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Supplementary Materials Shaping Improvised Directions for More Efficient Coral Reefs Rehabilitation Attempts

Amro Abd-Elgawad[1,2]*, Hala F Mohamed[1,3], Ahmed Hellal[4], Haixia Guo[1], Rongshuo Cai[1]**

[1]Third Institute of Oceanography, Ministry of Natural Resources, Xiamen, P. R. China
[2]Tourism Development Authority, Ministry of Tourism, Cairo, Egypt
[3]Al-Azhar University (Girls Branch), Faculty of Science, Botany & Microbiology Department, Cairo, Egypt
[4]Al-Azhar University, Faculty of Science, Marine Biology & Ichthyology Branch, Cairo, Egypt

Table S1. Coral rehabilitation attempts around the world sheet.

S1, Attempts done		
ID	Year	Objective
PR001	2000	1
PR002	2008	1
PR003	2010	5
PR004	2007	1
PR005	2010	1
PR006	2001	7
PR007	2001	7
PR008	2001	7
PR009	2001	7
PR010	2008	1
PR011	2009	7
PR012	2010	7
PR013	2012	1
PR014	2012	7
PR015	2012	7
PR016	2015	7
PR017	2014	1
PR018	2001	7
PR019	2001	7
PR020	2001	7
PR021	2001	7
PR022	2001	7
PR023	2006	1
PR024	2014	1
PR025	2005	7
PR026	2005	7
PR027	2005	1
PR028	2013	1
PR029	2005	7
PR030	2017	1
PR031	1982	7
PR032	2000	7
PR033	2010	7
PR034	2001	1
PR035	2001	7
PR036	2001	7
PR037	2012	7
PR038	1997	7
PR039	1997	7
PR040	1997	7
PR041	1997	7
PR042	1997	7
PR043	2001	7
PR044	2008	7
PR045	2015	7
PR046	2016	1

Table S1. Continued.

PR047	2015	7
PR048	2015	8
PR049	2017	7
PR050	2013	7
PR051	1997	7
PR052	1995	1
PR053	1997	7
PR054	2014	7
PR055	2015	7
PR056	2012	4
PR057	2002	7
PR058	2017	7
PR059	2015	7
PR060	2005	7
PR061	2006	7
PR062	2015	7
PR063	2014	7
PR064	2003	7
PR065	1997	7
PR066	2002	7
PR067	2003	7
PR068	1989	1
PR069	2006	7
PR070	2004	7
PR071	2004	7
PR072	2004	7
PR073	2006	7
PR074	2008	7
PR075	2017	7
PR076	2010	7
PR077	1993	1
PR078	1981	5
PR079	1997	3
PR080	2003	7
PR081	2002	1
PR082	1988	1
PR083	1997	7
PR084	2003	7
PR085	2013	7
PR086	2012	7
PR087	2014	7
PR088	2010	7
PR089	2015	7
PR090	2008	7
PR091	2012	1
PR092	2011	7
PR093	2015	7
PR094	2015	1
PR095	2015	1
PR096	2011	7
PR097	2014	7
PR098	1991	1
PR099	2014	1
PR100	2011	1
PR101	2015	1
PR102	2015	1
PR103	2008	3
PR104	2016	3
PR105	2016	7
PR106	2011	7
PR107	2011	7
PR108	2003	1
PR109	2010	7
PR110	2014	7
PR111	2015	7
PR112	2013	1
PR113	2014	7
PR114	2015	1
PR115	2001	1
PR116	2014	7
PR117	2016	1
PR118	2010	1
PR119	2016	1
PR120	2000	7
PR121	2010	7
PR122	2004	7
PR123	2009	1
PR124	2009	7
PR125	2005	7
PR126	2006	1
PR127	1987	1
PR128	2001	7
PR129	2004	7
PR130	2000	7
PR131	2014	7
PR132	2008	3
PR133	2018	7
PR134	2010	7
PR135	2010	7
PR136	2003	7
PR137	2011	7
PR138	2000	3
PR139	2014	7
PR140	2014	1

Table S1. Continued.

PR141	2010	1
PR142	2017	7
PR143	2004	7
PR144	2009	1
PR145	2003	7
PR146	1992	7
PR147	1998	7
PR148	2008	1
PR149	2009	7
PR150	1994	1
PR151	1994	1
PR152	1994	1
PR153	1999	1
PR154	2012	7
PR155	1999	1
PR156	*2018*	7
PR157	2012	1
PR158	*2018*	7
PR159	2012	1
PR160	*2017*	7
PR161	1989	7
PR162	*2017*	7
PR163	2015	1
PR164	*2017*	7
PR165	1999	1
PR166	*2017*	7
PR167	2007	7
PR168	*2017*	7
PR169	2003	7
PR170	*2017*	7
PR171	2003	1
PR172	*2017*	7
PR173	1998	7
PR174	2010	7
PR175	2002	7
PR176	1994	1
PR177	2000	7
PR178	2017	3
PR179	2004	7
PR180	1984	7
PR181	1985	7
PR182	2017	7
PR183	1981	7
PR184	2008	7
PR185	2009	7
PR186	2009	7
PR187	2005	3
PR188	1996	7
PR189	1996	7
PR190	1996	7
PR191	1996	7
PR192	2009	7
PR193	2014	1
PR194	2006	7
PR195	2012	3
PR196	1994	3
PR197	1999	7
PR198	2006	1
PR199	2012	7
PR200	2015	1
PR201	2014	7
PR202	2018	7
PR203	2016	7
PR204	2015	7
PR205	2016	1
PR206	2017	7
PR207	2018	1
PR208	2011	7
PR209	2013	1
PR210	2015	1
PR211	2017	1
PR212	2015	7
PR213	2018	1
PR214	2017	1
PR215	2017	1
PR216	2017	7
PR217	2018	1
PR218	2018	7
PR218	2018	1
PR219	2018	7
PR220	2018	7
PR222 added	2014	7
PR223 added	2017	7
PR224 added	2019	7
PR225 added	2020	7
PR226 added	2020	7
PR227 added	2012	7
PR228 added	2016	7
PR229 added	2013	5
PR230 added	2013	5
GL001	1979	1
GL002	1995	7
GL003	1995	7
GL004	2000	5

Table S1. Continued.

GL005	2000	1
GL006	2004	1
GL007	2004	1
GL008	2004	7
GL009	2006	1
GL010	2007	5
GL011	2007	1
GL012	2007	1
GL013	2009	4
GL014	2010	4
GL015	2010	7
GL016	2010	7
GL017	2010	1
GL018	2010	
GL019	2011	4
GL020	2011	4
GL021	2011	4
GL022	2011	7
GL023	2011	1
GL024	2011	1
GL025	2011	4
GL026	2011	7
GL027	2012	2
GL028	2012	7
GL029	2012	1
GL030	2012	1
GL031	2012	1
GL032	2012	1
GL033	2013	1
GL034	2013	3
GL035	2013	1
GL036	2013	1
GL037	2013	1
GL038	2013	1
GL039	2014	1
GL040	2014	5
GL041	2014	7
GL042	2014	7
GL043	2014	7
GL044	2014	7
GL045	2014	7
GL046	2014	7
GL047	2015	2
GL048	2015	4
GL049	2015	1
GL050	2016	4
GL051	2016	2
GL052	2016	5
GL053	2016	1
GL054	2017	1
GL055	2019	1
GL056	2019	1
GL057	2019	1
GL058	2017	1
GL059	2010	1
GL060	2013	1
GL061	2000	1
GL062	2011	1
GL063	2012	1
GL064	2012	1
GL065	2017	1
GL066	2017	1
GL067	2017	1
GL068	2017	1
GL069	2017	1
GL070	2017	1
GL071	2017	1
GL072	2017	1
GL073	2017	1
GL074	2017	1
GL075	2017	
GL076	2013	1
GL077	2015	1
GL078	2012	1
GL079	2017	
GL080	2018	
GL081	2018	
GL082	2018	
PR=	Peer Reviewed literature	
GL=	Grey literature	

Coral rehabilitation attempts around the world challenges according to [31] with a historical glance, updated to include other cases from the Red Sea [14, 16, 115] and South china Sea ex. [80, 116]; all updates are found at file (Supported Documents No. 1 & 2). All cases were classified depending on different rehabilitation objectives "Eight inferred objectives according to [31, 35]".

Table S1 Conclusion	Objective number								
Historical glance/Attempts	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**No of Attempts**
Before 1990: 10 attempts	4				1		5		10
1990 - 1999: 31 attempts	10		2				19		31
2000 - 2009: 85 attempts	23		4	1	2		55		85
2010 - 2020: 180 attempts	74	3	4	8	5		85	1	180
	111	3	10	9	8	0	164	1	306

Table S2. Objectives of rehabilitation sheet.

Objective, Indicator Number	Description	Rationale	**Source of case**
1	Accelerate reef recovery post-disturbance	Natural reef recovery is a lengthy process ranging from 5 years to decades (e.g. Pearson 1981; Connell et al. 1997), and transplanting coral colonies on reefs affected by recruitment limitation may kick-start the recovery process	**From Hein et al. 2017**
2	Reestablish a self-sustaining, functioning reef ecosystem	Objective here is not to restore a known coral community but rather rehabilitate coral reef ecosystem processes to secure critical ecosystem services	**From Hein et al. 2017**
3	Mitigate anticipated coral loss prior to a known disturbance	Mitigation strategy, whereby coral colonies are relocated from a soon-to-be impacted site to a safer site	**From Hein et al. 2017**
4	Reduce population declines and ecosystem degradation	Conserve endangered coral species, and safeguard critical ecosystem services on threatened coral reefs by increasing coral cover, diversity, and overall structural complexity. This objective also includes creating artificial "sacrificial" sites to move tourism pressures away from pristine, natural reef areas"	**From Hein et al. 2017**
5	Provide alternative, sustainable livelihood opportunities	Coral transplantation efforts may provide alternative livelihood opportunities, such as enhancing fisheries habitat, tourism, and coral farming	**From Hein et al. 2017**
6	Promote coral reef conservation stewardship	Involvement in coral transplantation will foster conservation stewardship through increased education and research opportunities	**From Hein et al 2017**
7	Scientific Research	A research project specifically testing the effectiveness of methods against each other	**From Bostrom. et al. 20**
8	Ecological engineering	Creating new habitat filling a biological-ecological function (ie construction of seawalls capable of sustaining a complete coral reef community).	From Bostrom. et al. 20

Objectives of restoration, according to: Hein, M. Y., Willis, B. L., Beeden, R. & Birtles, A. The need for broader ecological and socioeconomic tools to evaluate the effectiveness of coral restoration programs. Restoration Ecology 25, 873-883, doi:10.1111/rec.12580 (2017). & Boström-Einarsson, L. et al. Coral restoration – A systematic review of current methods, successes, failures, and future directions. PloS one 15, e0226631, doi:https://doi.org/10.1371/journal.pone.0226631 (2020).

Table S3. Coral reefs rehabilitation techniques used, countries attempting with authors sheet (consequently to the published date) collected from cases around the world.

Coral reef rehabilitation techniques used, countries attempting with authors			
No.	Techniques used	Country example	Related authors
1.	Sexual techniques: (most of cases around the world)	1. Australia	1. Heyward,et. al., 2002.
		2. Egypt	2. Abd-Elgawad, 2004
		3. Egypt	3. Abd-Elgawad, and Abou-zaid, 2012
		4. Palau	4. Boch, C. A., and A. N. C. Morse., 2012.
		5. Palau	5. Edwards, et. al., 2015.
		6. Philippines	6. Dela Cruz, D. W., and P. L. Harrison., 2017.
		7. Curacao	7. Chamberland, V. F., et. al., 2017.
		8. Dominican	8. Calle-Triviño, et. al., 2018.
2.	Asexual techniques: (Samples from cases around the world)		
2.1.	Transplantation:	1. USA	1. Maragos JE., 1974.
		2. Guam	2. Birkeland et al. 1979.
		3. Jordan	3. Bouchon, et al., 1981.
		4. Philippines	4. Alcala, A. C., et. al., 1982.
		5. Guam	5. Plucer-Rosario, et al., 1987.
		6. Costa Rica	6. Guzman, H. M., 1991.
		7. Maldives	7. Clark, S. and Edwards, A. J., 1994
		8. Philippines	8. Yap, H. T., et al., 1998.
		9. Egypt	9. Ammar, et al. 2000.
		10. USA	10. Thornton, S. L., et al., 2000
		11. Egypt	11. Abd-Elgawad, 2004
		12. USA	12. Garrison and Ward 2008 & 2012.
		13. Indonesia	13. Ferse, et al. 2013.
		14. Egypt	14. Ammar, et. al., 2013.
		15. Australia	15. Casey, J. M., et. al., 2015.
		16. Jordan	16. Kotb, 2016.
		17. India	17. Kumar JSY, et. al., 2017.
		18. Spain	18. Montero-Serra, I., et. al., 2018.
		19. China	19. HUANG Hui, et. al., 2020.
		20. China	20. Zheng, X., et. al., 2020.
2.2.	Coral gardening:	1. Hong Kong	1. Clark, T., 1997.
		2. Philippines	2. Raymundo, L. J. H., et. al., 1999.
		3. USA	3. Gleason, D. F., et. al., 2001.
		4. Taiwan	4. Soong, K., and Chen, T., 2003.
		5. Japan & Netherlands	5. Petersen, D., et. al., 2005.
		6. Japan	6. Omori, M., et. al., 2007.
		7. Indonesia	7. Ferse, S. C. A., and A. Kunzman, 2009.
		8. Puerto Rico	8. Griffin, S., et. al., 2012.
		9. Singapore	9. Ng, C., et. al., 2015.
		10. USA	10. Pausch, R. E., et. al., 2018.
		11. Australia	11. Tagliafico, A., et. al., 2018.
		12. Australia	12. Chan, W. Y., et. al., 2018.
2.3.	Micro-fragmentation:	1. USA	1. Page, C., and Vaughan, D. E., 2014
		2. USA	2. Hall ER, et. al., 2015.
		3. USA	3. Page, C. A., et. al., 2018.

Table S3. Continued.

3.	Substratum enhancements: (Samples from cases around the world)		
3.1.	Artificial reefs:	1. Philippines	1. Alcala, A. C., et. al., 1982.
		2. USA	2. Gittings, S. R., et. al., (1988)
		3. USA	3. Fitzhardinge RC & Bailey-Brock JH (1989)
		4. Maldives	4. Edwards, A., and Clark, S. (1993)
		5. Israel	5. Oren, U., and Benayahu, Y. (1997)
		6. USA	6. Miller, M. W., and Barimo, J. (2001)
		7. Japan	7. Okamoto, M., et. al., (2005)
		8. Philippines	8. Villanueva, R. D., et. al., (2010)
		9. Egypt	9. Polak, O., and N. Shashar (2012)
		10. Jamaica	10. Hogarth, J. R., and D. Wójcik. (2016)
		11. Indonesia	11. Williams, S.L., et. al., (2018)
3.2.	Substratum stabilisation:	1. Indonesia	1. Fox, H. E., et. al., (2005)
		2. Puerto Rico	2. Griffin, S. P., et. al., (2015)
3.3.	Substratum enhancement with electricity:	1. Jamaica	1. Goreau, T. J., and Hilbertz, W. (1996).
		2. Egypt	2. H. Schuhmacher, et. al., (2000)
		3. Philippines	3. Sabater MG and Yap HT (2004)
		4. Indonesia	4. Jompa, J., Suharto, and Husain, A. A. A. (2006)
		5. Indonesia	5. Borell, E. M., et. al., (2009)
		6. Indonesia	6. Romatzki, S. B. C. (2014)

Table S4. Statistics sheet. Number of coral rehabilitation attempts around the world.

	No of PR (228 Case)				No of GL (76 Case)				No of PR+GL Cases	
Objective	Objective = Outcome	Objective ≠ Outcome	Total	% of total	Objective = Outcome	Objective ≠ Outcome	Total	% of total	**Total**	**% of total**
1	49	16	**65**	**28.5**	16	30	**46**	**60.5**	**111**	**36.5**
2	0	0	**0**	**0.0**	2	1	**3**	**3.9**	**3**	**1.0**
3	9	0	**9**	**3.9**	1	0	**1**	**1.3**	**10**	**3.3**
4	1	0	**1**	**0.4**	2	6	**8**	**10.5**	**9**	**3.0**
5	1	1	**2**	**0.9**	4	0	**4**	**5.3**	**6**	**2.0**
6	0	0			0	0	**0**			
7	141	9	**150**	**65.8**	13	1	**14**	**18.4**	**164**	**53.9**
8	1	0	**1**	**0.4**	0	0	**0**	**0.0**	**1**	**0.3**
Total	**202**	**26**	**228**	**100.0**	**38**	**38**	**76**	**100.0**	**304**	**100.0**
	% of 304 case			**75**	**% of 304 case**			**25**		

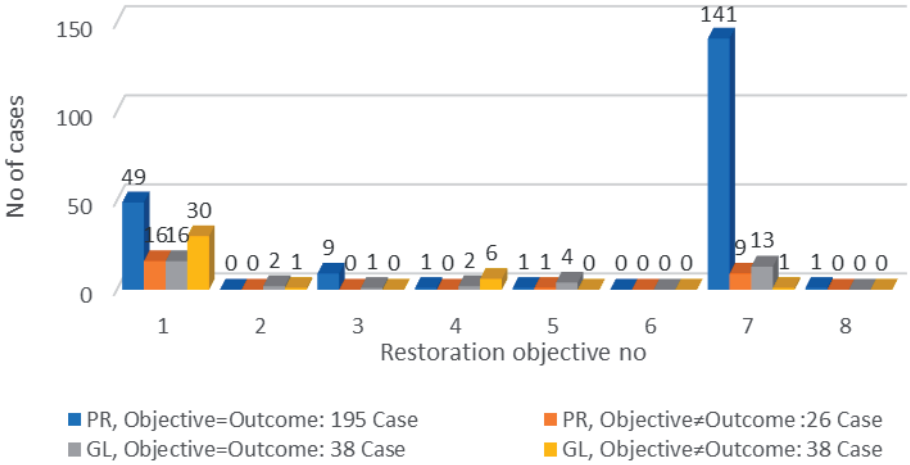


Fig. S1. Number of coral rehabilitation attempts around the world till 2020.