Monitoring Singapore's seagrass meadows: Trends and highlights of the first long-term seagrass monitoring initiative

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INTRODUCTION Seagrass are marine flowering plants that grow in shallow sheltered coastal waters. They can be found in temperate and tropical regions and on every continent except Antarctica. Despite its small size, Singapore has 12 of the 23 species of seagrass found in the Indo-Pacific region. Seagrass can be found on almost every shore in Singapore, but form large meadows at Chek Jawa on Pulau Ubin, the western coast of Pulau Semakau, and on the reef top of Cyrene Reef, a large patch reef off Pasir Panjang. As seagrass are a good indicator of coastal health and water quality, regular monitoring would provide an indication of changes in water quality parameters. Seagrass monitoring in Singapore started in 2007 and is carried out by a group of volunteers known as TeamSeaGrass. The volunteers comprise people from all walks to life who are dedicated to data collection as well as public outreach and education of all things seagrass. Here are some of the results of the monitoring data collected between 2007 and 2013.

MONITORING METHODOLOGY TeamSeaGrass uses the Seagrass-Watch methodology to conduct quarterly monitoring at 7 monitoring sites. Seagrass-Watch is a global participatory monitoring programme that empowers citizen scientists to collect scientifically rigorous data. Monitoring sites each measuring 50m x 50m were set up at Chek Jawa (2 sites), Pulau Semakau (3 sites) and Cyrene Reef (2 sites) (Fig. 1). Observers recorded the following parameters: sediment composition, percent seagrass cover, relative species composition, canopy height, percent macroalgal cover, epiphyte cover and water depth.

Data collected from each survey was compiled and submitted to Seagrass-Watch HQ where program scientists checked them for compliance and provided an independent assessment of their accuracy and quality. The above ground percent cover data for each of the three locations was averaged to obtain a general trend of seagrass cover between 2007 and 2012 (reproduced from Yaakub *et. al*., 2014). For comparisons of epiphyte cover and canopy height, data was averaged for 2007 and 2013. Species composition data was averaged across six years (2007-2013) and expressed as a percentage of the total.

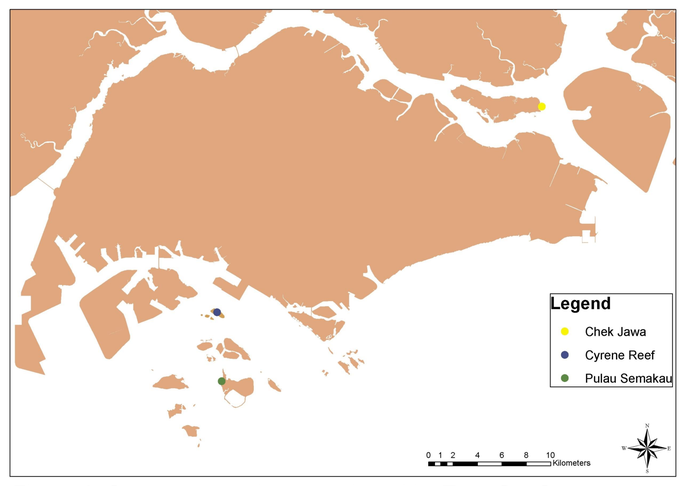

Figure 1: Seagrass meadows monitored by TeamSeaGrass

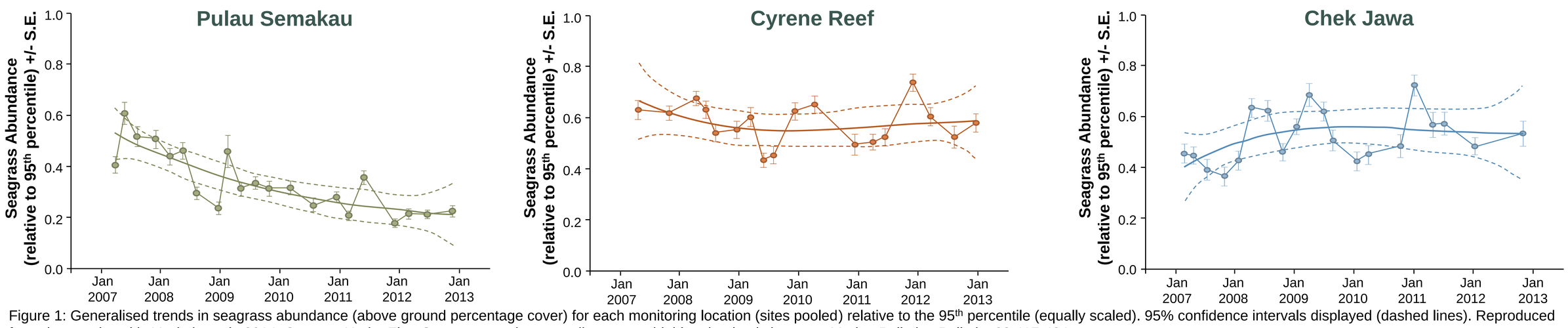

Figure 1: Generalised trends in seagrass abundance (above ground percentage cover) for each monitoring location (sites pooled) relative to the 95th percentile (equally scaled). 95% confidence intervals displayed (dashed lines). Reproduced from data analysed in Yaakub et al., 2014. Courage Under Fire: Seagrass persistence adjacent to a highly urbanised city-state. Marine Pollution Bulletin, 83:417-424.

SEAGRASS COVER Monitoring data between 2007 and 2012 indicates that there is a trend of decreasing seagrass cover at Pulau Semakau, while Cyrene Reef shows stable trend of seagrass cover despite some fluctuations between monitoring points. Chek Jawa is the only seagrass meadow that shows a trend of increasing seagrass cover during the first 18 months of monitoring, which stabilised between 2009 and 2012 (Figure 1). Continued monitoring is recommended across the three sites to determine if the current trends have any permanence.

SPECIES COMPOSITION Species composition at Pulau Semakau is largely dominated by climax species *E. acoroides* although this is expected to change over time given the decline in seagrass cover at the site. Cyrene reef has a relatively even cover of seven different seagrass species. Chek Jawa is dominated by *C. rotundata* and *H. ovalis* (Figure 2).

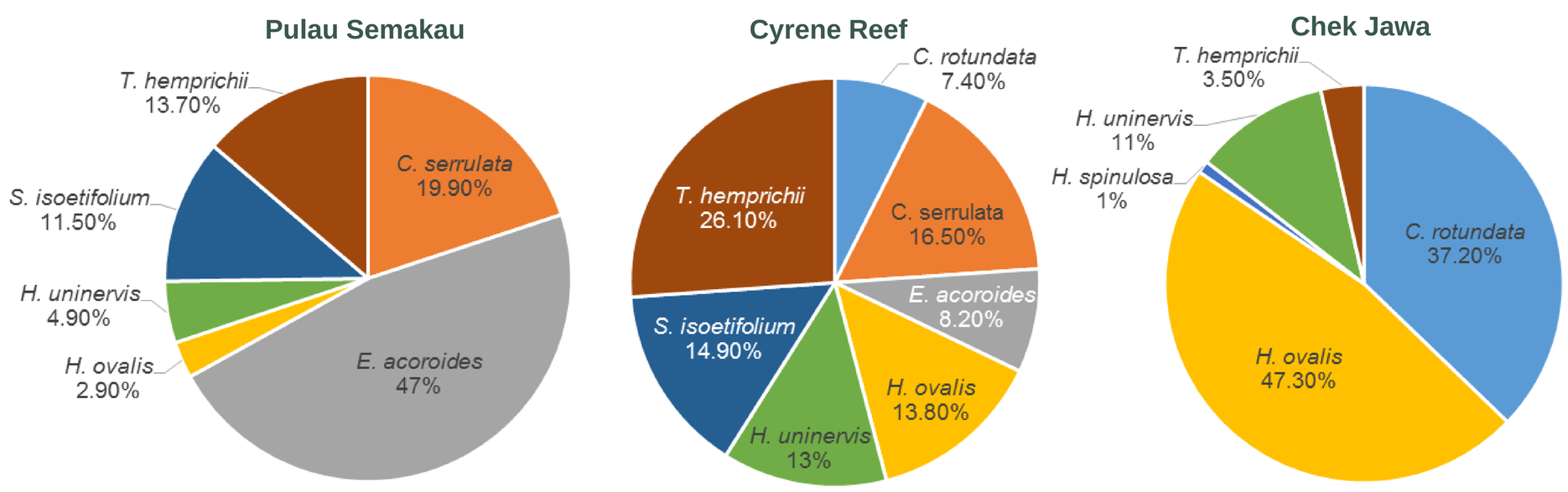

Figure 2: Average recent composition of seagrass meadows in the three monitoring sites (Averaged across 6 years and all transects, and expressed as a percentage of the total)

Table 1: Percent change in epiphyte cover between 2007 and 2013

	2007	2013	% Change
P. Semakau	45.3%	19.7%	**-25.5%**
Cyrene Reef	16.3%	8.2%	**-8.1%**
Chek Jawa	23.4%	11.7%	**-11.7%**

EPIPHYTE COVER Epiphyte cover affects the growth and photosynthetic efficiency of seagrass. It is also an indicator of water quality. The percentage of leaf area covered by epiphytes has decreased across all sites over the past 6 years (Table 1).

SEAGRASS CANOPY HEIGHT Canopy height is a rough indicator of habitat complexity within the seagrass meadow. Canopy height has decreased at both Semakau and Cyrene Reef, which could be an artefact of the shrinking populations of strap-like species (Table 2).

Table 2: Change in average canopy height between 2007 and 2013

	2007	2013	% Change
P. Semakau	37.9	10.5	**-27.4**
Cyrene Reef	9.0	4.8	**-4.2**
Chek Jawa	2.6	4.8	**+2.2**

CONCLUSIONS Seagrass populations have been declining slowly in P. Semakau and Cyrene Reef, which were largely contributed by shrinking *Cymodocea* populations. Percentage cover of pioneer species, such as *H. ovalis* have been steady or increasing across all sites. Continual monitoring is important to understanding the dynamics of these seagrass meadows for better management.

We would like to thank our volunteers and our partners, NParks and Seagrass-Watch.