











Guidelines for Seagrass Ecosystem Restoration in the Western Indian Ocean Region











Published by the United Nations Environment Programme/Nairobi Convention Secretariat.

Copyright © Nairobi Convention 2020. All rights reserved

Rights and Permissions:

This publication may be reproduced in whole or in part and in any form for educational or non-profit services without special permission from the copyright holder, provided acknowledgement of the source is made. However, the Nairobi Convention encourages dissemination and use of the materials in this report. The Nairobi Convention would appreciate receiving a copy of any publication that uses this publication as a source. No use of this publication may be made for resale or any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme-Nairobi Convention.

Disclaimer:

The findings, interpretations and conclusions expressed herein are those of the authors and do not necessarily reflect the views of the Contracting Parties to the Nairobi Convention, UNEP and WIOMSA This publication has been produced by the United Nations Environment Programme/Nairobi Convention Secretariat through the GEF funded WIOSAP and the SIDA Partnership Project, WIOMSA through the MASMA Programme in collaboration with various governments, Civil Society Organizations, and other partners in the region.

Compiled and prepared by:

Paul L.A. Erftemeijer

Series Editor.

Matthew D. Richmond

Designed by:

Marco Nunes Correia

Coordinated by:

Jared Bosire, Julius Francis and Timothy Andrew

Drawings:

Figure 1 courtesy of the National Oceanic and Atmospheric Administration (NOAA), drawn by Natalie Cosentino-Manning and Milena Viljoen

Citation:

UNEP-Nairobi Convention/WIOMSA (2020). Guidelines for Seagrass Ecosystem Restoration in the Western Indian Ocean Region. UNEP, Nairobi, 63 pp. A digital copy of this report is available at: www.nairobiconvention.org/; www. wiomsa.org

Western Indian Ocean Ecosystem Guidelines and Toolkits ISSN: 2714-1942

Table of Contents

1. INTRODUCTION	1
1.1 Background	1
1.2 Objectives of the Guidelines	1
1.3 Target readership	1
1.4 Process followed in the development of the guidelines	1
2. SEAGRASS ECOSYSTEMS IN THE WIO REGION	5
2.1 Seagrass species	5
2.2 Ecosystem functions and values	6
2.3 Drivers of decline	7
2.4 The case for seagrass restoration	
2.5 Incorporating seagrass restoration into policy frameworks	8
3. SEAGRASS RESTORATION – GENERAL CONSIDERATIONS	
3.1 Terms and definitions	
3.2 Common sense considerations	
3.3 Hierarchy of approaches to seagrass restoration and management	13
4. RESTORATION METHODS	
4.1 Manual transplanting	
4.1.1 Sediment-free methods	
4.1.2 Seagrass-with-sediment methods	
4.1.3 Seed-based methods	
4.2 Mechanical transplanting	22
5. RESTORATION SITE IDENTIFICATION	
5.1 Checklist of criteria for site selection	29
6. PRINCIPLES OF BEST PRACTICE – A RESTORATION PROTOCOL	31
6.1 Guiding principles for restoration planning	
6.2 Other practical considerations	32
7. RESTORATION MONITORING	
7.1 Introduction	
7.2 Monitoring indicators	
7.3 Monitoring reports	40
8. SEAGRASS RESTORATION MANAGEMENT PLAN	
8.1 Project planning phase	41
8.2 Project implementation phase	
8.3 Project monitoring & evaluation phase	
8.4 Recommendations for research	43
9. REFERENCES	45

Case Studies

CS 1.	Seagrass Zostera capensis restoration experiment using a 'plug' method on tidal flats in Maputo Bay (Mozambique)	2
CS 2.	Susceptibility and clean-up of seagrass beds impacted by oil spills By Matthew D. Richmond	9
CS 3.	Passive seagrass restoration at Port Manatee, Florida (USA)	12
CS 4.	Translocation of a Ruppia tuberosa seed bank in the Coorong	14
CS 5.	Eelgrass restoration in Chesapeake Bay using adult plants and seeds	23
CS 6.	Relocation of large sods of intertidal Zostera noltii eelgrass using a modified excavator in The Netherlands	25
CS 7.	Community-based seagrass restoration trial at Beravy, Toliara (Madagascar)	28
CS 8.	Facilitating Amphibolis seedling recruitment with artificial substrates	33
CS 9.	'Seeds for Snapper': Collection, processing and broadcast delivery of <i>Posidonia australis</i> seeds	34
CS 10.	Community-based seagrass bed restoration trials at Diani and Wasini Island, Kenya	44

List of Plates

Plate 1.	Photographic impression of the ongoing seagrass restoration project at Maputo Bay (Mozambique) using cores of seagrass for the transplantation of Zostera capensis on intertidal flats affected by clam digging.	2
Plate 2.	Seagrass species of the WIO region (scans of dried herbarium specimen; note flowering parts in specimen for <i>Ruppia maritima, Enhalus acoroides</i> and <i>Syringodium isoetifolium</i>).	. 5
Plate 3.	Impressions of typical seagrass meadows in the Western Indian Ocean, here showing a mixed stand of <i>Thalassodendron ciliatum</i> and <i>Enhalus acoroides</i> (left), and a close-up of <i>Thalassodendron ciliatum</i> (right).	6
Plate 4.	Seagrass meadows in the WIO region serve a range of important ecosystem services, including as feeding grounds for endangered species such as Green turtles (left) and sustaining local fisheries (right).	7
Plate 5.	Impact of tourism industry on seagrasses. Seagrass cover declined in front of a Mombasa north coast beach hotel.	8
Plate 6.	Seagrass salvage and restoration work at Tampa Bay (Florida): Top: 'Giga-unit sod' transplanting machine. Bottom (left): intertidal area from where 1x1 m seagrass sods have been removed with the 'giga-sod' machine (see frame for reference of scale). Bottom (right): demarcation buoys used to prohibit all entry, transit, anchoring or drifting within restricted areas to allow seagrass to recover from boating damage.	12
Plate 7.	Stages in the <i>R. tuberosa</i> translocation program 2014/2015: (a) harvesting seeds in sediments at Lake Cantara, (b) stores of sediments containing seeds, (c), placement of stored sediments and (d), spreading actions.	14
Plate 8.	Diagram showing the general morphology of a seagrass plant	18
Plate 9.	Demonstration of the staple method, showing the attachment of a seagrass shoot to the staple (left) and insertion of the staple into the sediment during planting.	19
Plate 10.	Demonstration of weaving seagrass shoots into biodegradable hessian mesh material	19
Plate 11.	Demonstration of an adapted version of the frame method (as successfully tested in Kenya), whereby seagrass plants are tied to a metal frame that is placed and secured on the seafloor to restore damaged areas.	20
Plate 12.	Demonstration of 'seagrass-with-sediment' methods, showing sod with shovel (left) and two sizes of plugs with corers (centre and right).	21
Plate 13.	Demonstration of the Buoy-Deployed Seed Bags (BuDs) method, showing individual bag-with-buoy units filled with seed-containing flowering shoots and spathes (left) and their field deployment on an intertidal flat (right).	22

Plate 14.	Buoy-deployed seed bag method (including assemblage and deployment), one of the methods used to restore eelgrasses at Chesapeake Bay (USA).	23
Plate 15.	Mechanical harvesting of seed stock from donor areas, seed processing in tanks at the lab, and handling of seeds ready for casting out, usually from a small boat.	_24
Plate 16.	Photographic impression of the sod relocation method at the intertidal sites in the Eastern Scheldt, showing the modified backhoe scraping technique and transplant relocation.	_25
Plate 17.	Photographic impression of the ongoing seagrass restoration project at Beravy, Tuliara (Madagascar) using spades for the excavation of seagrass sods for transplantation into degraded areas.	28
Plate 18.	Amphibolis antarctica recruitment facilitation approach showing: (a) Amphibolis seedling with close-up of grappling hook (see arrow) to assist anchorage; (b) recently deployed sand bags laid out for monitoring; (c) 6-month old deployment covered in Amphibolis seedlings; (d) restored Amphibolis patch showing coalescence from ~40 bags.	33
Plate 19.	 (a) Mature <i>Posidonia australis</i> fruit prior to collection; (b) harvested fruits in 100 L cooler for transport to lab; (c) processing fruit after collection; (d) after processing, seeds are clean and ready for delivery to field sites; (e) seeds scattered on surface of sediment (200 seeds m⁻²); (f) close up of seeds settled on the sea floor; (g) 1 year old established seedlings; (h) seedlings established in high density; (i) two year old seedling with multiple shoots. 	34
Plate 20.	Community-based seagrass restoration project at Wasini Island, involving the planting of seagrass seedlings using hessian bags for anchorage and sediment stabilisation (right), after advance consultation and planning by the local community (left).	44

List of Tables

Table 1.	Suitability of different seagrass restoration methods by species.	26
Вохе	es	
Box 1.	Common reasons for failure of seagrass restoration attempts	13
List	of Figures	
Figure 1.	Potential impacts of oil spills to seagrass and associated organisms.	g
Figure 2.	Basic steps and considerations of a seagrass restoration management plan.	41

预览已结束,完整报告链接和二维码如下:

https://www.yunbaogao.cn/report/index/report?reportId=5_13796



