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STATUS AND REVIEW OF HEALTH OF INDIAN CORAL REEFS

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Abstract: Status of reef health incorporating species-wise cover of scleractinians has been reported covering 61 stations in 29 reef locations of the four major reef regions in India as of March 2011, alongside a review of available reef health data since 1998 until 2011. Coral bleaching has been identified as a major factor determining the live coral cover (in the order high to low impact) in Lakshadweep, Gulf of Mannar (GOM) and Andaman reefs. Reductions in live cover (from 2010) were observed in Lakshadweep and GOM reefs. Recovery from the bleaching event in 2010 was reported from Andaman, though long-term impacts of bleaching, reef area loss due to seismic up-lift and the 2004-tsunami were observed by the declining trend in reef health. Local scale stressors are more intense in Gulf of Kachchh (GOK) and GOM reefs, however are more chronic in the former, which is reflected in the species composition as stress tolerators (Edinger and Risk 2000) forming the major cover in these reefs. In GOM, recovery from bleaching events are impeded by the local stressors, thus showing low scleractinian species richness in the transects (n = 19). Live cover versus diversity indices showed positive correlation (R^2 = 0.96) with the dominance indices, of reefs influenced both by local and bleaching stresses (e. g. GOM). Conversely, good species diversity and richness were observed for majority of the reefs in Lakshadweep and Andaman, where the local stressors are minimal; which also indicated, most significantly, the resilience in these reefs in terms of maintaining diversity despite the large-scale mortality events.

Key words: Coral reefs, India, Monitoring, Status, Scleractinian diversity

INTRODUCTION

Quantitative measure of the status of health for the major Indian reefs (Gulf of Kachchh, Lakshadweep, Gulf of Mannar and Andaman and Nicobar) began after the initiative by Global Coral Reef Monitoring Network, Southeast Asia, with several capacity development programs in coral reef monitoring from 1998-2001, held in India and abroad. A comprehensive base-line status assessment based on these protocols or otherwise, despite this initiative, is available only for Gulf of Mannar (Venkataraman *et al.*, 2004; Patterson *et al.*, 2005a; Venkataraman and Raghuram, 2006; Patterson *et al.*, 2008) and select Andaman Nicobar reefs (Turner *et al.*, 2001; Kulkarni *et al.*, 2008). There were nonetheless, studies addressing specific issues which also provided information on reef status: such as extent and impact of bleaching during 1998 in Indian reefs (Wafar, 1999; Venkataraman, 2000; Arthur, 2000; Pet-Soede *et al.*, 2000; Kumaraguru *et al.*, 2003); reef status and restoration activities in Gulf of Mannar (Patterson, 2002), disease and stress-induced mortality in Indian reefs (Ravindran *et al.*, 1999); coral community patterns in Andaman Nicobar (Kulkarni and Saxena, 2002); post-bleaching recovery in Lakshadweep (Arthur *et al.*, 2006; Arthur, 2008); impact of reef area loss due to earthquake in Andaman Islands (Rajan *et al.*, 2008); impact of tsunami on Indian reefs (Patterson *et al.*, 2005b); post-tsunami status in Andaman Nicobar Islands (Saxena *et al.*, 2008); and the latest bleaching episode in Andaman Nicobar Islands (Krishnan *et al.*, 2011). Besides, information on status of Indian reefs is also available on the overall status reports for South Asia (Wafar, 1999; Rajasuriya *et al.*, 1999;

Muley *et al.,* 2000; Rajasuriya *et al.,* 2000a; Rajasuriya *et al.,* 2000b; Rajasuriya *et al.,* 2002; Rajasuriya *et al.*, 2004; Tamelander and Rajasuriya, 2008).

In this account is presented: (i) the status of four major reef areas in India, based on the assessments made in March 2011, alongside (ii) a review of monitoring data since 1998, until 2011 – in terms of analyses of bio-physical characteristics, and (iii) hard coral species diversity, in order to identifying changes with regard to large-scale natural calamities, Global climate change, and local anthropogenic disturbances.

MATERIALS AND METHODS

Status of coral reef health was assessed from a total of 61 stations marked in 29 reef locations under the 4 major reef regions in India in March 2011 (Fig. 1): which include, 13 stations in the reefs named Jindra, Piroton, Mundeka, Goose, Narrara, Kalubar, Bural, Paga, Dholiodugar, Azad, Pashu, Laku, and Boria in Gulf of Kachchh; 20 stations in the atoll reefs of Minicoy, Kavaratti, Agatti and Amini in Lakshaweep; 15 stations in the island reefs of Shingle, Kurusadai, Pullivasal, Poomarichan, Shenbagamuruvai, and Manoliputti, in the northeast of Gulf of Mannar (GOM); and 13 stations in Outram Island, Henry Lawrence, Havelock Island, North Bay, Jollybouy Island, and Chidiyatapu, in Andaman Islands. The stations marked in Lakshadweep reefs were also assessed under a monitoring exercise since 2006, until the latest observation in 2011.

Benthic coverage of life-forms up to species-level cover of scleractinian corals were recorded from a minimum of five transects in each stations, using photo quadrat method (English *et al.,* 1997). The quadrats (1 m^2) were placed along a 50 m transect line at every 10 m interval (total of 5 quadrats per transect) and photographed. Based on the extent of the reef from the crest, transects were laid at three depth gradations. The range (lowest – maximum) of depth between which the transects were laid are: 0.5 – 4 m in GOK, 3 – 20 m in Lakshadweep, 1 – 7 m in GOM, and 3 – 16 m in Andaman Islands. In conditions of poor visibility and in shallow water transects the quadrats were split into smaller units (0.25 m^2) and photographed, where the full quadrat could not be covered in a single shot. Macro photographs of coral colonies were taken for confirming species level identification of corals, wherever necessary. The photographs were printed in plain paper and the outlines of corals and other life-forms traced onto graph sheets by means of carbon paper. The area of corals and other life-forms were calculated by counting the number of squares for each life forms in the graph sheet. The percentages of benthic coverage were estimated for each scleractinian species, Dead Coral (DC), bare substrate or Dead Coral Rock (DCR), Dead Coral grown over by Algae (DCA), Dead coral grown over by Turf Algae (DCTA), fleshy and filamentous Algae (AL), Calcareous and coralline algae (CA), soft coral (SC), gorgonians, echinoderms, molluscs and other sessile benthos as Others (OT), Rubble (R), Sand (S) and Seagrass (SG). The Live Coral (LC) cover is the total cover of all the scleractinian species in the transect / quadrat and DC includes the recently dead and bleached dead colonies alone.

RESULTS

Status of reef health (bio-physical characteristics) March 2011

The average values of bio-physical characters for each reef area assessed during January – March 2011 are shown in Fig. 2; and the summary values for four reef regions are presented in Table 1. For *Gulf of Kachchh*, the average LC cover value suggests the reefs being in fair to good condition - as per Gomez and Yap (1988), the values however, varied between reefs. The live cover in 6 out of 13 reefs surveyed (Piroton, Goose, Laku, Paga, Pashu, Bural) were >25% which also had <10% algal cover, except for Paga and Bural where the algal covers were 14 and 21% respectively; Conversely, reefs with algal covers >20% had very low live coral cover (ex., Narara, Kalubar) (Fig. 2). It was observed that the live coral cover dominated reefs are located close to the open sea, whereas the algae / dead coral / rubble dominated reefs are located near shore. For *Lakshadweep* reefs, the average LC cover recorded is the lowest of the reef areas covered in this study, with DCR dominating the category. The DCA cover is much lower compared to DCR indicate the DCR has not been overgrown yet by algae, and the coral mortality has been of the recent past. Unlike GOK reefs, the percent cover values too did not vary greatly between reefs, thereby negating any regional influence. In Gulf of Mannar (GOM), the AL cover dominated the benthic category followed by DCTA. Slightly higher LC values were observed in reefs which had comparatively low algal cover (ex. Pullivasal and Shenbagamuruvai) (Fig. 2). For *Andaman* reefs, the summary values show the reefs sporting good coral cover – as per Gomez and Yap (1988) and LC cover the dominating category in majority of the reefs studied. DC is observed as the second highest category in all the reefs, and as the increase DC cover simultaneous decrease in live coral cover was clearly observed (Fig. 2).

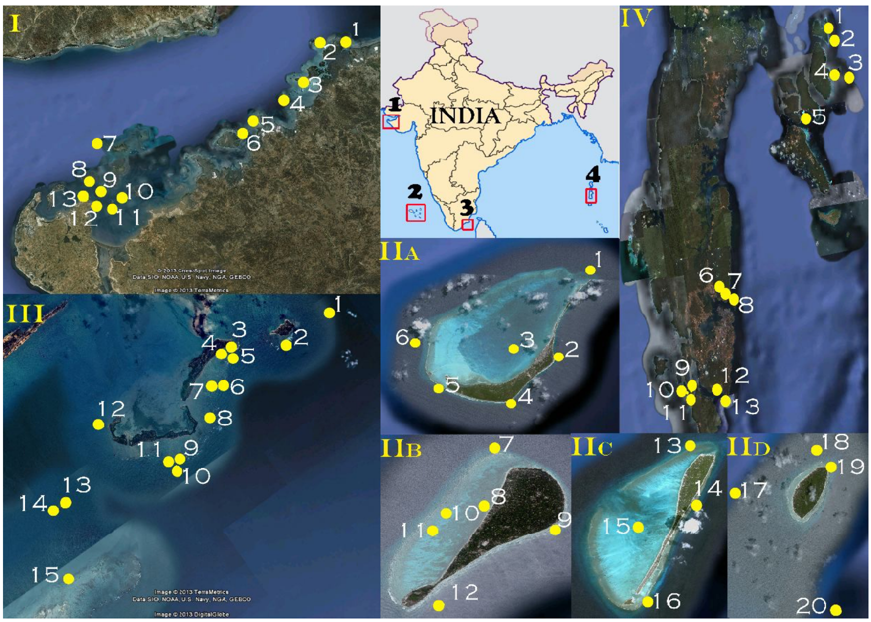

Fig. 1. Stations covered: I – Gulf of Kachchh [Jindra (Stn.1), Piroton (2), Mundeka (3), Goose (4), Nararra (5), Kalubar (6), Bural (7), Paga (8), Doliogugar (9), Azad (10), Pashu (11), Laku (12), Boria (13)]; II – Lakshadweep [IIA – Minicoy (Stns.1-6), IIB – Kavaratti (7-12), IIC – Agatti (13-16), IID – Amini (17-20)]; III – Gulf of Mannar [Shingle Island (1-2), Kurusadai Island (3-7), Pullivasal Island (8-11), Poomarichan Island (12), Shenbagamuruvai reef (13, 14), Manauliputti Island (15)]; IV – Andaman Islands [Outram (1, 2), Henry Lawrence (3, 4), Havelock (5), North Bay (6-8), Jollybouy (9-11), Chidiyatapu (12,13)]

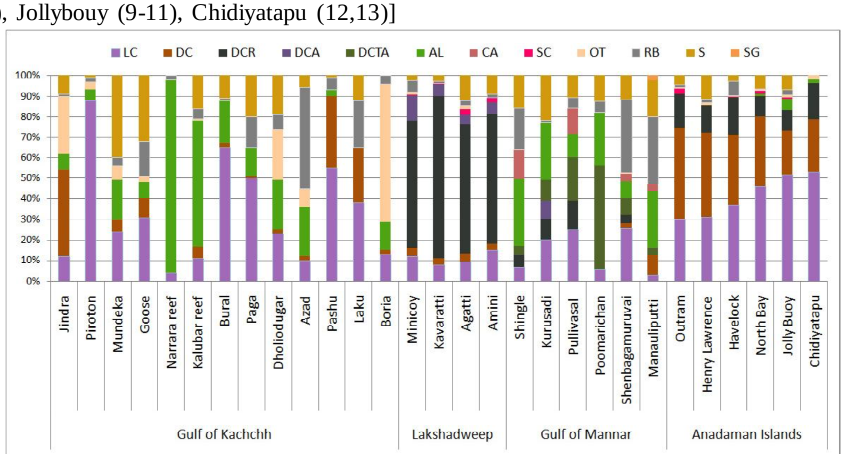

Fig. 2. Percentage covers of bio-physical categories for the reef locations under the major reef areas in March 2011.

Table 1. Summary values of bio-physical characteristics for the reef regions in India during January – March 2011

Bio-Physical Characteristics	% cover values (average and standard deviation)			
	Gulf of Kachchh	Lakshadweep	Gulf of Mannar	Andaman
LC	32.62 ± 25.37	11.0 ± 2.78	14.53 ± 11.15	41.49 ± 9.98
DC	10.31 ± 14.45	3.65 ± 0.53	1.95 ± 1.10	33.45 ± 9.61
DCR	0.0 ± 0.0	66.74 ± 8.29	5.56 ± 4.20	14.28 ± 4.53
DCA	0.0 ± 0.0	7.045 ± 3.56	1.45 ± 0.55	0.0 ± 0.0
DCTA	0.0 ± 0.0	0.0 ± 0.0	16.33 ± 4.34	0.0 ± 0.0
SC	0.0 ± 0.0	1.45 ± 1.25	0.0 ± 0.0	0.78 ± 1.04
OT	11.08 ± 19.28	0.92 ± 0.86	0.13 ± 0.11	1.22 ± 0.70
AL	22.69 ± 26.41	0.0 ± 0.0	22.22 ± 9.74	1.33 ± 2.27
TA	0.0 ± 0.0	0.0 ± 0.0	3.73 ± 1.69	0.0 ± 0.0
CA	0.0 ± 0.0	0.0 ± 0.0	5.68 ± 3.64	0.0 ± 0.0
R	10.46 ± 13.46	2.67 ± 2.055	16.76 ± 6.02	2.15 ± 2.50
S	12.85 ± 12.52	6.53 ± 4.78	14.98 ± 3.14	5.30 ±4.58
SG	0.0 ± 0.0	0.0 ± 0.0	0.42 ± 0.32	0.0 ± 0.0

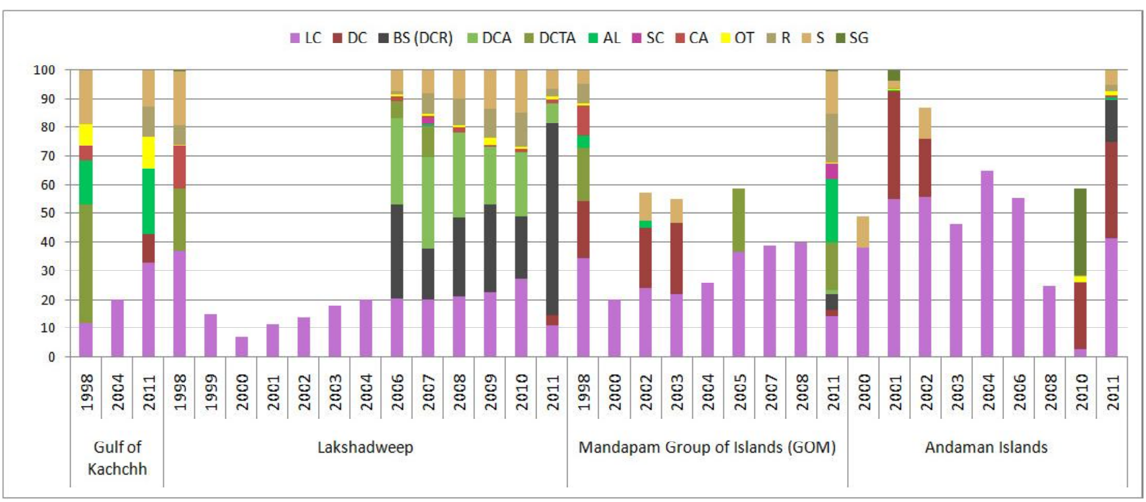

Fig. 3. Average bio-physical values for the reef regions, from the published data (Arthur, 2000; Pet-Soede *et al.*, 2000; Rajasuriya *et al.*, 2000a; Rajasuriya *et al.*, 2000b; Turner *et al.*, 2001; Venkataraman 2000; Kulkarni and Saxena 2002; Rajasuriya *et al.*, 2002; Rajasuriya *et al.*, 2004; Venkataraman *et al.*, 2004; Arthur *et al.*, 2006; Venkatarman and Raghuram 2006; Arthur 2008; Patterson *et al.*, 2008; Kulkarni *et al.*, 2008; Saxena *et al.*, 2008; Tamelander and Rajasuriya 2008; Krishnan *et al.*, 2011), plotted in conjunction with the monitoring data from 2006-11 for Lakshadweep reefs, and the status assessment data of 2011 for the other three reef areas, of the present study.

Review of status of Indian reefs since 1998

Despite lacking data on all the bio-physical categories, relatively continuous reef health data are available for the Indian reefs of the previous studies on reef health (Arthur, 2000; Pet-Soede *et al.*, 2000; Rajasuriya *et al.*, 2000a; Rajasuriya *et al.*,2000b; Turner *et al.*, 2001; Venkataraman, 2000; Kulkarni and Saxena, 2002; Rajasuriya *et al.*, 2002; Rajasuriya *et al.*, 2004; Venkataraman *et al.*, 2004; Arthur *et al.*, 2006; Venkatarman and Raghuram, 2006; Arthur, 2008; Patterson *et al.*, 2008; Kulkarni *et al.*, 2008; Saxena *et al.*, 2008; Tamelander and Rajasuriya, 2008; Krishnan *et al.*, 2011). Lakshadweep reefs were monitored from 2006-11 under the present study. Average bio-physical values for the reef regions since 1998, until 2011 are plotted, in conjunction with the present data (Fig. 3). The graph shows a clear reduction in live coral cover as a result of the bleaching in 1998 for Lakhadweep and GOM, following until 2000 and the recovery thereafter. In Lakshadweep reefs, the recovery was marked by the reduction in DCA and DCR covers. However, there is reduction in LC cover in these reefs in the latest observation (March 2011), pointing to the bleaching in 2010. Quantitative data were not available for the 1998 bleaching and related mortality for Andaman reefs, and the data since 2000 show a declining trend in reef health, notwithstanding some increased live cover values observed in the years in-between. The noted decrease in live cover in 2010 is due to not accounting the bleached cover (along with live cover), where these reefs experienced summer bleaching, and the recovery of bleached corals has been observed with the increase in LC cover in the latest observation.

Diversity and species-wise percent cover of scleractinians (January – March 2011)

The number of species recorded and the diversity indices for each reef area studied are presented in Table 2. All the reefs studied in Lakshadweep and a majority (5 out of 6) in Andaman sported good diversity and evenness indices ($H' \geq 2.0$; $E \geq 0.7$) with low dominance ($D \geq 0.1$) of species. On the other hand, 1 out of 6 and 2 out of 13 reefs respectively in GOM and GOK exhibited similar status, where the remaining reefs in these regions showed dominance of species with low diversity and evenness indices (Table 2). The live cover versus diversity indices tested (Fig. 5) for the reef regions showed no significant correlations except with the negtive correlation (decrease in dominance with the increase in live cover; $R^2 = 0.6$) in the case of Lakshadweep and the positive correlation (increase in dominance with the increase in live cover; $R^2 = 0.96$) exhibited for GOM, attesting the good diversity status of Lakshadweep reefs as against the reefs shifting to poor diversity status in GOM.

Species-wise % cover estimates (Table 3) showed that in GOK, species categorized as stress tolerators such as *Favia favus, Porites compressa* and *Goniastrea pectinata* – as per Edinger and Risk (2000) forming the major cover. In GOM, the reefs which are represented with high coral cover (>20%) had usually one species dominating. Nonetheless, the dominant species differed from reef to reef, and thus - as per conservation classes, competitors (*M.digitata;* % contr.: 79.2) in Shenbagamuruvai (No. 22; Table 3), ruderals (*A. hyacinthus*; % contr.: 73.3) in Pullivasal (No. 20; Table 3) and stress tolerators (*Porties lutea*; % contr.: 66.6. in Kurusadai (No. 19; Table 3). Conversely, in Lakshadweep and Andaman reefs, though the stress tolerators such as *Porites solida*, *P. lobata* and *P. lutea* formed the highest cover in most of the reefs, species dominance was not observed – except for Outram Island in Andaman (No. 24; Table 3), which showed dominance of *Porites lobata*, and *Heliopora*

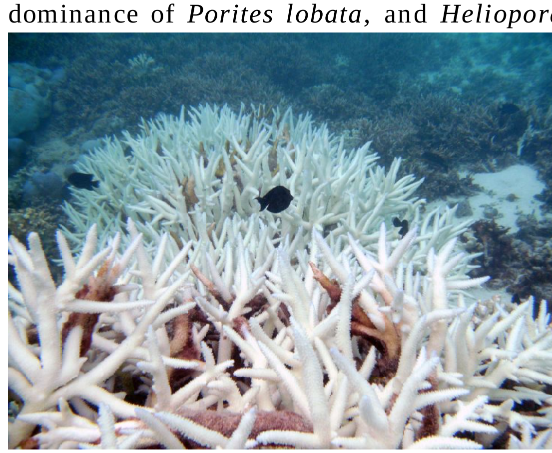

Fig. 4. Bleaching at Kavaratti atoll, Lakshadweep, in May 2010.

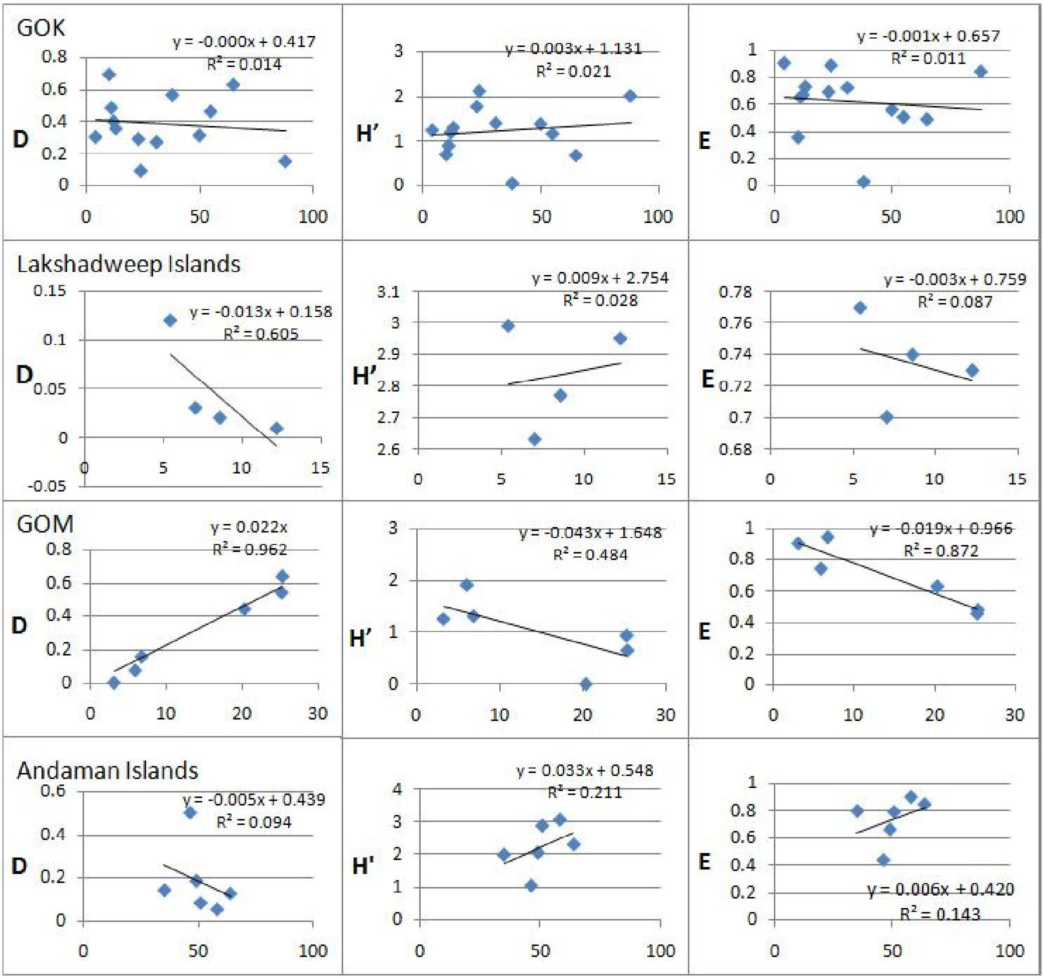

Fig. 5. Correlation plots of LC cover (%) vs diversity indices (*D* - Simpson’s dominance Index, *H* - Shannon’s diversity index, *E* - Evenness index). GOK - Gulf of Kachch, GOM - Gulf of Mannar, AN - Andaman reefs.

DISCUSSION AND CONCLUSIONS

The >25% live coral cover in six of the total 13 reefs surveyed in GOK (Fig. 2) shows that some of the reefs have fair to good coral cover. An earlier study had observed that coral cover and diversity as low and patchy in these reefs (Arthur, 1995). Apparently 30% of the corals bleached in March 1998 (Wafar, 1999). An average of 11% cover was observed in a survey after the bleaching event, with the reefs showing comparatively low bleaching related mortality of 1.92% of the coral cover (Arthur, 2000). About 20% live coral cover was observed in the year 2004 (Rajasuriya *et al.*, 2004). The high average live cover (however, with variation in values between reefs; 32.62%; range: 4 - 89%) in the present investigation from the previous shows recovery in some of the reefs assessed, especially the sub-tidal ones, while the intertidal and the near-shore reefs face exposure to sun due to the high tidal amplitude, siltation and eutrophication (e. g., Narara and Kalubar reefs).

Lakshadweep atolls suffered severe bleaching in March 1998 associated with the ENSO event. Bleached corals comprised 82% of the coral cover in the lagoon reefs of Lakshadweep with the

Table 2. Species richness and Diversity Indices of Scleractinian corals for the reef areas in March 2011. (*S* – Species No., *D* – Simpson's Index of dominance, *H'* – Shannon Diversity Index, *E* – Shannon Evenness Index)

Name of the Reef	*S*	*D*	*H'*	*E*
Gulf of Kachchh				
Jindra	6	0.405	1.209	0.675
Piroton	10	0.153	2.034	0.848
Mundeka	11	0.095	2.142	0.893
Goose	7	0.276	1.418	0.728
Narrara	4	0.307	1.26	0.909
Kalubar	4	0.489	0.913	0.658
Bural	4	0.635	0.686	0.495
Paga	7	0.317	1.402	0.564
Dholiogugar	11	0.295	1.788	0.697
Ajad	7	0.7	0.706	0.363
Pashu	9	0.466	1.176	0.511
Laku point	5	0.57	0.054	0.034
Boria	5	0.36	1.317	0.735
Lakshadweep				
Minicoy	42	0.02	2.77	0.74
Kavaratti	44	0.12	2.99	0.77
Agatti	43	0.03	2.63	0.7
Amini	56	0.009	2.95	0.73
Gulf of Mannar				
Shingle	4	0.163	1.309	0.944
Kurusadai	6	0.445	0.013	0.629
Pullivasal	7	0.544	0.943	0.453
Poomarichan	11	0.079	1.907	0.74
Shenbagamuruvai	4	0.639	0.664	0.48
Manauliputti	4	0.005	1.254	0.904
Andaman Islands				
Outram	11	0.506	1.056	0.48
Henry Lawrence	12	0.144	1.995	0.74
Havelock	22	0.187	2.062	0.904
North Bay	38	0.084	2.897	0.944
Jollybouy	15	0.128	2.31	0.453
Chidiyatapu	30	0.054	3.079	0.629

bleaching related mortality of 26% (Arthur, 2000), which corroborates with another assessment of 43 - 87% bleaching cover in 1999 (Wafar, 1999). Arthur (2000) recorded the live coral cover of 8% in Kavaratti after the monsoon in the same year of bleaching. Observations in October and November 1999 showed an increase of 10% cover (Pet-Soede *et al.*, 2000). Observations after 5 years of bleaching showed again gains in coral cover (approximately 19% at Kavaratti), in spite of the phase-shift to algal dominance precluding the coral recovery (Arthur *et al.*, 2006). The monitoring observations from 2006 until 2010, shown by the steady reduction/decrease either in the DCA or DCR – in spite of them dominating the categories (Fig. 3), indicate that the reefs had been recuperating. Concurrently, Arthur (2008) in 2008 observed 20% cover of DCTA which is considerably lower than his previous estimate in 2000 which was between 30 and 50%, helped apparently by the healthy populations of herbivorous fish particularly *Scarids* and *Acanthurids*. The coral recovery has been observed by the new recruits, which contribute to most of the live coral cover (Arthur, 2008). Interestingly, the availability of bare substrate (DCR) did not comprehensively favoured new recruitment *vis-a-vis* increase in live coral cover is in conformity with the observations in the reefs on the eastern side where coral cover remained relatively low despite the substrate not overgrown by algae (Arthur *et al.*, 2006). There is, however, a characteristic reduction in LC cover and an increase in DCR in the latest observation, which point to a coral mortality event, past the monitoring observation in 2010. Local information is available of a bleaching event in May 2010 (Fig. 4), however with no quantitative records. The presence of high DCR (not covered with algae) cover in 2011 (particularly after a year of the bleaching event) negates the impact of local stressors due to eutrophication or siltation in these reefs.

GOM was heavily exploited for fisheries and other resources until the declaration as the Marine National Park. Though coral mining in these reefs has stopped, illegal fishing, collection of shells and sea cucumbers still appears to continue clandestinely. These activities causing mechanical damages to live corals are evident from coral rubbles dominating the benthic category in few reefs (Fig. 2), which is reflected in the high average cover of rubbles next to algae. The average live coral cover in the present estimation is lowest from the previous status reports (Fig. 3). Except a narrowly lower value in 2000 (Rajasuriya *et al.*, 2002) the live coral covers were >25% since 1998 until the maximum value of 40% in 2008 (Fig. 3). However, the present values are remarkably lower (>50% decline) and most of the reefs studied were dominated either by fleshy or turf algae (Fig. 2). An average of 89.24% of the corals were bleached in Gulf of Mannar during the

Table 3. Percentage cover (average) of scleractinian species for the reefs studied in March 2011. [1-Jindra, 2-Piroton, 3-Mundeka, 4-Goose, 5-Nararra, 6-Kalubar, 7-Bural, 8-Paga, 9-Doliogugar, 10-Azad, 11-Pashu, 12-Laku, 13-Boria, 14-Minicoy, 15-Kavaratti, 16-Agatti, 17-Amini, 18-Shingle, 19-Kurusadi, 20-Pullivasal, 21-Poomarichan, 22-Shenbagamuruvai, 23-Manoliputti, 24-Outram, 25-Henry Lawrence, 26-Havelock, 27-North Bay, 28-Jolly Bouy, 29-Chidiyatapu]

Species	Gulf of Kachchh													Lakshadweep				Gulf of Mannar						Andaman Islands					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Montipora crassituberculata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	0.5	--	--	--	--	--	--
M. monasteriata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	--	--	--	--
M. tuberculosa	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	0.1	0.02	0.2	--	4.6	--	--	0.7	--	--	--	--	2.1	--	1
M. peltiformis	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.1	0.02	0.8	--	--	--	--	--	--	--	--	--	--	--	--
M. efflorescens	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	--	--	--	--	--	--	--	--	--	--
M. corbettensis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.3	--	--	--	--	--	--	--	--	--	--	--
M. informis	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	0.2	0.1	0.6	--	--	--	--	--	--	--	--	--	--	--	--
M. orientalis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--
M. angulata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--
M. caliculata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.9	--	--	--
M. venosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.5
M. hispida	--	--	--	--	--	--	--	--	1.7	--	--	--	--	--	0.03	0.1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
M. digitata	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.1	0.1	0.2	--	--	--	0.4	20	1.4	--	--	--	--	--	--
M. sp.	--	--	3	--	--	--	--	--	--	--	--	--	7.2	0.2	0.9	0.05	0.4	--	--	--	--	--	--	--	1.6	--	--	--	--
Acropora palifera	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	--	--	--	--	--	--	--	--	--	3.8
A. formosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.3	1.2	--	--	--	--	--	--	--	0.6	5.6	1.2
A. grandis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3
A. pinguis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
A. robusta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	2.9
A. nobilis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	5.3	0.8	--	--	1
A. divaricata	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--
A. florida	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	--	--	--
A. austera	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
A. forskali	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.3	--	--
A. seriata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.8	--	--
A. micropthalma	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--	0.8	--	--

A. clathrata	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	--	--	--	--	--	--	--	--	--	--	--	--	1.3	--	1.7
A. cytherea	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	--	--	--	0.2	--	--
A. hyacinthus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.03	0.03	--	2.1	19	0.3	4	--	--	--	--	--	--	--
A. humilis	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.01	0.1	0.04	--	--	--	--	--	--	--	--	0.5	--	--	4.8
A. monticulosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--
A. samoensis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--
A. gemmifera	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.1	0.2	0.01	--	1.9	--	--	--	--	--	--	--	0.2	5.6	1.5
A. digitifera	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	0.4	0.4	0.2	--	0.1	3.6	1.3	0.7		--	--	--	--	--	--
A. millepora	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.03	0.03	0.06	--	--	--	--	--	--	--	--	--	--	--	--
A. aspera	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--
A. subulata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	2.2	--
A. anthocersis	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.1	0/01	0.1	--	--	--	--	--	--	--	--	--	--	--	--
A. macrostoma	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
A. squarrosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--
A. plantaginea	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	0.8	1.1	--
A. secale	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	0.01	0.01	0.05	--	--	--	--	--	--	--	--	1	--	--	--
A. nasuta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	0.03	--	--	--	--	--	--	--	--	1.1	--	--	1
A. cerealis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	1.6	3.4	--
A. valida	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.01	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
A. variabilis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--
A. subglabra	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.4	--	--	--	--
A. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	0.6	--	--	--
Astreopora suggesta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	--	--	--	--	--	--	--	--	--	--	--	--
A. ocellata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--
A. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Pocillopora damicornis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	0.1	--	--	--	--	--	--	--	0.5	1.6	0.2	1.1	3.4
P. verrucosa	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	0.7	0.6	0.8	--	--	--	--	--	--	--	--	--	--	--	--
P. meanderina	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	0.1	0.05	--	--	--	--	--	--	--	--	--	--	--	--	--
P. elegans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	0.05	--	--	--	--	--	--	--	--	--	--	--	--
P. eydouxi	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	0.3	0.6	0.6	--	--	--	--	--	--	--	--	--	0.1	--	0.5
Seriatopora hystrix	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	--	--	--	--	--	--	2.2	--	--	--	--
S. aculeata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S. caliendrum	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	0.1	1.8	--	--	--	--	--	--	--	--	--	--	--	--
Stylophora pistillata	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	0.1	0.5	0.3	--	--	--	--	--	--	0.2	--	--	--	--	1
S. subseriata	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	0.7	0.3	--	--	--	--	--	--	--	--	--	--	--	--

Galaxea facicularis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	0.5	--	--	--
G. astreata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--	--
Pseudosiderastrea tayami	--	--	--	0.4	--	--	--	--	0.6	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Siderastrea savignyana	0.2	1	--	0.8	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Psammacora stellata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--
P. digitata	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	--	--	--	--	0.7
Coscinaraea monile	--	--	0.7	--	--	--	--	--	1.2	0.2	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pavona clavus	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pavona sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.03	0.01	0.01	--	--	--	--	--	--	--	--	--	--	--	--
Pachyseris rugosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	--	--	--	--
P. foliosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cycloseris patelliformis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fungia danai	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.9	--	--	0.3	--	--
F. fungites	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--
Ctenactis echinata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	4.2
Pectinia paeonia	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydnophora rigida	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.2	--	--	8.3
H. exesa	--	10.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Merulina	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--	--	--	--
Turbinaria peltata	--	--	0.4	--	--	--	--	--	11.9	8.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acanthastrea rotundoflora	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--
A. hillae	--	1.8	0.5	--	--	--	--	--	0.9	0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lobophyllia corymbosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.8	--	--	--	1
L. hemprichii	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	0.05	0.04	--	--	--	--	--	--	--	--	0.3	--	--	--
Symphyllia recta	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	--
S. radians	--	18.2	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	0.01	--	--	--	--	--	--	--	--	--	0.4	--	0.6
S. agaricia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.01	0.03	--	--	--	--	--	--	--	--	--	0.8	--	--
Favia matthaii	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F. speciosa	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.01	0.01	--	--	--	--	--	--	--	0.1	--	--	0.2	--	--
F. pallida	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	1
F. favus	7.2	17.5	4	13	0.4	1.2	10.4	24.7	0.8	--	36.2	28.2	1.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F. lizadensis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--
F. maxima	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Favia sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	0.01	--	--	--	--	--	--	--	--	--	--	--	--
Favites pentagona	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	2.3	--	0.8	--	--	--	--	--	--	--	--	--

F. besiae	1.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F. halicora	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.01	--	--	--	--	--	--	--	--	0.1	0.1	--	--	--
F. abtida	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.2	0.03	0.1	--	--	--	--	--	--	0.8	--	--	0.5	--	1.2
F. russelli	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	--	--	--	--	--	--	--	--	--	--	--
F. complanata	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	0.03	0.1	--	--	--	--	--	--	--	--	--	0.2	--	--
Favites sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.04	0.1	0.05	--	--	--	--	--	--	--	0.8	--	--	--	--
Goniastrea minuta	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--
Goniastrea edwardsii	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.03	0.2	0.3	--	--	--	--	--	--	--	--	--	0.3	1.1	1.1
G. retiormis	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.2	0.1	0.2	--	--	--	0.1	--	--	--	--	--	0.2	--	--
G. aspera	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--
G. favulus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
G. pectinata	1.5	3.5	3.7	2.2	1.2	--	--	2.4	0.7	0.2	0.6	0.2	1.8	--	--	--	0.03	--	--	--	--	--	--	--	--	0	--	--	--
Goniastrea sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	--	0.01	0.01	--	--	--	--	--	--	--	--	--	--	--	--
Platygyra pini	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	0.2	--	--	0.7
P. sinensis	0.2	6.3	--	--	--	--	--	4.2	--	--	2	1.5	--	0.1	--	0.02	0.02	--	--	--	--	--	--	--	--	--	--	--	0.7
P. daedalia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	0.2	0.1	--	--	--	--	--	--	--	--
Leptoria irregularis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	--	--	--
Plesiastrea versipora	--	--	0.5	0.7	--	--	--	--	--	0.2	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diploastrea heliopora	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	--	--	--	--	--	--	--	--	--	--	--	0.5
Leptastrea pupurea	--	--	--	--	--	--	--	3.3	--	--	0.8	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--
Cyphastrea serailia	1.8	--	4.8	4	1.7	1.2	1.5	1	2.1	--	9.1	1.9	0.2	0.1	0.01	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
C. micropthalma	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	--	--	--	--
Echinopora lamellosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.2	--	--
Porites solida	--	--	--	--	--	--	--	--	--	--	--	--	--	1.7	0.3	1.9	1	--	--	--	--	--	--	--	7.6	13	2.6	1.1	0.7
P. lobata	--	--	--	--	--	--	--	--	--	--	--	--	--	1.5	1.5	1.1	1.7	--	--	0.2	2.5	--	--	21	--	3.6	4.4	4.5	1.5
P. lutea	--	--	--	--	--	--	--	--	--	--	--	--	--	2.5	1.1	1.6	3.2	--	10.4	1.7	--	--	--	--	--	--	8.5	16	0.7
P. mayeri	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.9	--	--
P. murrayensis	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.2	0.02	0.4	--	--	--	--	--	--	--	--	0.6	1.3	3.4	--
P. lichen	--	--	--	--	--	--	2.2	0.2	--	--	0.2	--	--	--	0.03	--	--	--	--	--	--	--	--	--	--	--	--	--	--
P. annae	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	3.4	--
Porites rus	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	0.01	0.01	0.02	--	--	--	--	--	--	--	--	2.5	--	--	--
P. latistella	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	0.3	--	--
P. cylindrica	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	0.7	0.1	0.4	--	--
P. compressa	--	10	1.5	10	0.7	7.8	51	14.1	0.3	--	5	6.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Porites sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Goniopora planulata	--	17.9	2	--	--	--	--	--	2.6	0.8	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
G. stuichburyi	--	--	2.9	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Heliopora coerulea	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	0.04	--	--	--	--	--	--	4.6	--	--	--	--	--
Tubastrea aurea	--	--	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

bleaching event in 1998 (Arthur, 2000) with the bleaching related mortality of 82.49%, 60% and 53.31% respectively of the corals of Mandapam, Keelakari and Tuticorin group of Islands (Venkataraman, 2000). These reefs may have experienced bleaching stressed coral mortality, simultaneous to the episode in May 2010 in Andaman and Nicobar reefs (Krishnan *et al.*, 2011) may well be the reason for low cover in the latest assessment. Unlike Lakshadwep reefs, however, the local disturbances impeding recovery are evident by the immediate dominance of algae.

The Islands of Andaman and Nicobar were severely affected by the earthquake and tsunami in 2004. Damages on account of seismic related reef up-lift in North Andaman and tsunami disaster in Nicobar reefs had caused reduction in live coral cover – 41% and 55% less cover for North Andaman and Nicobar reefs respectively, from the 2003 values – were documented earlier (Kulkarni *et al.*, 2008; Rajan *et al.*, 2008; Saxena *et al.*, 2008). Though Turner *et al.* (2001) argued that the Andman reefs do not seem to have experienced severe bleaching in the past, there are reports that the reefs may have bleached upto 80% in 1998 (Wafar, 1999), along with anecdotal information of 80% bleaching during this time (Pet-Soede *et al.*, 2000; Sastry, 1998). However, quanditative estimations of bleaching data were lacking for the 1998 event. The long-term impacts of bleaching, reef up-lift and tsunami on coral health is clear from the declining trend in reef health of these reefs from status assessment data since 2000 and the latest assessment. The account of bleaching in 2010 in South Andaman reefs is reported by Krishnan *et al.* (2011): the cover of fully bleached corals ranged from 8.27 - 45.29 %. Reefs with high dead coral cover in Andaman and Nicobar (e.g., Henry Lawrence, Havelock (Elephant Beach), and Outram in Rani Jhansi Marine National Park) show comparatively low live coral cover in 2011 (Fig. 2) could be attributed to this cause.

The above analyses point to the fact that all the reefs in India are facing impacts from climate change and natural events to local activities - albeit in varying degrees. Siltation and eutrophication (Ravindran *et al.*, 1999) have been identified as major, long-term and chronic stressors in GOK reefs, amplifying the impacts of long exposures (due to high tidal amplitude) and summer bleaching. Bleaching has been identified as the major factor determining reef health in Lakshadweep reefs, with very little impact from local scale factors such as periodic dredging for boat passage in the lagoon. In Andaman and Nicobar there is siltation and eutrophication at a minimal scale through: deforestation, sewage discharge, terrestrial runoff and shore erosion associated with land subsidence in South Andaman. Gulf of Mannar reefs are stressed more by means of intense local activities besides the regular bleaching events. Shore-based pollution, intensive fishing, illegal harvesting of protected resources compound the long-term impacts of bleaching, thereby resulting into loss of species, alteration in species dominance, and many algal dominated reefs.

Changes in community patterns of corals in bleached reefs are manipulated by tolerence level of each species to elevated temperatures has been indicated earlier (Done, 1999; Coles *et al.*, 2003; Loya *et al.*, 2001). The reefs in India at present may have different scleractinian species composition on account of the extent of the impacts of climate change and natural calamities, notwithstanding the lack of studies citing evidences on this account, are also being strongly influenced by localized stressors. The dominance of species indicated by stress tolerators, of the reefs severely affected by sedimentation, had been identified in some Andaman reefs (Kulkarni and Saxena, 2002), which is shown by the present study in majority of the reefs studied in GOM, GOK and Outram Island in Andaman (Table 3), and the increase in species dominance with the increase in live cover in GOM (Fig. 5). Despite the stress tolerators foming high benthic cover (Table 3), the species dominance was not manifested in the reefs studied in Lakshadweep, and Andaman, which exhibited high scleractinian species richness, diversity and evenness indices. To conclude, the impact on diversity was more pronounced on reefs where local stressors are more, than the the reefs affected by mortality events alone (e.g., Lakshadweep reefs, despite having reduced live cover on account of bleaching in 2010, showed decrease in speceis dominance with the increase in live cover; Fig. 5).

The recovery from major bleaching and other catastrophic events has been steady in reefs where the local stressors are minimal (e.g. Lakshadweep & Andaman), which helped maintaining diversity, is one pointer to the resilient character in these reefs. Identifying as well as quantifying pressures due to developmental and social activities is the first part, therefore to managing reef health in Indian reefs. Though there are many studies that touched upon the issue of pollution and regional stressors in Indian reefs, the sources and behaviour of pollutants in a reef, their qualitative and quantitative assessments and the impacts of which to the reef communities at a spatial scale are some of the many lacunae to be addressed. Devoted long-term monitoring of the benthic and fish communiities is another significant one for interpreting the impact of unexpected events (Arthur, 2006). Speical attention also to be given to address social problems by understanding the availability of resources and the long-term sustenance of resources. Lastly, facing global threats should evolve from the understanding of resiliecne of each reef to frequent and persistent global threats. Conservation efforts should be based on the consultation from these studies and regional level planning by involving discussions at the community level.

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