Report by the Reef Restoration *ad hoc* Committee to the 35th General Meeting

Action requested of the 35th ICRI General Meeting

The ICRI General Meeting is invited to review the outputs of the *ad hoc* committee and:

1. Note progress of the work of the *ad hoc* committee;
2. Consider and if appropriate continue ICRI's engagement with coral restoration and adaptation, including via revision of the terms of reference for the continuation of an *ad hoc* committee (Annex 1);
3. If the *ad hoc* committee is continued, consider joining the *ad hoc* committee if not already engaged.

Background

ICRI Plan of Action

The ICRI 2018-2020 Plan of Action included the following objectives:

- Establish an inventory of existing and future reef restoration activities throughout the world;
- Identify leading and innovative practices, techniques and strategies (including their limits, conditions of implementation, financing, and an assessment of their results);
- Revise the 2005 ICRI resolution on coral reef restoration in light of new scientific and management knowledge;
- Seek active collaboration and participation with organisations in the field including the International Coral Reef Society (ICRS), Commonwealth Blue Charter, the Coral Restoration Consortium (CRC), and Australia's Reef Restoration and Adaptation Program (RRAP).

Ad hoc committee on reef restoration formation

An *ad hoc* committee on reef restoration was created at the 33rd ICRI General Meeting (Monaco, December 2018).

Chaired by Australia, the committee gathered experts from the ICRI membership to assess and document:

- Global needs and priorities for current and future reef restoration and adaptation programs;
- Global research and development priorities to deliver the methods, productivity and cost breakthroughs needed to support restoration and adaptation program objectives;

- Priority drivers and areas for reef investment.

Additionally, the committee gathered expert views to:

- Identify mechanism(s) to improve joint planning and delivery of reef restoration and adaptation research and development;
- Identify (at a high level) opportunities to partner on reef restoration and adaptation research and development activities.

Further, in 2019, the committee was tasked with the following aims:

- To establish an inventory of existing and future reef restoration activities throughout the world;
- To identify leading and innovative practices, techniques and strategies.

UNEP Resolution

The United Nations Environment Assembly (UNEA) resolution 4/13 on "Sustainable coral reefs management" was adopted by all member states during the fourth UNEA in Nairobi in March 2019. Following this resolution, UNEP supported the development of a compilation of best practices for coral reef restoration in collaboration with ICRI.

Ad hoc committee on reef restoration extension

At the ICRI General Meeting in Townsville, December 2019 a resolution was passed to extend the *ad hoc* committee for another year and update the terms of reference as follows.

- To continue to assess and document global needs and priorities for current and future reef restoration and adaptation programs;
- To continue to assess and document global research and development priorities;
- To provide a coordinating mechanism for international collaboration on coral reef restoration research and development;
- To advocate for the use of best practice restoration techniques and highlight examples of relevant policy and legislation as part of a broader strategy that involves traditional management and reducing carbon emissions in order to maintain coral reef function, structure and resilience;
- To facilitate the transfer of new knowledge of restoration techniques to managers and restoration practitioners; and
- To update the global database on coral restoration methods and integrate it with the ICRI website, if resources are available.
- The *ad hoc* committee will last not more than one year, with the final report to be presented at the 35th ICRI General Meeting.

The composition and functioning of the *ad hoc* committee

The *ad hoc* committee has been chaired by Australia. The membership includes: Australia, Belize, Blue Charter, France, Great Barrier Reef Foundation (GBRF), Indonesia, ICRI Secretariat, International Coral Reef Society, Reef-World, Japan, Monaco / CSM, SPREP, The Nature Conservancy, UNEP-WCMC, USA/ NOAA, UN Environment. A coordinator (Ian McLeod) was recruited in April 2019, thanks to the financial support of Australia. Mars Incorporated joined the *ad hoc* committee in January 2021. A web page with information on the work of the *ad hoc* committee and providing links to its outputs and other relevant material was set up on the ICRI Forum in late 2019: https://www.icriforum.org/reef-restoration-ad-hoc-committee.

The *ad hoc* committee has for the most part worked virtually. A virtual collaborative working space (a shared folder in Google Drive) was provided by Australia to help facilitate online engagement. Virtual online meetings with the full *ad hoc* committee were held most months between April 2019 and December 2020. To cope with the range of time zones each meeting was held twice, with the same agenda to maximise opportunities to contribute. These were well attended with around 10 member representatives joining each month across the two meetings. The combined notes from each of the meetings were made available via the Google Drive folder. One face-to-face meeting was held at the ICRI General Meeting in Townsville, December 2019. There have also been numerous side meetings with committee members to work on specific projects and outputs. There has been a good level of engagement of *ad hoc* members and all members were supportive of the continuation of the *ad hoc* committee into 2021.

Progress and outputs

Establish an inventory of existing and future reef restoration activities throughout the world

A coral restoration database with 364 individual projects was built and published online along with a supporting journal article 'Coral restoration - a systematic review of current methods, successes, failures and future directions' (Boström-Einarsson et al. 2020). This article was nominated by reviewers to F1000 as an outstanding contribution to research and had been cited 34 times by 1st February 2021. This was produced by the *ad hoc* committee in partnership with Australia's Reef Restoration and Adaptation Program and the Australian Government's Nation Environmental Science Program (NESP). The article and database were supported with an interactive visualisation built using the software program Tableau. This database and supporting interactive visualisation was updated by the ICRI *ad hoc* committee in October 2020, bringing the total number of case studies to 407. This was added to the ICRI website's Restoration Hub in January 2021.

Identify leading and innovative practices, techniques and strategies (including their limits, conditions of implementation, financing, and an assessment of their results)

In 2019, the *ad hoc* committee surveyed ICRI members about their views and needs for coral restoration through an online survey, expert elicitation through meetings, and a desktop review. The findings from this survey and a literature review were brought together in the *ad hoc* committee's major report for 2019 'Mapping current and future priorities for coral restoration and adaptation programs' (McLeod et al. 2019). This report described the current coral restoration landscape, and identified gaps in knowledge between management practices, policy and future plans.

The *ad hoc* committee partnered with UNEP to produce the major report 'Coral Reef Restoration as a strategy to improve ecosystem services - A guide to coral restoration methods' (Hein et al. 2020). This report presents an overview of current methods, and the best-available knowledge in the field of coral reef restoration. A set of recommendations are also provided to assist key actors such as managers, practitioners, policy makers, and funding agencies to make informed decisions when applying coral reef restoration more broadly as an integrated reef management strategy. This was supplemented with a Policy Brief, an animated video, a scientific publication (Hein et al. in revision), and a webinar in January 2021.

The *ad hoc* committee facilitated the translation into English of restoration guides in French 'Guide to ecological engineering: the restoration of coral reefs and associated ecosystems' (Léocadie et al. 2020) and Japanese 'A guidebook for coral propagation through asexual reproduction' (Japanese Fisheries Agency. 2019) to share knowledge.

A 'Restoration Hub' designed to be a focal point for all information, whether that is the latest guidelines, new and existing initiatives, recent news and events related to the restoration of coral reefs and their related ecosystems (mangroves and seagrass) was added to the ICRI website in November 2020, with advice and contributions from the ad hoc committee

Revise the 2005 ICRI resolution on coral reef restoration in light of new scientific and management knowledge

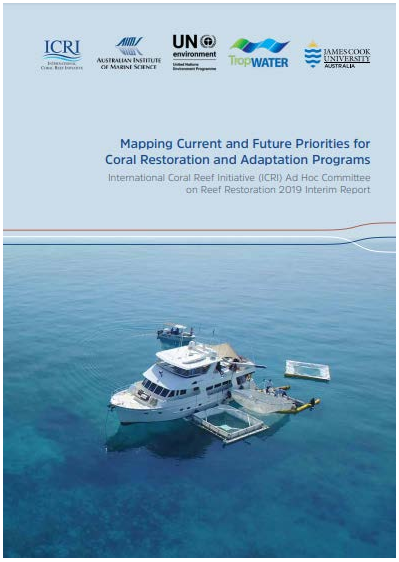
A resolution to update the 2005 ICRI resolution on artificial coral reef restoration and rehabilitation was drafted by the *ad hoc* committee and adopted in December 2019, at the 34th ICRI General Meeting.

Seek active collaboration and participation with organisations in the field including the International Coral Reef Society (ICRS), Commonwealth Blue Charter, the Coral Restoration Consortium (CRC), and Australia's Reef Restoration and Adaptation Program.

The *ad hoc* committee has been an important avenue for collaboration and knowledge sharing. The International Coral Reef Society, Commonwealth Blue Charter and the Reef Restoration and Adaptation Program have active representatives on the committee. The Coral Restoration Consortium (CRC) have applied to join ICRI and the *ad hoc* committee co-chair Ian McLeod is part of the CRC Executive Team providing a strong link between the initiatives. The *ad hoc* committee has provided advice and feedback for many relevant initiatives such as 'A manager's guide for coral reef restoration planning and design', the X-Prize 'Saving Coral Reefs' challenge, the Coral Restoration Consortium's coral restoration glossary, and SPREP's 'Pacific Coral Reef Action Plan 2020-2030'.The *ad hoc* committee members have contributed to many restoration and adaptation focused journal articles and reports including providing a case study on restoration for the upcoming Global Coral Reef Monitoring Network report.

Major outputs from the *ad hoc* committee

'The coral reef restoration as a strategy to improve ecosystem services: A guide to coral restoration methods' (Hein et al. 2020) was the first official report for the UN Decade of Ecosystem Restoration. It presents an overview of the best-available knowledge in the field and provides realistic recommendations for the use of restoration as a management strategy for coral reefs to assist managers, practitioners, policy makers, and funding agencies to make informed decisions. Whilst not designed to reduce climate impacts, coral reef restoration can be a useful tool to support resilience, especially at local scales where coral recruitment is limited, and disturbances can be mitigated. Ongoing investment in coral reef restoration research and development globally will improve the scale and cost-efficiency of the methods currently applied.



'Mapping current and future priorities for coral restoration and adaptation programs' (McLeod et al. 2019) was the main report from the *ad hoc* committee in 2019. An online survey was distributed to ICRI members and supplemented with expert knowledge. Most ICRI countries were using coral restoration as a tool to manage their reefs. The most commonly used techniques were coral gardening and direct transplantation, followed by artificial structures. The most common objectives were engaging local communities and supporting tourism and fisheries production. ICRI members also highlighted the importance of research into coral adaptation or climate protection. Almost all ICRI country-members stated that new policy relevant to restoration was needed.

Further links and updates from *ad hoc* committee members in 2020

ICRI Secretariat

- Launched the Restoration Hub designed to be a center point for all information, whether that is the latest guidelines, new and existing initiatives, recent news and events related to the restoration of coral reefs and their related ecosystems (mangroves and seagrass);
- Produced a special newsletter focused on coral restoration in November 2020;
- Became a Supporting Partner of the UN Decade on Ecosystem Restoration 2021-2030.

France

- MERCI-Cor method training (French Ministry of Environment);
- Produced an overview of Coral Reef Restoration using Eco-design and Nature Based Solution approaches, by Sylvain Pioch and Aurore Léocadie;
- Produced a practical review about coral reef restoration projects and ecosystems associated (mangroves and seagrasses), "Guide to Ecological Engineering: The restoration of coral reefs and associated ecosystems", published by IFRECOR, by Aurore Léocadie, Sylvain Pioch and Mathieu Pinault.

USA

- NOAA Action Plan on Coral Interventions launched in November 2020;
- A Manager's Guide to Coral Reef Restoration Planning and Design (Shaver et al. 2020) published and four US Jurisdictions (Guam, Hawaii, Northern Mariana Islands and American Samoa) are actively being guided through the guide for their local restoration planning.

UNEP

- Launch of the UN Decades of Ecosystem Restoration and Ocean Science.

Australia

- RRAP AUD 160 million R&D Phase launched;
- Policy of Great Barrier Reef Intervention created.

Great Barrier Reef Foundation

- Launched the Cairns/ Port Douglas Reef Hub to support local coral rehabilitation and stewardship initiatives, including a project funding round;
- Launched the Reef Island Initiative in the Whitsundays, piloting new approaches to ridge-to-reef restoration and reef industry sustainability.

Belize

- Under the Resilient Reefs Initiative, where the Belize Barrier Reef Reserve System is one of the five beneficiary World Heritage sites under the project, Belize has recently signed the contract and is currently undergoing the interview process for the hiring of the Chief Resilience Officer to assist the Government in developing a multi-year resilience strategy;
- Under the Mesoamerican Reef Rescue Initiative, Belize has recently established the Post Storm Coral Response Plan Committee for two pilot areas in order to develop a response plan for corals after a storm. This initiative will address the formulation of an emergency fund, an insurance scheme for the reef and the formulation and training of brigades to carry out the response plan;
- The Government of Belize continues to work with its partner, Fragments of Hope, in the restoration of coral along the coast for the past decade. As of December 2020, there are 23 in-situ coral nurseries and over 274,374 corals that have been outplanted throughout the waters. Fragments of Hope have also begun using photomosaics to document coral cover changes on 100-200 m^2 plots;
- In the process of increasing the replenishment zones (no take zones) to 10% of the territorial waters of Belize, in 2020, the Government of Belize had expanded the boundaries of the Sapodilla Cayes Marine Reserve making it the second largest MPA in Belize. The expansion was to protect an important reef ecosystem known as the Corona Reef/Cayman Crown which exhibits up to 60% live coral cover. One of the newly designated conservation zones of the MPA represents approximately 6% of the EEZ.

Indonesia

Coral Rehabilitation and Economic Stimulation during Pandemic Covid 19

The Indonesia Coral Reef Garden (ICRG) project is one of the labor-intensive programs under the National Economic Recovery Program, initiated by the Indonesian government to support the tourism sector that has been paralyzed due to the Covid-19 pandemic. Through this program, restoration of coral reef ecosystems was carried out by the Ministry of Marine Affairs and Fisheries (MMAF) in five locations in Bali (Nusa Dua, Serangan, Sanur, Pandawa Beach and Buleleng).

The main objective of the ICRG was to stimulate economic recovery activities that lead to environmental improvement, with a focus on coral reefs. The ICRG program involves approximately 11,000 workers so that this program will leverage the economic conditions of coastal communities and business actors during the Covid-19 pandemic and simultaneously restore the environment of coral reef ecosystems in Bali.

The coral reef rehabilitation method used is the placement of artificial reefs made of iron and cement and transplanting corals onto these artificial structures (Figure 1). A total of 95,000 units of artificial structures were deployed at the five ICRG locations. With the aim of creating underwater tourist locations, these concrete structures are made in the form of sculptures, animals, and other forms that create the beauty of the underwater scenery.

Thousands and various types of coral structures were drowned, including the eagle-shaped structure. This structure forms clusters which are expected to provide artificial habitat and enrich the underwater ecosystem and be able to become a tourist attraction in the future. For example, in Buleleng Regency there are 13,486 units of artificial coral structures consisting of hexagonal, fish dome, crocodile form, and statues. The artificial reef structure is placed in six sites, with a total area covering 7.4 hectares.

In the implementation of the ICRG, hundreds of Balinese people were trained in the process of building coral gardens. The training which was held in parallel in five locations, involved approximately 125 participants in each location. Komang Suarsa, one of the participants of the coral garden development training, expressed his enthusiasm in participating in this activity.

"With this program, I want to help restore the coral in my place, and it can become a tourist attraction that will revive the economy of residents affected by Covid-19," said Komang.

Maintenance is carried out after rehabilitation by replacing dead corals and cleaning up rubbish. Community groups care for these coral gardens by cleaning up the trash stuck in the hexagonal structures.

The MMAF and Indonesia Central Bank (BI) carried out the ICRG replication in Gili Meno, North Lombok, West Nusa Tenggara (NTB). This replication is a collaboration between MMAF, BI and the local community in particular the Dive Community. The coral gardens developed in North Lombok supported by the Bank Indonesia Social Program (PSBI) through its Branch office at NTB.

PSBI has built a coral garden with the structure of one unit of Garuda, eight units of fish dome, and 100 units of hexagonal / spider web. In addition, four units of mooring buoys with 20 weights were also installed to mark the location of the coral gardens. To support community empowerment in managing coral gardens, MMAF provided community with diving gear and underwater camera to assist the community surveillance group.

The replication of ICRG Bali shows that ICRG carries a positive message for the preservation of coral ecosystems, new marine tourism attractions and an impact on increasing people's income during a pandemic. Since the start of the ICRG program in October 2020, this activity has been covered by more than 200 reports in the media.

The implementation of the ICRG provides lessons, including: 1) ecosystem rehabilitation can synergize with economic recovery, 2) synergy with economic recovery increases the sense of community ownership and participation, 3) massive coral rehabilitation also has a positive impact on community education and awareness, and 4) local community role is critical in the maintenance and post project utilization.

Short term economic stimulus has been achieved with the completion of the project, but critical long-term works are more challenging to monitor the coral growth, maintain the structure from wave and current damage, and evaluate positive impacts to coastal ecosystem and local community.

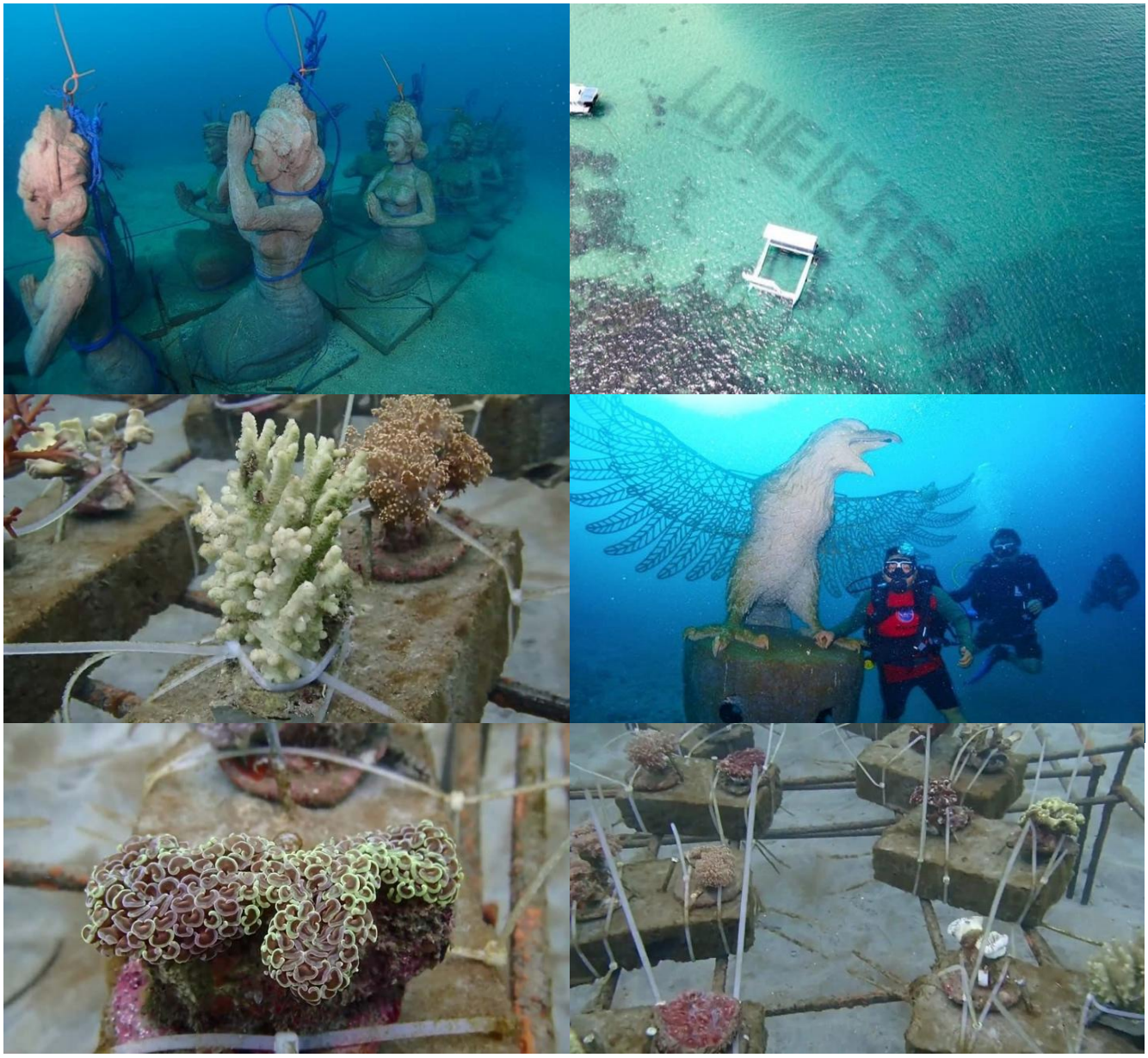


Figure 1: Indonesia Coral Reef Garden (ICRG) project images.

Annex 1: Proposed revision of the terms of reference for the continuation of an ad hoc committee

Proposed resolution to extend the ICRI Ad Hoc Committee on coral reef restoration and adaptation research and development

In response to the recent disturbances affecting coral reefs, particularly thermal-stress induced, global mass coral bleaching events between 2015 and 2017, there is growing recognition that traditional coral reef management approaches alone will be insufficient to counter the increasingly frequent and more severe stresses imposed by a changing climate. This had led to a surge in interest in active interventions to restore coral reefs.

The ICRI Plan of Action 2018-2020 calls for the promotion of leading reef restoration practices by facilitating partnerships, investment and capacity-building among ICRI members. In order to fulfil the objectives of the Plan of Action, ICRI established an Ad Hoc Committee on Coral Reef Restoration and Adaptation Research and Development at its General Meeting in Monaco in December 2018. The Committee has sought to identify common interests, facilitate global and regional collaborations, and help identify opportunities for co-investment in research and development on coral reef restoration and adaptation.

While undertaking this work, opportunities have emerged to work with a broader group of nations and partners including the Commonwealth Blue Charter Action Group on Coral Reef Protection and Restoration, the United Nations Environment Programme (UNEP), the French Coral Reef Initiative (IFRECOR) and the Coral Restoration Consortium (CRC) to further advance the work of the Committee and the ICRI Plan of Action.

Annex: Amended terms of reference

Working with ICRI members, reef-bearing nations and relevant partners, the Committee will:

- Provide a coordinating mechanism for international collaboration on coral reef restoration research and development;
- Advocate for the use of best practice restoration techniques and highlight examples of relevant policy and legislation as part of a broader strategy that involves traditional management and reducing carbon emissions in order to maintain coral reef function, structure and resilience;
- Facilitate the transfer of new knowledge of restoration techniques to managers and restoration practitioners.

Chair: Australia
Members: Experts from the ICRI Membership, other reef-bearing nations and relevant partners.
Duration: The *ad hoc* committee will last not more than one year, with the final report to be presented at the 36th ICRI General Meeting. The report will be available on the ICRI Forum.
Working procedures: The *ad hoc* committee will conduct its work via email, telephone, video conference and, when necessary, internet-based services.

References

Boström-Einarsson L, Babcock RC, Bayraktarov E, Ceccarelli D, Cook N, Ferse SCA, Hancock B, Harrison P, Hein M, Shaver E, Smith A, Suggett D, Stewart-Sinclair PJ, Vardi T, McLeod IM. (2020). Coral restoration – A systematic review of successes, failures and future directions. PlosOne. DOI: 10.1371/journal.pone.0226631

Hein MY, McLeod IM, Shaver EC, Vardi T, Pioch S, Boström-Einarsson L, Ahmed M, Grimsditch G (2020). Coral Reef Restoration as a strategy to improve ecosystem services – A guide to coral restoration methods. United Nations Environment Program, Nairobi, Kenya

Japanese Fisheries Agency (2019). A guidebook for coral propagation through asexual reproduction'. Japanese Fisheries Agency, Japan. 85 pages.

Léocadie, A., Pioch. S., Pinault, M. (2020). Guide to Ecological Engineering: The restoration of coral reefs and associated ecosystems. Published by IFRECOR. 114 pages

McLeod IM, Newlands M, Hein M, Boström-Einarsson L, Banaszak A, Grimsditch G, Mohammed A, Mead D, Pioch S, Thornton H, Shaver E, Souter D, Staub F. (2019). Mapping Current and Future Priorities for Coral Restoration and Adaptation Programs: International Coral Reef Initiative Ad Hoc Committee on Reef Restoration 2019 Interim Report. 44 pages. Available at icriforum.org

Shaver E C, Courtney C A, West J M, Maynard J, Hein M, Wagner C, Philibotte J, MacGowan P, McLeod I, Boström-Einarsson L, Bucchianeri K, Johnston L, Koss J. (2020). A Manager's Guide to Coral Reef Restoration Planning and Design. NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 36, 128 pages