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Shrinking seagrass meadows-observations from four Lagoons of Lakshadweep Archipelago

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Original Article

Abstract

Seagrass meadows worldwide are declining fast, taking with them many species which depend on these underwater prairies as their habitat and feeding as well as breeding grounds. Our results obtained on the biomass and density of seagrass vegetation in the reef and lagoons of Agatti, Chetlat, Kavaratti and Kiltan Islands of U.T. Lakshadweep, indicated gradual but steady shrinking of seagrass meadows. The percentage reduction in density of seagrass meadows since December 2011 to November 2015 was estimated at 88.5% in Agatti, 88.7% in Chetlat, 78.4% in Kavaratti and 81.3% in Kiltan. Wet biomass of parts below the sediment were always higher than the epigeal parts comprising leaves, stem and bracts. The possible reason behind this decline in seagrass biomass might be grazing, deterioration of water quality due to increased anthropogenic activities and climate change. This situation calls for urgent steps to monitor the ecology and physico-chemical parameters of water and sediment in the existing meadows and to undertake immediate habitat restoration programmes.

Keywords: *seagrass meadows, Lakshadweep archipelago, wet biomass, root-shoot ratio*

Introduction

Marine macrophytes such as seaweeds and seagrasses form highly productive ecosystems in the coastal ocean (Orth *et al.*, 2006; Duarte *et al.*, 2010). Seagrasses are economically important based on their function in maintaining coastal fisheries by serving as nursery habitat for juvenile fish and invertebrates. They stabilize beaches, act as a bio-shield against strong waves and land runoff, prevent siltation, improve water transparency and save coral polyps from mortality due to siltation. Seagrass meadows are actively involved in cycling of nutrients from water column as well as sediments. Considered among the oldest living organisms on earth, seagrasses play a vital role to exacerbate the effect of climate change. Also known as blue carbon, a meadow of seagrass per unit area can store twice as much carbon as the world's tropical forests-a hectare of seagrass meadow can sequester 366.8 kg of carbon per year (Fourqurean *et al.*, 2012; Greiner *et al.,* 2013).

Of the 72 species reported so far across the world (Short *et al.*, 2007; Unsworth and Unsworth, 2013), India has 16 species and all of them occur in Gulf of Mannar and Palk Bay, seven species in Lakshadweep and nine in Andaman and Nicobar archipelagos (Thangaradjou and Bhatt, 2018).

Primary productivity of seagrasses, their distribution and biology and decline due to herbivory in some Atolls of Lakshadweep Sea are understood extensively (Qasim and Bhattathiri, 1971; Kaladharan and David Raj, 1989; Nobi *et al*., 2011; Kaladharan *et al*., 2013). Growing coastal populations and increasing coastal developments threaten seagrass habitats globally and the loss in seagrass habitats is estimated to 29% (Duarte *et al*., 2010; Unsworth and Unsworth, 2013; Waycott *et al*., 2009). This communication is indented to bring out the rate of decline in the vegetation cover and wet biomass of seagrass meadows and the current status of seagrass growing areas in four atolls of Lakshadweep Archipelago.

Material and methods

Observations on the seagrass meadows of four Lakshadweep Islands such as Agatti, Chetlat, Kavaratti and Kiltan (Fig. 1) from December 2011 to November 2015 were made on periodical but opportunistic visits to these Islands by the second author. The geo-locations of the Island (marked with the help of hand held geographical positioning system GPS mp 76 CSX, Garmin model) and the sampling period are given in the Table 1. Samples of seagrass plants from the meadows were collected using a quadrat of 0.25 x 0.25 m size selected randomly on a line transect at three locations (north, middle and southern parts) in each lagoon during low tide hours. Leaves, shoots (plant parts above sediment) and rhizomes and roots (parts below the sediment) dug out from the quadrat were cleaned to remove sand and attached flora and fauna and weighed after draining the water completely. The harvestable wet biomass of seagrass (W) in an atoll was determined using the following equation:

$$W = \frac{w \times A}{a \times n}$$

Where,

a - Area of the quadratused

n - Number of times the quadrate was operated

w - Total wet weight of seagrass harvested from the quadrats

A - Total area of the lagoon in an atoll

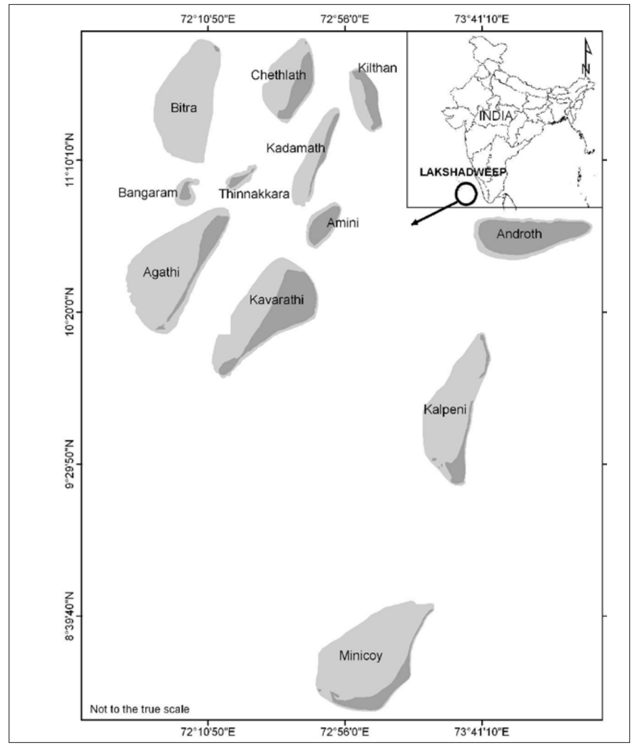

Fig. 1. Map of Lakshadweep Islands to show the location of four atolls of present investigation

Results and discussion

The seagrass vegetation in the lagoons of Agatti, Chetlet, Kavaratti and Kiltan Atolls is composed of species of *Thalassia, Cymodcea, Syringodium*, *Halodule* and *Halophila* at varying densities and standing stock as shown in the Table 2. Our observations on the standing stock and wet biomass of seagrass meadows in these four atolls made annually for five years indicate steep decline in all the four Atolls studied (Table 2). The rate of seagrass decline in the Atolls Agatti, Chetlet and Kavaratti as shown in Table 2 was acute since 2013 while in Kiltan it was from 2014. The percentage reduction in the seagrass biomass in the four Atolls ranged from 78.44 in Kavaratti to 88.74 in Chetlet (Table 3). The magnitude of decline of seagrass meadows in these lagoons can be viewed from the photographs taken in 2011 and 2015 (Figs. 2- 6)

Table 1. Geo locations and the period of sampling in four atolls of Lakshadweep Islands between 2011- 2015.

Islands	Latitude & Longitude	Sampling period				
Agatti	10° 52' N; 72° 11' E	8-12-2011	9-11-2012	10-10-2013	8-08-2014	16-11-2015
Chetlet	11° 42' N; 72° 42' E	7-12-2011	8-11-2012	11-10-2013	7-08-2014	17-11-2015
Kavaratti	10° 34' N; 72° 39' E	8-12-2011	9-11-2012	10-10-2013	8-08-2014	16-11-2015
Kiltan	11° 29' N; 72° 50' E	7-12-2011	8-11-2012	11-10-2013	7-08-2014	17-11-2015

The root: shoot ratio of seagrass plants sampled from the four Atolls as shown in Table 3 indicates higher biomass below the sediment than the shoot system comprising leaves, stem and bracts in Agatti, Chetlet and Kavaratti Atolls until 2013 which might be due to grazing by herbivores as reported by Kaladharan *et al.* (2013). After 2013, even the root system consisting of roots and rhizomes also showed decline and showed low values of root: shoot ratio. It is evident from earlier reports that seagrass cover in Agatti lagoon has been shrinking considerably from 0.05 km^2 during 1990 (Ansari *et al.,* 1991) to 0.005 km^2 during 1997 (Jagtap, 1998) and further to 0.0023 km^2 during 2011 (Kaladharan *et al*., 2013). The declined seagrass meadows in these four atolls were seen filled with fine silt and coral stones besides debris possibly due to periodical deepening of boat channels and runoff from shore.

Table 2. Total biomass (g wet weight/m2, mean ± SE, n=9) in four Atolls

Year	Agatti	Chetlet	Kavaratti	Kiltan
2011	1524± 186	2265± 312	1957± 168	1500± 210
2012	1200± 108	2274± 293	1342± 162	1335± 169
2013	529.3± 69	774± 117	844.7± 111	1189±123
2014	281± 60	518± 90	391± 99	443± 104
2015	175± 39	255± 72	422± 109	281± 84

Table 3. Root- shoot ratio of seagrass wet biomass and % reduction in wet biomass since December 2011

Year	Agatti	Chetlet	Kavaratti	Kiltan
2011	12.6	8.1	11.2	2.6
2012	11.5	8.4	10.6	2.6
2013	14.9	4.8	11.7	3.6
2014	2.2	3.0	3.0	2.8
2015	2.4	2.31	3.7	3.0
% reduction from 2011	88.52	88.74	78.44	81.27

Fig. 2. View of Sea-grass meadow in the lagoon of Chetlet Atoll during December, 2011

Fig. 3. View of vanished seagrass meadow in the lagoon of Chetlet Atoll during November 2015

Fig. 4. View of the lagoon in Kavaratti Atoll during November 2015 where a dense bed of *Cymodocea serrulata* existed in 2011

Fig. 5. View of seagrass meadow in the lagoon of Kiltan Atoll during November 2012.

Fig. 6. Close up view of declining seagrass meadow in the lagoon of Kiltan Atoll observed during November 2015.

As seagrass ecosystems are well known for their ecosystem services, even a slightest decline in seagrass meadows is sufficient enough to cause serious ecological and economical consequences. A severe decline of seagrass meadows on the Atlantic coast during the 1930s resulted in the extinction of marine molluscs and devastated the scallop fishery (Orth *et al*., 2006). Globally the decline of seagrass meadows is caused generally by manifold factors such as sediment and nutrient runoff, physical disturbance, navigation and commercial fishing practices, aquaculture, invasive species, disease, grazing, algal blooms, pollution and global warming (Orth *et al*., 2006; Short *et al*., 2007). Thangaradjou *et al.* (2008) have estimated a reduction of 56.08% in the seagrass meadows in Chinnapalam area, Rameswaram coast due to shell mining. It is estimated that nearly 65% of eelgrass (*Zostera marina*) meadows have been lost in the Chesapeake Bay which impacted ill effects on the ecosystem and its stakeholders who rely upon the bays for food, livelihood and recreation (Orth *et al*., 2010).

Overgrazing of seagrass plants by turtles is considered as prime cause for the decline of seagrass meadows in some of the Lakshadweep Atolls (Kaladharan *et al*., 2013). It is known that turtles and dugongs require nearly 40kg of fresh seagrass plants a day. While the dugongs consume the entire plants including the roots and rhizomes through browsing (Thayer *et al*., 1984; Aragones and Marsh, 2000; D'Souza *et al*., 2015) turtles crop the fresh leaves only which is also unraveled from the higher root: shoot ratio (Table 3) that we observed from the Agatti, Chetlet and Kavaratti Atolls up to the year 2013. Hence, this destructive feeding can impair the existence of seagrass meadows. All the four atolls we studied are thickly populated and the domestic sewage watershed from these islands increases the dissolved nutrients in the lagoon which in turn might alter the water quality adverse for survival of seagrass plants. Seagrass being rooted plants they absorb nutrients from sediment through their root system and the excess nutrients available in the ambient water can cause blooming of blue green or green algae which will smother the seagass beds. In Chetlet Atoll during November 2015 we could notice thick bed of green alga *Caulerpa racemosa* in the lagoon where *Syringodium isoetifolium* was growing densely (Fig. 7).

Though this communication is made out of observations from only four atolls, the current status of seagrass meadows in other inhabited islands within U.T. Lakshadweep may not be different. Seagrass species as a community serve the atoll ecosystem for its sustainability and hence they are termed as ecosystem engineers, while the mega herbivores such as turtles and other marine mammals are considered as ecosystem modifiers due to their destructive feeding habits and protection they enjoy from the wildlife act. When the predator is protected their prey (food organism) also need to be protected as both are interdependent and when the predator is allowed to flourish the other will perish. Hence seagrass meadow restoration programmes should be taken up with immediate effect.

Fig. 7. Bed of green seaweed *Caulerpa racemosa* found colonised in the degraded seagrass meadow in the lagoon of Chetlet Atoll (Picture taken during Nov. 2015).

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