

Preface

Disturbance is a key concept in understanding various ecological issues such as biodiversity, community assemblages, ecosystem stability and resilience, and nature conservation. Earthquakes and resulting tsunamis are extreme examples of such disturbance. Because these events can result in rare but intensive disturbance of large areas, monitoring and examination of organismal response to these events at species, population, community and landscape levels provide invaluable opportunity to uncover the ecological significance of large-scale disturbances.

In our society, earthquake and tsunami disasters have the potential to cause great loss to human lives and properties. Therefore, society has made extensive efforts to reduce the risks of such natural disasters. However, knowledge of biological and ecological responses regarding such extreme disturbances is also essential and has led to the recent development of the Ecosystem based Disaster Risk Reduction (EcoDRR). Ecosystems routinely provide us with important ecosystem services. Therefore, a harmonious balance needs to be considered between ecosystem properties and man-made infrastructure to reduce disturbance risk to ecosystems.

The Great East Japan Earthquake on 11 March 2011, registering 9.0 on the Moment Magnitude Scale (Mw), caused large tsunamis that struck the Pacific coastline of eastern Japan (Tohoku), creating intense high impact disturbances to various ecosystems along the coastline. In advance of the disaster, the coastal ecosystems in Tohoku area had been frequently visited and studied by animal and plant ecologists, in part due to the great natural value of the area. Immediately after the Great East Japan Earthquake it was difficult to access and examine coastal ecosystems in detail because infrastructures were heavily damaged in the region. However, as soon as possible following the disturbance, a number of ecologists initiated studies to examine and evaluate the impacts and implications of the Great East Japan Earthquake tsunamis to these coastal ecosystems in the Tohoku area. This book is a compilation

of edited articles from these studies. Most authors of these articles have previously studied the coastal ecosystems in Tohoku area prior to this earthquake and thus were highly qualified to describe the changes in the ecosystems as a result of the tsunamis.

This book begins by presenting an outline of the Great East Japan Earthquake disaster (Chap. 1). The book is then divided into two parts; Part I reports on 14 aquatic studies (Chaps. 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15) and Part II is composed of eight terrestrial studies (Chaps. 16, 17, 18, 19, 20, 21, 22, and 23).

The Great East Japan Earthquake affected various aquatic ecosystems not only because of the tsunamis but also as a result of land subsidence. In Chaps. 2, 3, 4, and 5, responses of sessile animal populations and rocky shore communities to these disturbances are described. In Chap. 6, successional changes in a subtidal benthic community after the tsunami disturbances are analyzed. Among the coastal ecosystems, tidal flats were probably the most vulnerable to disturbances by the tsunamis and land subsidence. In the following six chapters (Chaps. 7, 8, 9, 10, and 11), ecological impacts of these disturbances to the tidal flat communities are reported. These studies uncover how and why the community response differed depending on the tidal flats. In Chaps. 12, 13, and 14, direct and indirect effects of disturbances by the earthquake on molluscan populations are described. These studies serve to understand species-specific differences in vulnerability to the tsunami disturbances. In addition to natural ecosystems, the earthquake and resulting tsunamis significantly damaged coastal infrastructures. Accordingly, harmful substances such as fuels were released from some storages facilities in the coastal areas of Tohoku region. In Chap. 15, the ecological consequences of these fuel spills and the subsequent conflagration are reported.

The Great East Japan Earthquake also seriously affected terrestrial vegetation along the Tohoku Pacific coastal area. In Chapter 16, a remote sensing study of the impacts of the tsunamis on a wide range of coastal ecosystems are reported. Chapters 17 and 18 give accounts of the damages and recovery of coastal sand dune communities, in particular the role of buried seeds in the recovery process as seen in Chap. 18. In Chapter 19, a comprehensive evaluation of the tsunami impacts on coastal flora is presented. In addition, damages to the coastal pine forests by the tsunamis are analyzed in detail in Chap. 20. The tsunamis also created wetlands behind sand dunes. Chapter 21 reports on unexpected disturbance outcomes that lead to a revival of certain endangered species. In Chapter 22, the effect of the tsunamis on forest vegetation and its recovery are reported. And, in the final chapter (Chapter 23), the comprehensive monitoring system about the impact and recovery of ecosystems conducted by Ministry of Environment Japan, is introduced.

Since these are natural events, earthquakes and tsunamis will inevitably recur sometime and somewhere in the future. However, such large and rare disturbances are limited, and thus so is ecological knowledge about these disturbances. We believe that the studies in this book are useful not only to deepen our understanding

of these disturbances in ecology but also to seek a way for practical applications of EcoDRR to coastal ecosystems.

We acknowledge Drs. Yoh Iwasa, Tetsukazu Yahara and Takashi Saitoh for their recommendations and encouragements for publishing this book. Finally, we would like to dedicate this book to all the peoples who fell victim and suffered greatly due to the Great East Japan Earthquake and subsequent tsunamis.

Sendai, Japan

Jotaro Urabe
Tohru Nakashizuka

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Urabe, J.; Nakashizuka, T. (Eds.)

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