nature of interactions between factors such as ice growth rate, seawater salinity, ocean currents and biological life. Include the iterative feedback and interactions with global climate and the future becomes even more uncertain. Nevertheless, *Sea Ice* provides an unparalleled resource for all matters related to sea ice, and will be of interests to students, researchers and teachers across a diverse range of disciplines.

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