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Seagrass restoration trials in Kavaratti Lagoon, Lakshadweep: Growth patterns of transplants and their impact on overgrazing

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Original Article

Abstract

It is essential to restore degraded seagrass habitats as they are among the major blue carbon ecosystems undergoing degradation at alarming proportions throughout the globe. As our earlier attempts at seagrass transplanting trials ended up in grazing by herbivores, fresh trials in enclosed rafts were initiated which resulted in an 80% survival rate. The results indicated the magnitude of overgrazing on seagrass shoots and the height of transplants after 37 days in the enclosed rafts was 105 mm registering a net height of 71.05±9.1mm, while in the exposed rafts the leaves of the transplants were found grazed and the final mean height was only 13.3 mm registering a net height of shoots far below its initial height. Any initiative to restore seagrass meadows in the degraded areas must be taken up under protected mode or the existing seagrass meadows should be allowed to recover on their own by preventing overgrazing and checking man-made interferences.

Keywords: *Cymodocea serrulata, seagrass meadows, blue carbon, Lakshadweep, grazing pressure*

Introduction

Seagrass meadows provide shelter, breeding ground and food for fish species and thus support coastal fisheries through recruitment and sustainability. These meadows are one of the components of the blue carbon ecosystem that can absorb and bury more carbon per unit area than terrestrial forests. Throughout the world, seagrass habitats face severe decline due to herbivory (Lal *et al.*, 2010; Kaladharan *et al.*, 2013; D'Souza *et al.*, 2015), habitat destruction (Thayer *et al.*, 1975; Hastings *et al.*, 1995; Orth *et al.*, 2006) and climate change (Duarte, 2002; Waycott *et al.*, 2009) that has become faster in the current decade. The magnitude of the decline in seagrass cover is also known from Lakshadweep (Kaladharan *et al.*, 2013; Nobi *et al.*, 2013; Kaladharan and Anasukoya, 2019).

It has become essential to restore degraded seagrass habitats to sustain coastal fishery (Zhang *et al.*, 2018), check ocean acidification (Kennedy *et al.*, 2010; Waldbusser and Salisbury, 2014) and prevent coastal degradations (Evans *et al.*, 2019). Restoration of seagrass meadows worldwide aims to bring back the degraded ecosystem so close to its original conditions along with its associated flora, fauna and its beneficiaries of ecosystem services (Weins and Hobbs, 2015). Restoration of seagrass habitats can lead to rapid recovery of coastal ecosystem services (Greiner *et al.*, 2013; Orth *et al.*, 2020). Several restoration methods of seagrass are being followed in different parts of the world such as the hand broad-cast method (Phillips, 1974), the Staple method (Paling *et al.*, 2000; Liu *et al.*, 2015), the Framework (TERFS) method (Short *et al.*, 2002). Balaji *et al.* (2020) compared the establishment of *Cymodocea serrulata* sprigs in three types of rafts made of PVC pipes, bamboo frames and coconut fibre ropes as well as its cost benefits in the Palk Bay region. An extensive review on seagrass restoration has been attempted by Tan *et al.* (2020) taking lessons from Australia and New Zealand.

The success of seagrass transplantation depends on many factors. Park and Lee (2007) have found that transplanting time has a decisive role in the establishment of transplanted *Zostera marina* plants. Sediment quality of the transplanting site (van Keulen *et al.*, 2003) and the unit size of the transplanting unit (Zhou *et al.*, 2014) also have direct binding on the success of seagrass transplanting. As the seagrass transplanting trials we attempted earlier in Kavaratti Lagoon, U.T. of Lakshadweep ended up in grazing by herbivores, a fresh trial was initiated in enclosed rafts to offer protection to the transplants and hence this communication to highlight the variability in growth patterns of transplants in enclosed and exposed sites and the impact of grazing.

Material and methods

Seagrass transplantation trails in enclosed rafts were attempted in Kavaratti Lagoon during August- September 2020. A metal frame of 0.36 m^2 (60 x 60 cm) area was made with 0.5 inches square GI pipes and the four corners were fitted with 0.6 m long pipes of the same specifications, leaving 25 cm below to serve as pegs and the remaining length above to hold the transplants attached on jute ropes and cage made of weldmesh (size 0.6 x 0.6 x0.5 m, Fig. 1) to cover the rafts above the sediment level to prevent the entry of herbivores. Close to the enclosed rafts, a 0.36 m^2 area marked with wooden pegs and jute ropes without weld mesh enclosure was left exposed and marked as control plots (Fig. 2).

Fig. 1. Photograph showing the enclosed raft. Sprigs tied on thin jute ropes can be attached on the lower frame

Intact sprigs of *C. serrulata* (R. Br.) Asch. & Magnus bearing rhizome, roots and shoot collected from beach-cast samples or the same lagoon were tied to thin jute ropes to hold a sprig at 10 cm interspace so that each frame had 25 sprigs and been assigned a serial number from left to right side to determine the final shoot length and the net height achieved by the particular sprig. The rafts tied with transplanted ropes were taken to the lagoon during the ebb tide and the legs of enclosed rafts were fixed 25 cm deep into the sediment so that the rhizome and roots could be buried in the sediment which was achieved by forking the sediment (Fig. 3). The transplantation trial in enclosed and exposed rafts started on 21-8-2020 were monitored weekly for the stability and to remove any epiphytes, dead leaves or debris deposited over the weld mesh enclosures in the protected plots and the boundaries of the control plots. The final length of the shoots from both plots was measured on 26.09.2020.

Results and discussion

The mean value of the initial height of sprigs in the enclosed rafts was 33.9 mm, while that of the exposed rafts was 34.6 mm. The height of transplants after 37 days in the enclosed rafts was 105 mm registering a net height of 71.05± 9.1 mm (Table 1), while in the exposed rafts the leaves of the transplants were found grazed and the final mean height was only 13.3 mm registering a net height of shoots below zero, a negative value (-21.3 ± 9.91 mm, Table 2). Although the success rate of transplanting *C. serrulata* sprigs in the Kavaratti Lagoon was 80%, the net height achieved by the transplanted sprigs in the enclosed rafts was 71.05± 9.1 mm (Table 1), while in the exposed rafts was (-) 21.3 ± 9.91 mm (Table 2) was possible in enclosed rafts which were protected from herbivores most likely turtles, while in the exposed, transplants failed to achieve height as they were exposed to the herbivores. According to Liu *et al.* (2015), the survival rate of eelgrass transplants (*Z. marina*) exhibits a seasonal difference in survival rates than those planted during spring ranging from 76.5 to 90.4%

Fig. 2. View of enclosed and exposed rafts in one site

Fig. 3. View of seagrass transplantation trial in Kavaratti Lagoon

Table 1. The initial height of sprigs and the final height of transplants under enclosed rafts

No.	Initial height of sprig (mm)	Height of transplant in an enclosed plot after 37 days (mm)	Length gained under the protection (mm)
1	56	115	56
2	58	118	60
3	40	112	72
4	38	108	70
5	28	84	56
6	27	108	81
7	44	122	78
8	27	108	81
9	39	98	59
10	22	96	74
11	25	84	59
12	31	98	67
13	30	110	80
14	30	103	73
15	32	116	84
16	20	104	84
17	18	84	66
18	15	83	68
19	60	135	75
20	38	116	78
Mean	33.9	105.1	71.05
SD	12.54	13.77	9.1

Table 2. The initial height of sprigs and the final height of transplants under exposed rafts

No.	Initial height of sprig (mm)	Height of transplant in exposed plot after 37 days (mm)	Length lost without protection (mm)
1	38	10	28
2	38	15	23
3	30	14	16
4	30	13	17
5	38	10	28
6	31	13	18
7	19	11	8
8	34	14	20
9	44	17	27
10	30	15	15
11	25	12	13
12	22	14	8
13	29	12	17
14	32	13	19
15	55	13	42
16	52	18	34
17	41	16	25
18	24	12	12
19	22	10	12
20	58	14	44
Mean	34.6	13.3	(-) 21.3
SD	10.75	2.17	9.91

with the minimum value in April; whereas the survival rate of transplants planted during summer was 100%.

The results also indicated the magnitude of overgrazing on seagrass shoots in Kavaratti in particular and in the lagoons of Lakshadweep in general. The specific growth rate of transplanted sprigs was 1.92 mm per day in the absence of herbivores. Whereas the unprotected sprigs that were exposed to herbivores could not register a growth of shoots and result in negative growth rates. When overgrazing was checked by protection, our results (1.92 mm/day) on *C. serrulata* from Kavaratti Lagoon were comparable with that of *Z. marina* (2.22 mm/day) reported from Chuado Island, PR of China (Gao *et al*., 2020). However, the transplantation trial involving *Posidonia oceanica* in a marina expansion site was found to be not feasible (Sanchez-Lizaso *et al*., 2009).

Recent studies on the capture and burial of carbon (Kaladharan *et al.,* 2022) in six islands of Lakshadweep Atolls indicated poor rates when compared with that of the Indian Archipelago. This is considered mainly due to degraded seagrass patches. It has been well established that seagrass restoration can greatly improve the blue carbon storage in its habitats (Greiner *et al*., 2013; Mazarrasa *et al*., 2021). Hence large-scale restoration programmes have to be undertaken in all the lagoons of Lakshadweep Atolls. Nobi *et al.* (2013) have identified 21.48 ha in Kavaratti Lagoon using IRS P6 data and GIS tools that can be restored with seagrass transplants. Natural recovery of turtle grass meadows without human intervention after massive die-offs due to hypersalinity has been reported from Florida Bay (Hall *et al*., 2021) as well as from Australia and New Zealand (Tan *et al*., 2020).

Conclusion

Results of the present study indicated the problem of overgrazing existing in Kavaratti Lagoon in particular and Lakshadweep in general and any attempts at seagrass restoration should consider tackling the overgrazing menace. It can be inferred from this experiment that restoration of any degraded seagrass meadows will become successful if the ecosystem modifiers like the green turtle population are kept away from the reach of transplanted sites at least for a period of initial three months as well as minimising any sort of human interferences

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