World Atlas of Mangroves
World Atlas of Mangroves

Mark Spalding, Mami Kainuma and Lorna Collins
First published by Earthscan in the UK and USA in 2010

Copyright © 2010 jointly vested by ITTO, ISME, FAO, UNEP-WCMC, UNESCO-MAB and UNU-INWEH. This publication may not be reproduced, in whole or in part, by any method or process, without written permission from ISME, the focal copyright holder. Applications for such permission with a statement of the purpose and extent of the reproduction desired should be made through and addressed to International Society for Mangrove Ecosystems (ISME), c/o Faculty of Agriculture, University of the Ryukyus, Okinawa 903-0129, Japan (email: isme@mangrove.or.jp). ISME would appreciate receiving a copy of any publication that uses this publication as a source.

All rights reserved

This publication was primarily funded by the International Tropical Timber Organization (ITTO) through ITTO Project PD 276/04 Rev.2 (F). The project was implemented by the International Society for Mangrove Ecosystems (ISME). In addition to ITTO, project partners included FAO Forestry Department, UNEP-World Conservation Monitoring Centre (WCMC), UNESCO-Man and the Biosphere Programme (MAB), and UNU-Institute for Water, Environment and Health (INWEH) and substantial collaboration by The Nature Conservancy (TNC) all of who provided materials or in-kind inputs. The Japanese Government financially supported this project through ITTO.

The designations of geographical entities in this atlas, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of the participating organizations concerning the legal status of any country, territory or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Earthscan Ltd, Dunstan House, 14a St Cross Street, London EC1N 8X, UK
Earthscan LLC, 1616 1 Street, NW, Washington, DC 20036, USA
Earthscan publishes in association with the International Institute for Environment and Development

For more information on Earthscan publications, see www.earthscan.co.uk or write to earthinfo@earthscan.co.uk

ISBN: 978-1-84407-657-4

Typeset by FISH Books
Cover design by Andrew Corbett
Background picture © Earth Observatory/NASA; mangrove picture © Luiz C. Marigo/Peter Arnold/Still Pictures.

A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data

Spalding, Mark.
World atlas of mangroves / Mark Spalding, Mami Kainuma and Lorna Collins. p. cm.
Includes bibliographical references and index.
ISBN 978-1-84407-657-4
G1046D2. S6 2010
335.75 —dc22 2009031020

At Earthscan we strive to minimize our environmental impacts and carbon footprint through reducing waste, recycling and offsetting our CO₂ emissions, including those created through publication of this book. For more details of our environmental policy, see www.earthscan.co.uk.

This book was printed in Malta by Gutenberg Press.
The paper used is FSC certified and the inks are vegetable based.

®
Mixed Sources

Product group from well-managed forests and other controlled sources

www.fsc.org, Cert. No. TT-COC-30434
© 2000 Forest Stewardship Council
The International Tropical Timber Organization (ITTO) is an intergovernmental organization promoting the conservation and sustainable management, use and trade of tropical forest resources. Its 60 members represent about 80 per cent of the world’s tropical forests and 90 per cent of the global tropical timber trade. ITTO develops internationally agreed policy documents to promote sustainable forest management and forest conservation and assists tropical member countries to adopt such policies to local circumstances to implement them in the field through projects. In addition, ITTO collects, analyses and disseminates data on the production and trade of tropical timber and funds projects and other actions aimed at developing industries at both community and industrial scales. All projects are funded by voluntary contributions, mostly from consumer member countries. Since it became operational in 1987, ITTO has funded 900 projects, pre-projects and activities valued at more than US$330 million. The major donors are the governments of Japan, Switzerland and the United States. [www.itto.int](http://www.itto.int)

The International Society for Mangrove Ecosystems (ISME) was established in August 1990 with its headquarters in Okinawa, Japan. The society was registered as a non-profit organization. The statutes stipulate that ISME shall collect, evaluate and disseminate information on mangrove ecosystems, and promote international cooperation. ISME has been conducting its activities at the global level through knowledge application; training and education; and information exchange. As of 2009, ISME’s membership includes 38 institutional and over 1000 individual members from 90 countries. [www.mangrove.or.jp](http://www.mangrove.or.jp)

The Food and Agriculture Organization of the United Nations (FAO) is one of the largest specialized agencies in the United Nations system and the lead agency for agriculture, forestry, fisheries and rural development. The Forestry Department helps nations manage forests in a sustainable way. The Organization’s approach balances social, economic and environmental objectives so that present generations can reap the benefits of the Earth’s forest resources while conserving them to meet the needs of future generations. [www.fao.org](http://www.fao.org)

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the biodiversity assessment and biodiversity policy support arm of UNEP. The Centre has operated for over 25 years, providing objective, scientifically rigorous products and services to help decision-makers recognize the value of biodiversity and apply this knowledge to all they do. The Centre’s core business is locating data about biodiversity and its conservation, interpreting and analysing that data to provide assessments and policy analysis, and making the results available to both national and international decision-makers and businesses. [www.unep-wcmc.org](http://www.unep-wcmc.org)

United Nations Educational, Scientific and Cultural Organization (UNESCO) functions as a laboratory of ideas and a standard-setter to forge universal agreements on emerging ethical issues. The Organization also serves as a clearing house for the dissemination and sharing of information and knowledge while helping Member States to build their human and institutional capacities in diverse fields. The Man and the Biosphere Programme (MAB), proposes an interdisciplinary research agenda and capacity-building aiming to improve the relationship of people with their environment globally. It uses its World Network of Biosphere Reserves as vehicles for knowledge-sharing, research and monitoring, education and training, and participatory decision-making. [www.unesco.org/mab](http://www.unesco.org/mab)

United Nations University Institute for Water, Environment and Health (UNU-INWEH) is the UN think tank on water and contributes to resolving the global water challenges through applied research, capacity-building and policy advice. It is a member of the United Nations University family of organizations, and is supported by the Government of Canada. A dedicated programme focuses on the integration of coastal science and management. It aims to foster sound decision-making, especially in developing countries, through scientific research, and human and institutional capacity-building. Activities particularly focus on coral reef and mangrove habitats. [www.inweh.unu.edu](http://www.inweh.unu.edu)

The Nature Conservancy is a leading conservation organization working around the world to protect ecologically important lands and waters for nature and people. The Conservancy has more than 700 staff scientists, and uses science to guide its work and to build effective conservation actions. With more than one million members the Conservancy works in more than 30 countries. With partners it has helped protect more than 480,000 square kilometres of land and more than 8000 kilometres of rivers, while it operates more than 100 marine conservation projects. [www.nature.org](http://www.nature.org)
Supporting countries/organizations

The objectives of Japan’s Official Development Assistance (ODA) are to contribute to the peace and development of the international community. Japan has utilized its ODA to actively support a number of activities/issues including human resource development as well as global issues such as those related to the environment and water, which are important issues that need to be addressed in order for the international community as a whole to achieve sustainable development. This Atlas project was made possible by an ODA grant provided by the Government of Japan through ITTO. [www.mofa.go.jp](http://www.mofa.go.jp)

Founded in May 1993 on the belief that partnership is the most effective approach achieving a more sustainable way of life, the Thailand Environment Institute (TEI) advocates a participatory approach to shared environmental responsibility. Only through harnessing our collective strengths can we hope to achieve a better life for all. [www.tei.or.th](http://www.tei.or.th)

Tokio Marine & Nichido Fire Insurance is a leading company in Japan's nonlife insurance industry. It was established as the first Japanese nonlife insurance company in August 1879, and this year is the 130th anniversary of the foundation. In 1999, we launched the mangrove reforestation project in areas centred on southeast Asian countries as one of our 120th Anniversary Commemorative Projects. ISME has been supporting our project from the technical side. We have declared our intention to continue this mangrove reforestation project for 100 years. During the last decade, we have planted over 5000 hectares of forests. [www.tokiomarine-nichido.co.jp/en/index.html](http://www.tokiomarine-nichido.co.jp/en/index.html)

The University of the Ryukyus was established in 1950 with the support of the United States Military Government of the Ryukyu islands and it became a national university of Japan in 1972. The university has conducted distinctive research and education based on unique geological and historical characteristics of Okinawa, such as marine sciences, tropical agriculture and Okinawan studies, and has promoted academic exchanges with countries/areas in the Asia-Pacific regions. The university consists of seven faculties (Law & Letters, Tourism Sciences & Industrial Management, Education, Science, Medicine, Engineering and Agriculture) and eight graduate schools. [www.u-ryukyu.ac.jp/en](http://www.u-ryukyu.ac.jp/en)

The Tropical Biosphere Research Center (TBRC) of the University of the Ryukyus was established in 1994 through the unification of the Sesoko Marine Science Center and the Ishigaki Research Institute of Tropical Agriculture. In 2009, TBRC was merged with the Center of Molecular Biosciences. The main objective of the center is to promote broad-based research on the diversity of tropical and subtropical biota and to promote research at molecular level in the fields of natural and biomedical sciences and biotechnology. The TBRC has been hosting more than ten thousand scientists per year to promote research collaborations. [www.u-ryukyu.ac.jp/tbrc](http://www.u-ryukyu.ac.jp/tbrc)

Wetlands International is an independent, non-profit, global organization that works to sustain and restore wetlands and their resources. Based mostly in the developing world, we have 20 offices on all continents and projects in over 100 countries. Our head office is in Ede, the Netherlands. We work from coastal regions up to high mountain wetlands, at river basin scale and in global flyways to address biodiversity and poverty–environment issues. This involves research, capacity building, community-based projects, advocacy and local to international policy influencing. [www.wetlands.org](http://www.wetlands.org)
Guam .......................................................... 172
Kiribati ....................................................... 172
Marshall Islands ........................................... 173
Nauru .......................................................... 173
Northern Mariana Islands .............................. 173
Palau .......................................................... 173
Polynesia ..................................................... 174
American Samoa .......................................... 174
French Polynesia ........................................... 174
Hawaii ......................................................... 174
Niue .......................................................... 175
Samoa ......................................................... 175
Tokelau ....................................................... 175
Tonga .......................................................... 175
Tuvalu .......................................................... 175
Wallis and Futuna ......................................... 176

11 North and Central America
and the Caribbean ......................................... 181
The Bahamas ............................................... 181
Belize .......................................................... 183
Bermuda ...................................................... 183
Cayman Islands .......................................... 185
Costa Rica ................................................... 185
Cuba ........................................................ 186
The Dominican Republic ................................. 189
El Salvador ................................................... 191
Guatemala ..................................................... 191
Haiti .......................................................... 192
Honduras ...................................................... 192
Jamaica ......................................................... 193
Lesser Antilles ............................................. 194
Anguilla (UK) ............................................... 194
Antigua and Barbuda ...................................... 194
Barbados ...................................................... 196
British Virgin Islands (UK) ............................ 196
Dominica ...................................................... 196
Grenada and the Grenadines ............................ 196
Guadeloupe (France) ...................................... 196
Martinique (France) ....................................... 197
Montserrat (UK) ............................................ 197
Netherlands Antilles and Aruba (Netherlands) ... 197
St Kitts and Nevis ......................................... 197
St Lucia ........................................................ 198
St Vincent and the Grenadines ......................... 198
US Virgin Islands (USA) ................................. 198
Mexico .......................................................... 198
Nicaragua ...................................................... 204
Panama ........................................................ 206
Puerto Rico .................................................... 207
Trinidad and Tobago ....................................... 207
Turks and Caicos .......................................... 208
United States of America ............................... 208

12 South America .......................................... 215
Brazil .......................................................... 215
Colombia ...................................................... 222
Ecuador ......................................................... 225
French Guiana ............................................... 229
Guyana ........................................................ 232
Peru ............................................................ 232
Suriname ...................................................... 234
Venezuela ..................................................... 234

13 West and Central Africa ............................... 241
Angola .......................................................... 241
Benin .......................................................... 242
Cameroon ..................................................... 243
Congo ........................................................ 243
Democratic Republic of the Congo .................... 245
Equatorial Guinea ......................................... 246
Gabon ........................................................ 246
The Gambia ................................................... 247
Ghana ........................................................ 249
Guinea ......................................................... 250
Guinea-Bissau ............................................... 252
Liberia ........................................................ 253
Mauritania ..................................................... 253
Nigeria ........................................................ 255
São Tomé and Príncipe .................................... 257
Senegal ........................................................ 258
Sierra Leone ................................................ 260
Togo ............................................................ 261

Annex 1 Species Descriptions and Range Maps ...... 263
Annex 2 National Species Lists ........................ 277
Annex 3 National Statistics ............................ 287
Index .......................................................... 305
Tables, Boxes and Maps

Tables
1.1 The world's 73 mangrove species and hybrids 2
1.2 Regional summaries of mangrove area 6
1.3 The world's largest near-unbroken mangrove tracts 7
1.4 The 12 countries with the largest mangrove areas in the world 8
1.5 Mangrove biomass statistics 13
1.6 Productivity statistics for tropical mangrove systems 14
2.1 Selected examples of economic valuation 30
2.2 Estimated declines in mangrove area by region since 1980 36
2.3 Selected examples of mangrove declines 37
2.4 Examples of mangrove restoration projects 39
3.1 List of acronyms and abbreviations used for protected areas 52
6.1 Impact of the 2004 tsunami upon loss of human lives and wealth in 18 different fishing villages along the south-east coast of India 91

Boxes
2.1 Mangroves and climate change 34
5.1 The unique mangroves of the United Arab Emirates 82
6.1 Coastal protection against tsunami by mangroves and other vegetation along the south-east coast of India 90
6.2 Post-tsunami mangroves of Andaman and Nicobar Islands 93
7.1 Firefly ecotourism in Malaysia 115
7.2 Primate herbivores of the mangroves of Borneo 119
11.1 Mangrove restoration encouraged by plants–microbe interaction in the arid environment of Baja California Sur, Mexico 203
12.1 Experiences in sustainable management and restoration of mangrove forests in Colombia 226
12.2 Coastal dynamics and their consequences for mangrove structure and functioning in French Guiana 230
13.1 Conserving mangroves in Cameroon 244

Maps
1.1 The global distribution of mangroves 8
1.2 The diversity of mangrove species worldwide 10
2.1 Protected areas with mangroves 40

Regional map 1 Western Indo-Pacific 55
4.1 Kenya and Tanzania 59
4.2 Madagascar 60
4.3 Mozambique 63
4.4 South Africa 66
5.1 Red Sea 73
5.2 Arabian Gulf and Gulf of Oman 76
5.3 Gulf of Aden 78
6.1 Northern Bay of Bengal 86
6.2 Southern India, Sri Lanka and the Maldives 89
6.3 Pakistan and north-west India 95

Regional map 2 Central Indo-Pacific 101
7.1 South Sumatra and Java 106
7.2 Borneo 109
7.3 Sulawesi 110
7.4 Nusa Tenggara 111
7.5 Papua (Indonesia) 113
7.6 Peninsula Malaysia and Sumatra 116
7.7 Myanmar 120
7.8 Northern Philippines 122
7.9 Southern Philippines 123
7.10 Thailand 127
7.11 Cambodia and southern Vietnam 130
8.1 Northern Vietnam and southern China 136
8.2 Eastern China and Taiwan 138
8.3 Japan 140
9.1 Northern Australia 144
9.2 North-eastern Australia 146
9.3 Eastern Australia 149
9.4 South-eastern Australia 150
9.5 South Australia 152
9.6 Western Australia 153
9.7 North-western Australia 154
9.8 New Zealand 156

Regional map 3 Eastern Indo-Pacific 159
10.1 Fiji 162
10.2 Papua New Guinea 165
10.3 Solomon Islands 167
10.4 Vanuatu and New Caledonia 168
10.5 Western Micronesia 170
10.6 Kiribati and Tuvalu 171
Regional map 4: The Americas 179
11.1 Yucatan, Belize and northern Honduras 184
11.2 Cuba and Jamaica 187
11.3 Eastern Greater Antilles 190
11.4 Lesser Antilles 195
11.5 Gulf of California 200
11.6 Gulf of Mexico 201
11.7 Central America 205
11.8 Florida and the Bahamas 209
12.1 Northern Brazil 216
12.2 North-eastern Brazil 219
12.3 Southern Brazil 221
12.4 Northern Colombia and western Venezuela 223
12.5 Pacific South America 228
12.6 Eastern Venezuela and the Guianas 233

Regional map 5: West and Central Africa 239
13.1 North-west Africa 248
13.2 Guinea Bissau to Sierra Leone 251
13.3 Liberia, Cote d'Ivore and Ghana 254
13.4 Gulf of Guinea 256
13.5 Gabon to Angola 259