Community-based monitoring detects catastrophic earthquake and tsunami impacts on seagrass beds in the Solomon Islands

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A R T I C L E  I N F O

Keywords:
Seagrass
Marine protected area
Earthquake
Subsidence
Tetepare

A B S T R A C T

Seagrass beds are an important component of the marine ecosystem and play a significant role in coastal protection and maintaining fish production. Despite a global decline in seagrass, the Indo-Pacific region supports a high diversity of seagrass species with many seagrass beds still intact and healthy. Tetepare Island in the Solomon Islands is the largest uninhabited island in the South Pacific and supports seagrass beds inside fringing reefs along its southern coastline. We monitored the diversity and abundance of seagrass species on Tetepare and nearby sparsely-populated Rendova Island over a 12 year period, 4 years before and up to 8 years after a major earthquake and tsunami event in January 2010. Changes to seagrass beds were compared at sites close to and remote from the earthquake epicentre. Before the earthquake, eight seagrass species were recorded on Tetepare Island with an average cover at monitoring sites of approximately 50%. The 2010 earthquake registered 7.1 on the Richter scale and the epicentre was only 20 km from Rendova and Tetepare Island. It created a tsunami wave that surged at least 7 m, caused permanent subsidence of up to 70 cm and caused major landslides that deposited sediment onto the seagrass beds inside the fringing reefs of the Tetepare MPA. Both seagrass cover and diversity declined after the tsunami. Seagrass cover declined the fastest at sites on Rendova, closest to the epicentre, declining from 50% to <10% cover within 12 months of the earthquake. At sites within the Tetepare MPA, seagrass cover took longer to decline and dropped from an average of 50% to <10% within 2 years of the 2010 earthquake and became dominated by Halophila ovalis. Species richness declined from 9 to 4 species and diversity significantly declined with some species such as Syringodium isoetifolium disappearing completely from monitoring sites. Anecdotal turtle sightings reduced and the dugongs left the lagoon. Sites on Tetepare East, furthest from the epicentre, remained unaffected by the earthquake until 3 years later when they began to decline, possibly due to subsidence changing water depth and light availability. The 2010 earthquake triggered a major change in seagrass diversity and cover on Tetepare and neighbouring Rendova Islands and seagrass cover and diversity had not reached pre-earthquake levels 8 years after the event. Changes are likely to be related to physical damage from the tsunami wave, changes to turbidity from landslides and changes to water depth and light penetration from subsidence.

1. Introduction

Seagrass meadows represent an important marine habitat globally and are the dominant primary producer in coastal areas (Green and Short, 2003). Seagrass provides important ecological functions such as supporting nursery habitat for fish, stabilising the substrate in coastal areas and nutrient recycling (Green and Short, 2003). Seagrasses also produce large quantities of organic carbon (Suchanek et al., 1985; Orth et al., 2006) and are home to a high diversity of marine organisms such as crustaceans, polychaetes and molluscs (Williams and Heck Jr., 2001). Water quality is improved because seagrass beds trap a wide range of sediments and nutrients benefiting fringing coral reefs. Seagrasses are also directly consumed by a variety of herbivores including green turtles (Chelonia mydas) and dugongs (Dugong dugon) (Lanyon et al., 1989; Hughes et al., 2009).

The tropical Indo-Pacific region supports the highest diversity of seagrass in the world with >24 species recorded (Short et al., 2007). In some areas up to 14 species may be recorded at one site. The species

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https://doi.org/10.1016/j.marpolbul.2019.07.032
Received 21 May 2019; Accepted 12 July 2019
0025-326X/ © 2019 Published by Elsevier Ltd.
richness decreases from west to east with 10 species recorded in the Solomon Islands (McKenzie et al., 2006). Solomon Islands seagrasses are predominately found on fringing reef flats and more than half are found in Malaita province. Seagrass beds in the Solomon Islands are estimated to cover over 10,000 ha and are generally in healthy condition but high sedimentation from logging is thought to be a major threat to seagrass communities (McKenzie et al., 2006). An assessment of Solomon Island seagrass communities recommended that more protected areas are established to protect seagrass beds from overfishing, erosion and pollution (McKenzie et al., 2006).

Since historical times, the extent of global seagrass beds has declined by > 29% and has continued to decline at a rate of 110 km per year since 1980 (Waycott et al., 2009). Rates of decline are increasing and suggest that seagrasses are one of the most threatened habitats worldwide (Waycott et al., 2009). The most significant impacts to seagrass are anthropogenic (Short and Wyllie-Echeverria, 1996); direct impacts on seagrass include dredging and coastal development but indirect impacts such as nutrient enrichment, sediment run off, invasive species and overfishing can occur slowly over several years and thus effects are less obvious (Orth et al., 2006; Editorial-Marine Pollution Bulletin 2014). Climate change is also impacting seagrass meadows through processes such as leaf burning due to elevated temperatures and is likely to increase over time.

Aside from the significant human impacts on seagrass, seagrass meadows are dynamic and can change in response to natural disturbances such as earthquakes, volcanic eruptions, sand migration and cyclones (Short and Wyllie-Echeverria, 1996). Seagrasses can often be resilient to the impacts of physical disturbance and erosion due to their strong underground network of roots and rhizomes (Fonseca and Fisher, 1986) that buffer the effects of waves and currents (Koch and Gust, 1999). However, tsunamis can cause physical damage to seagrass beds, and earthquakes can cause landslides, increasing silt levels and sedimentation in seagrass lagoons and lowering light levels (Nakaoka et al., 2007; Lomovskiy et al., 2011). Silt and sedimentation from tsunamis can also cause seagrass burial leading to a decline in shoot density and death with some species recording complete shoot loss when buried under 8 cm of sediment (Cabanco and Santos, 2007). Earthquakes can cause subsidence and uplift (Newman et al., 2011) which can change the water depth and thus alter light and temperature conditions.

Here we investigate the impact of an earthquake and resultant tsunami on seagrass beds in the western province of the Solomon Islands. Tetepare Island supports seagrass beds behind > 13 km of reef on the southern coast of the island. The deeper seagrass beds within Tetepare’s Marine Protected Area (herein called MPA) on the SW side of the island support dugongs and green and hawksbill turtles. Shallower seagrass beds are also present on the SE side of Tetepare and on neighbouring Rendova Island behind fringing reefs. In 2010, an earthquake registering 7.1 on the Richter scale was reported with the epicentre only 20 km South of Rendova and Tetepare Islands (Newman et al., 2011). The earthquake created a tsunami wave that surged at least 7 m and also caused major landslides that deposited tonnes of sediment into the lagoons within Tetepare’s MPA. We documented the seagrass cover and species composition before and after the earthquake. Results were used to determine the temporal and physical scale of the impact on local seagrass beds. We used community-based monitoring and employed and trained local women to undertake the monitoring under the guidance of experienced ecologists. An important part of the monitoring program was to educate and inform the local community about the value of conserving seagrass beds in the Solomon Islands.

2. Materials and methods

At 11880 ha, Tetepare Island (8°, 45’ S, 157° 32’ E) in the Western Province of the Solomon Island is the largest uninhabited island in the South Pacific. Tetepare is owned and managed by the customary land owners through the Tetepare Descendants Association (TDA). Although Tetepare Island was once inhabited, the population declined significantly in the 19th century and the remaining islanders fled to neighbouring islands. TDA was formed in 2002 with the objective of conserving the island. A Marine Protected Area was established encompassing 13.3 km of coastline along the weather coast including 7 km of barrier reef and 5.3 km of fringing reef (Read et al., 2010). Seagrass beds are found along > 14 km of Tetepare’s southern coastline including 7 km within the MPA. Green and hawksbill turtles and dugongs are regularly observed in the seagrass beds (K. Moseby pers. comm). Seagrass beds are also found behind shallow fringing reefs on the southern coast of neighbouring Rendova Island situated to the west of Tetepare.

Seagrass monitoring was initiated by the Tetepare Descendants Association in 2006 after training by staff from the World Wildlife Fund (WWF) in Seagrass Watch (www.seagrasswatch.org) methodology. Monitoring was conducted by women from neighbouring villages with the assistance of an experienced ecologist (Katherine Moseby). Seagrass Watch cover species codes and percent cover standards were used during all monitoring events. These community-based monitoring reference sheets allowed the seagrass cover and species composition to be recorded in a consistent manner.

Rainfall records were taken from the nearest weather station at Munda, located 48 km from Tetepare Island.

2.1. Seagrass monitoring

Seagrass monitoring sites were established in 2006 in two zones; inside the Tetepare MPA and in a lagoon on neighbouring Rendova Island. A third zone was initiated in 2007 outside the MPA along the south eastern coastline of Tetepare (herein called Tetepare East, Fig. 1). All three zones supported thick, healthy seagrass beds at the time of first sampling. Female TDA members from local villages on Rendova Island were trained in seagrass monitoring in 2006 by local WWF staff using seagrass watch transect methodology. However, due to the large size of the seagrass beds, the intensive nature of individual seagrass watch sites and local capacity, methods were altered from 100 m fixed intertidal transects to quadrat based monitoring. Sites were established randomly along the seagrass coastline at a spacing of at least 500 m with the condition that all sites must contain seagrass. Sites were placed at varying distances from shore to ensure a range of depths were sampled. Depending on the tide, sites were between 20 cm and 3 m deep at the time of sampling. A total of 20 sites were established within a 3 km lagoon within the Tetepare MPA, 9 sites within shorter lagoons outside the MPA on Tetepare East and 6 sites at a lagoon on Rava Point on neighbouring Rendova Island (Fig. 1).

Sites were sampled once or twice a year from 2006 to 2017 inclusive with no sampling occurring in 2009 and 2011 due to a shortage of funds. Bad weather prevented sampling of the Tetepare East and Rendova sites on one occasion each. During sampling, each site was located using a handheld GPS unit (Garmin) and a small fibreglass boat with an outboard motor. When a site was located, the boat was anchored and three or four (depending on participants) 0.5 × 0.5 m quadrats were thrown randomly from the boat in different directions. Women then dived into the water and used masks and snorkels to observe the seagrass within the quadrats. The percentage cover of different seagrass species was relayed to a scribe sitting in the boat.

2.2. Training and implementation

Six women were originally trained in seagrass watch by Bruno Manele from WWF Solomon Islands in October 2006. The modified technique was developed by ecologist Katherine Moseby who participated in 10 of the 12 monitoring sessions including the first training session. Local Rendova woman Anna Daniel was assigned head seagrass
monitor and assisted in training from 2012. Anna participated in all seagrass monitoring sessions and trained new women when experienced monitors were unavailable. A total of 12 monitoring sessions were conducted with 18 local women trained during that time. The main reasons for monitoring staff being unavailable was women moving out of the region due to marriage or being temporarily unavailable for a year after the birth of children. Regardless of the number of new trainees, at the start of each monitoring session an initial classroom discussion was held where the various species and their identifying characteristics were discussed. The importance of seagrass beds was also discussed with experienced monitors leading the discussion. This was followed by a review of the monitoring method and then a demonstration at a site closest to the field station. New monitors were paired with experienced monitors during their first monitoring session.

Table 1

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Fig. 1. Map showing the location of the monitoring sites within the three zones (Tetepare MPA, Tetepare East and Rendova) and the epicentre of the 2010 Earthquake.

Fig. 2. Annual rainfall received over the study period at Munda, located 48 km from the study sites.

Table 1

Comparison of six different models explaining seagrass cover. Location is either Rendova, Tetepare MPA, or Tetepare East.
2.3. Tsunami and earthquake

On the 3rd of January 2010 an earthquake measuring $M_w$ 7.1 was recorded with its epicentre only 20 km south of Tetepare and Rendova Islands at 8 52' 2" S, 157 26' 24" E (Newman et al., 2011). A number of foreshocks were recorded in the preceding days measuring up to $M_w$ 6.6. The earthquakes triggered extensive landslides that deposited several tons of earth into the lagoons within the Tetepare MPA. More than 200 homes were destroyed on Rendova Island by the resulting tsunami that hit the shore of Tetepare and Rendova shortly after the earthquake. Almost one third of the residents of Rendova Island were rendered homeless. The tsunami run up, or height of the wave, reached a recorded 7 m on Rendova Island (but with a computed run up of up to 12 m) and then reduced in height to the east towards Tetepare Island. Along the southern side of Tetepare, the tsunami run up reduced in intensity from west to east (Newman et al., 2011). On Tetepare, the tsunami knocked down many shore trees which then fell into the lagoon (K. Moseby pers. obs). Subsidence of up to 70 cm also occurred with subsidence higher on Rendova in the west and reducing to approximately 40 cm on the southern side of Tetepare (Newman et al., 2011). The potential impacts of the earthquake and tsunami on seagrass beds thus included immediate physical damage from the tsunami wave and earthquake, changes in water depth from subsidence and longer term changes in water quality and visibility from landslides depositing soil into the lagoon. A total of 12 monitoring sessions were conducted between 2006 and 2017 inclusive. Three monitoring sessions were conducted in 2006, 2007 and 2008 before the tsunami and earthquake. After the earthquake and tsunami, seagrass monitoring occurred in April and December 2010 (3 and 12 months after the event) and then in April and October 2012, March and October 2013, October 2014, May and October 2015 and October 2017.

2.4. Data analysis

To investigate impacts of the earthquake and tsunami on seagrass cover, we used generalised additive models compared within an information theory framework. Smoothed terms were used as sampling covered both a pre-disturbance, disturbance and recovery stage; therefore results were predicted to be non-linear. Seagrass cover was square-root transformed to fulfil assumptions of normality. Due to the nested survey design, mixed effects models were used, with site treated as random effect using the R library 'mgcv' (Wood, 2001). Due to temporal autocorrelation of samples, we also added an ‘order 1’ autocorrelation structure to each model (Box et al., 1994). Models compared included one with a smoothed term for date, smoothed term for time since tsunami, location interaction terms for both respectively, location alone, and a null model. All models where compared using AICc in the ‘MuMIn’ library (Barton and Barton, 2018).

For understanding how the earthquake and tsunami affected seagrass diversity, we calculated the Shannon-Wiener diversity index for each site during each monitoring event. Results from the 3–4 quadrats at each site during each survey were merged together before analysis to reduce zero-inflation. Again, generalised mixed effects models were used with an ‘order 1’ autocorrelation structure to each model (Box et al., 1994). The same six models were also compared using AICc; a null model, location alone, smoothed term for date, smoothed term for time since tsunami, and location interaction terms for both respectively.

3. Results

Annual rainfall varied from 3325 mm to 4262 mm over the study period and was generally consistent with slightly drier conditions in 2008 and 2017 (see Fig. 2).

3.1. Rainfall

3.1.1. Seagrass species

Nine species of seagrass were recorded at monitoring sites, namely *Halophila ovalis* (Ho), *H. minor* (Hm), *Cymodocea rotundata* (Cr), *C. serrulata* (Cs), *Syringodium isoetifolium* (Si), *Thalassia hemprichii* (Th), *Halodule univis* (Hu), *Halodule pinifolia* (Hp) and *Ehalaus acaroides* (Ea). Some species were in very low abundance and were not recorded during every monitoring session. The most diverse seagrass beds were recorded within the Tetepare MPA which encompassed the longest and deepest lagoon (up to 3 m) and where 9 species were recorded. Within the MPA, green and hawksbill turtles were regularly observed at all sites and up to seven dugongs in a pod were also present at MPA sites. Other sites on Tetepare and Rendova islands supported a lower diversity of seagrass mainly comprised of Th and Cr. These sites were in narrower, shallower lagoons with depths of < 1.5 m.

3.1.2. Seagrass cover

Changes in seagrass cover were best explained in an information theory framework as months since tsunami and location, with a
different response within the Rendova, Tetepare MPA and Tetepare East locations (Table 1, $P < 0.001$ for all interactions, $R^2 = 0.52$). Rendova sites were the closest to the epicentre of the earthquake and were subjected to the highest run up (minimum 7 m, computed 9 m) and greatest subsidence (70 cm). These sites showed the sharpest decline with a significant decline in seagrass cover in December 2010 <11 months after the tsunami (Figs. 3 & 4). Average cover in quadrats declined from approximately 50% prior to the tsunami to <10% afterwards and remained low for the remainder of the monitoring periods up to 8 years after the tsunami. Unfortunately, sites were not surveyed in April 2010, 4 months after the tsunami due to bad weather preventing access so it is not known if declines in cover occurred immediately after the earthquake or up to 11 months after.

Tetepare MPA sites were next closest to the epicentre and received a computed run up of 6 m and 30 cm subsidence (Newman et al., 2011). This area was subjected to the most significant landslides due to the steep cliffs adjacent to the lagoons. During monitoring in 2006, 2008 and 2009, prior to the Tsunami, seagrass cover was high and averaged 40% at MPA sites. Monitoring in the year following the tsunami found that MPA sites were largely unaffected but in 2012, 2 years after the Tsunami, seagrass cover at MPA sites had declined significantly averaging only 10% cover (Figs. 3 & 4). Cover continued to decline at these sites over the next 2 years until 2014 when cover began to increase.

Tetepare East sites further east along the weather coast of Tetepare received less impact from the earthquake and tsunami (Newman et al., 2011). The run up was lower (computed run up 2 m, Newman et al., 2011) but the subsidence was slightly higher than the MPA at 40 cm. Landslides were less common due to the lower coastal topography. At Tetepare East sites the decline in seagrass cover was only slight and gradual (Figs. 3 & 4). Seagrass beds at these sites averaged 50% cover prior to the tsunami and did not change until October 2013, almost 4 years after the tsunami. From 2013 to 2017 a significant decline in cover was recorded from 50% to 10%.

3.1.3. Species diversity

Before the earthquake and tsunami in January 2010, there was

![Graphs of seagrass cover over time for Rendova, Tetepare MPA, and Tetepare East locations.]
dramatic variation in the community composition and diversity of seagrass at each of the three locations (Fig. 5). Tetepare MPA was the most diverse, with seven species well represented (Figs. 5 & 6) and 9 species recorded in total. The generalised mixed-effects models found that the model that had the most support for explaining seagrass diversity was months-since-tsunami interacting with location (AICc weight = 0.7), with some support also for date interacting with location (AICc weight = 0.3, Table 2). This suggests some variation pre-tsunami affected results, but post-tsunami impacts were substantially more important. The time-since-tsunami and location interaction term was largely driven by the changes at Tetepare MPA sites, which had high initial diversity but this decreased substantially in the following years (Figs. 5 & 6).

At Tetepare MPA sites, species richness declined from 9 to 4 species and only increased to 6 species nearly 8 years after the tsunami. Species that declined significantly at MPA monitoring sites after the tsunami included Si, Th, Cr, Hp, Ea, Hm and Cs. Two species of seagrass increased in abundance after the tsunami, namely Ho and Hu. Rendova sites were the least diverse with only one species of seagrass recorded prior to the tsunami (Th) compared with 5 species afterwards (Th, Hp, Ho, Cr and Si) suggesting an increase in species richness (Fig. 6). Ho was the only species to significantly increase after the tsunami. Tetepare East had four species recorded and species richness did not change over time with Th and Cr dominating during all monitoring sessions with lower cover of Ea and Cs (Figs. 5 & 6).

4. Discussion

The tropical Indo Pacific region has the highest diversity of seagrass in the world with up to 14 species growing together on reef flats (Short et al., 2007). Thirteen seagrass species are found in the Pacific Islands (Coles et al., 2003) with the highest diversity in Papua New Guinea (13 species) and lowest in French Polynesia (2 species) (Skelton and South, 2006). Prior to the 2010 earthquake and tsunami, we recorded up to 9 species of seagrass in a single lagoon on Tetepare Island supporting large populations of turtles and dugongs. Seagrass meadows are common inside the fringing reefs of Tetepare and Rendova Island and are used by locals for harvesting of clams and beche-de-mer. Due to the low human population (Tetepare is uninhabited and Rendova has a population of approximately 3000) and lack of extensive clearance for agriculture the seagrass beds on Tetepare and Rendova Islands do not receive high nutrient run off and pollution. During the 2006 and 2008 monitoring sessions these seagrass beds were healthy averaging up to 50% cover at monitoring sites and with seagrass beds extending from the low tide mark to depths of over 3 m.

The seagrass cover and diversity on Tetepare and Rendova Islands in the Solomon Islands changed significantly over a 12 year period from 2006 to 2017. Significant changes occurred after the 2010 earthquake and tsunami. At all three study areas, seagrass diversity declined, seagrass cover declined by as much as 40%, and species richness was reduced by 50% at sites within the Tetepare MPA. These changes are likely related to the impacts of the earthquake and tsunami including the physical damage caused by the tsunami itself, the increased water turbidity caused by landslides and the tsunami run up, and the changes in light penetration caused by subsidence. Light availability, wave velocity and tidal energy are important factors known to significantly influence seagrass cover and species composition. Light is considered the major limiting factor of seagrasses (Boer, 2007) and catastrophic weather events can reduce light availability through increased sediment loads. Increased turbidity decreases irradiance and thus affects photosynthesis rates, plant survival and recruitment. For example, cyclones and storms can suspend so much sediments that meadows become buried, seed germination reduced and light penetration low leading to die off of meadows (Preen et al., 1995; Koch and Gust, 1999). Pulsed turbidity events following tropical storms in Hervey Bay led to high mortality of seagrass and emigration of dugong (Preen and Marsch, 1995). Landslides caused by earthquakes can also increase sediment load and reduce light availability. The extensive landslides that occurred along the coast adjacent to the Tetepare MPA caused both direct deposition of sediment into the lagoon and increased run off of sediment in the following months and years until vegetation regrew. Physical erosion of bed material through catastrophic events is also an important phenomenon in seagrass beds (Boer, 2007). Storms or tsunamis can cause die off through uprooting plants (Preen et al., 1995, Koch and Gust, 1999).

Although it is likely that the major changes observed in seagrass composition and cover were caused by the 2010 earthquake and tsunami, ascertaining the true cause is difficult as true control sites remote from all disturbance were not sampled. Seagrass can be affected by anthropogenic influences as well as weather events. Seagrass beds in the Solomon Islands are considered to be in reasonably good condition but high sedimentation from logging is thought to be a major threat to seagrass communities (McKenzie et al., 2006). However, logging was not responsible for the changes in seagrass recorded in our study as all sites were adjacent to uncleared forest. Tetepare Island and the area adjacent to the sites on Rendova Island are uninhabited and so are not subjected to agricultural run off or other anthropogenic impacts. This strengthens the case for changes being due to the 2010 earthquake and tsunami but does not rule out effects of climate change or unknown impacts. However, annual rainfall was relatively consistent throughout the study period and no other significant weather events were recorded during that time.

The variation in earthquake and tsunami intensity at the three study areas (Newman et al., 2011) affords an opportunity to compare seagrass changes relative to high and low impact.

Changes to seagrass after the earthquake occurred within 11 months on Rendova and within 2 years at MPA sites but only after nearly 4 years at sites on the east of Tetepare Island. The 2004 tsunami in Thailand also caused variable impacts with some beds destroyed completely and others appearing to have negligible impact (Tanyaros and Crookall, 2011).

The variable impact of the earthquake and tsunami on seagrass meadows across Rendova and Tetepare is likely to reflect differences in intensity of the physical changes caused by the catastrophic event including variation in the impacts of wave erosion, increased water depth from subsidence and increased turbidity. Effects of the tsunami may have been evident at Rendova sites first because they received the full force of the tsunami with an estimated run up of 9 m. This may have
caused extensive uprooting or burial of seagrass and also increased suspended sediment loads which would have been exacerbated by the shallower depth of the lagoon in this region. Additionally, subsidence was highest along the South coast of Rendova (Newman et al., 2011) which would have exacerbated low light conditions by increasing the sea depth. In contrast, sites within the Tetepare MPA were slower to change possibly for a range of reasons including less subsidence, lower run up and deeper lagoons causing less physical damage to seagrass beds from the tsunami itself, and the sediment from the landslides taking longer to be suspended throughout the lagoon by tidal action. Although delayed, the impacts at Tetepare MPA sites were extreme, possibly due to the steep cliffs close to the lagoons that cause larger landslides and higher soil deposition. Sites further east along the coast of Tetepare outside of the MPA did not start declining until 3 years after the tsunami and such a slow response could be due to more subtle changes such as subsidence changing depth and therefore light intensity but no change in sediment loads because of low run up and no landslides along this stretch of flatter coastline.

The changes in species composition at many of the sites are likely related to the different tolerances of each seagrass species for light and temperature. For example, *Halophila* spp. has an advantage in deeper or more turbid water as it is able to tolerate low light intensity. Both *Halophila* spp. and *Halodule* spp. are colonising species that are commonly found in deep water up to 11 m in depth. Both of these genera gradually increased in abundance at MPA sites after the tsunami suggesting they were colonising sites that were no longer suitable for the other resident seagrass species. *Halophila ovalis* is the most widely distributed tropical seagrass species (Coles et al., 2003) and many of the

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**Fig. 6.** Cover of each seagrass species at the three monitoring zones (Tetepare MPA, Rendova, Tetepare East) over time. Black line denotes the timing of the earthquake and tsunami.
previously highly diverse sites within the Tetepare MPA became dominated with monocultures of *Halophila ovalis* after the earthquake. In comparison, the species *Thalassia hemprichii* dominated all three study areas prior to the tsunami but declined significantly after the tsunami and had not recolonised the same sites 8 years later. This species dominates >42% of all meadows surveyed in the Solomon Islands (McKenzie et al., 2006) and is common on reef platforms where it can form dense meadows. It can colonise muddy substrate and is tolerant of heat. It is possible that subsidence changes mean that previous sites were no longer suitable for *Th* and this species may recolonise new areas where monitoring sites are not currently established. However, active searches conducted during monitoring periods have not located new seagrass meadows outside of the current monitoring sites suggesting that conditions are still not suitable for some species and subsidence may render them permanently unsuitable.

Seagrass beds on Tetepare and Rendova had not recovered to pre-earthquake levels nearly 8 years after the earthquake. This is in direct contrast to studies in Thailand where seagrass beds in all areas hit by a tsunami were able to survive and regain previous levels within a year without replanting (Tanyaros and Crookall, 2011). Seagrasses meadows are dynamic (Short and Wyllie-Echeverria, 1996) often changing on an interannual basis and seagrass loss can be reversed following improvements in water quality (e.g. Preen and Marsh, 1995; Tomasko et al., 2005). Slower response and recovery of the seagrass beds on Tetepare and Rendova than in other regions may be due to the additive effects of subsidence permanently changing water depth, increased turbidity affecting light levels and physical wave action. The decline in seagrass health on Rendova and Tetepare is likely to be affecting a range of other species that utilise seagrass habitat including fish, crustaceans, polychaetes, molluscs, clams, turtles and dugongs. The decline in sightings of turtles and dugongs after the tsunami is probably related to the reduction in seagrass cover which forms a significant part of their diet (Lanyon et al., 1989; Hughes et al., 2009). Preen and Marsh (1995) also found dugongs leaving areas where seagrass meadows had been decimated in Australia from cyclones and floods. However, it should be noted that dugongs began returning to the Tetepare lagoon albeit in lower numbers about 6 years after the tsunami when *Halophila ovalis* began to recolonise. Monitoring will continue over the next few years in order to determine if seagrass beds return to pre 2010 levels of cover and composition. Community-based monitoring (www.seagrasswatch.org) has proven to be a useful method for measuring seagrass changes in the region. Methods were adapted to suit local conditions and the skills of the local Solomon Islander women who proved to be enthusiastic and hardworking monitors. Securing long term funding for seagrass monitoring has been problematic and is vital to understand the long term changes from anthropogenic causes and extreme natural events.

**Acknowledgements**

Thank you to all of the women who assisted with the seagrass monitoring including Primrose, Lavender, Calothly, Delzia, Ika, Tina, Ellie, Lorna, Iris, Stella, Sandy, Nua, Martrina, Ando, Marci and Lyn. Thanks to Gillian Goby for assisting with some sessions and to Mr. Leo Williams Vanualailai for kindly producing Fig. 1. Thank you to Bruno Manele from WWF who conducted the initial seagrass watch training and to Seagrass Watch in Australia for supplying the training materials.

**References**


