Journal of Aquatic Science & Management, Vol. 7, No. 1, 19-25 (April 2019) *e*-ISSN 2337-5000
Graduate Program, UNSRAT, Manado, Indonesia – Asosiasi Pengelola Sumber Daya Perairan Indonesia
(*Online submissions* – http://ejournal.unsrat.ac.id/index.php/jasm/index)

Benthic faunal assemblages in seagrass meadows in Albany, Western Australia

Kumpulan fauna bentik di hamparan lamun di Albany, Australia Barat

Husen Rifai

Indonesian Institute of Sciences, Marine Life Conservation Station. Jl. Kolombo Aspal, Kecamatan Maesa, Kota Bitung, Sulawesi Utara, Indonesia
E-mail: lamunhusen@gmail.com

Abstract: In order to compare benthic fauna assemblages in four locations of seagrass beds in Albany (Princess Royal Harbour, Oyster Harbour, Two People Bay and Frenchman Bay), a research had been conducted between 18 and 21 April 2017. There were two aims of this study. First, to investigate six sites within four locations with various degree of anthropogenic impact in order to understand the faunal richness and abundance in those locations. Second, to measure and record the environmental factors which are assumed to be important regulators of the observed patterns between the sites. The result showed that the highest faunal abundance (227 Faunal) was found at Frenchman Bay, a less anthropogenically impacted area, while the lowest abundance (26 Faunal) was at Oyster Harbour-Emu Point which was an anthropogenically affected site. However, in terms of faunal diversity, there was no significant difference among all sites. The environmental factor which had significant relationship with the difference in benthic faunal assemblages at each site was found to be coarse sand.

Keywords: faunal assemblage; seagrass meadows; coarse sand; Albany; Frenchman Bay; Australia.

Abstrak: Satu kegiatan penelitian pada tanggal 18 hingga 21 April 2017 telah dilakukan untuk membandingkan kumpulan fauna bentik di empat lokasi padang lamun di Albany (Pelabuhan Princess Royal, Pelabuhan Oyster, Teluk Two People, dan Teluk Frenchman). Penelitian ini mempunyai dua tujuan, yaitu: 1) menyelidiki enam titik penelitian yang berada dalam empat lokasi dengan berbagai tingkat dampak antropogenik untuk memahami kekayaan dan kelimpahan fauna di lokasi tersebut; dan 2) mengukur dan mencatat faktor-faktor lingkungan yang dianggap berperan sebagai pengatur dari pola yang diamati pada semua lokasi. Hasil penelitian menunjukkan, bahwa kelimpahan fauna tertinggi (227 fauna) ditemukan di Teluk Frenchman yang merupakan daerah yang kurang terdampak gangguan antropogenik; sedangkan kelimpahan terendah (26 individu) ditemukan di Oyster Harbour-Emu Point yang merupakan lokasi yang terpengaruh secara antropogenik. Namun, dalam hal keanekaragaman fauna, tidak ada perbedaan yang signifikan di antara semua lokasi. Faktor lingkungan yang memiliki hubungan signifikan dengan perbedaan kumpulan fauna bentik di masing-masing lokasi ialah pasir kasar.

Kata-kata kunci: kumpulan fauna; padang lamun; pasir kasar; Albany; Teluk Frenchman; Australia.

INTRODUCTION

Seagrass meadow is one of the most important ecosystems in coastal areas in the world since it has many vital functions including maintaining water quality (Hemminga and Duarte, 2000), providing living space for many commercially important marine life (Hemminga and Duarte 2000; Nagelkerken et al., 2002; Heck et al., 2003), trapping and stabilizing sediments (Hemminga and Duarte, 2000), providing food source for the marine grazing animals (Mckenzie and Yoshida, 2016) and as one of the most important carbon sinks in the ocean (Duarte et al., 2005; Fourqurean et al., 2012). With those important benefits, the total value of seagrass ecosystems in the world is projected to be $ 1.9 trillion per year (Waycott et al., 2009). Bulleri and Chapman (2006) estimated that by 2025, more than three quarter of the human population in the world is likely to live within 100 km of coastal area. This phenomenon might result in a rise in anthropogenic impact on coastal ecosystems including seagrass beds.

However, result of a study on 215 locations, revealed that since 1980, seagrasses have been disappearing at a rate of 110 km^2 per year and since the 1990s the rate of deterioration have accelerated to 7% per year compared to only 0.9% per year before the 1940s (Waycott et al., 2009). In the world, the degradation rate of seagrass ecosystems

has been reported to tenfold on the last 40 years (Orth et al., 2006). There are several causes of seagrass loss and the majority was caused by human activities such as dredging and land fill, human pollution (anthropogenic pollution), coastal development for port and housing, poor farming activities and recreational boating activities (Mckenzie and Yoshida, 2016).

Albany is one of cities in Western Australia which is situated at the Great Southern Region of Western Australia. This city has several seagrass meadow areas including Princess Royal Harbour, Oyster Harbour, Frenchman Bay and Two People Bay. Those locations have different degrees of anthropogenical impact on each location. This will affect the faunal assemblage within those locations. Therefore, a research on faunal assemblages is essential to be conducted.

There are two objectives of this study. First, to investigate six sites within four locations with various degree of anthropogenic impact in order to understand faunal diversity and abundance in each location. Second, to measure and record the environmental factors exist which are important regulators of the observed patterns between the sites. It is estimated that Posidonia seagrass meadows in anthropogenically affected locations will have different benthic faunal assemblages compared to less impacted seagrass areas.

This research is important since it will reveal the abundance and diversity of faunal assemblage within six sites in four locations. The information about faunal assemblage might be more useful than the information about percentage cover of seagrass in deciding whether a seagrass meadow is impacted anthropogenically and naturally. This is because seagrasses are more resistant to disturbances from human activities such as pollution and coastal development and natural cause like storm and strong wave, while faunal assemblage is very vulnerable to such disturbances (Bostrom et al., 2006).

MATERIALS AND METHOD

Site Description

This study was conducted on six sites of single species (*Posidonia australis*) seagrass meadow along with four locations in Albany including Princess Royal Harbour, Oyster Harbour, Frenchman Bay and Two People Bay from 18 to 21 April 2017 (Figure 1). Each location had specific characteristics. Princess Royal Harbour is an estuary system which is located near the port and city of Albany. It is a lagoonal shape location and

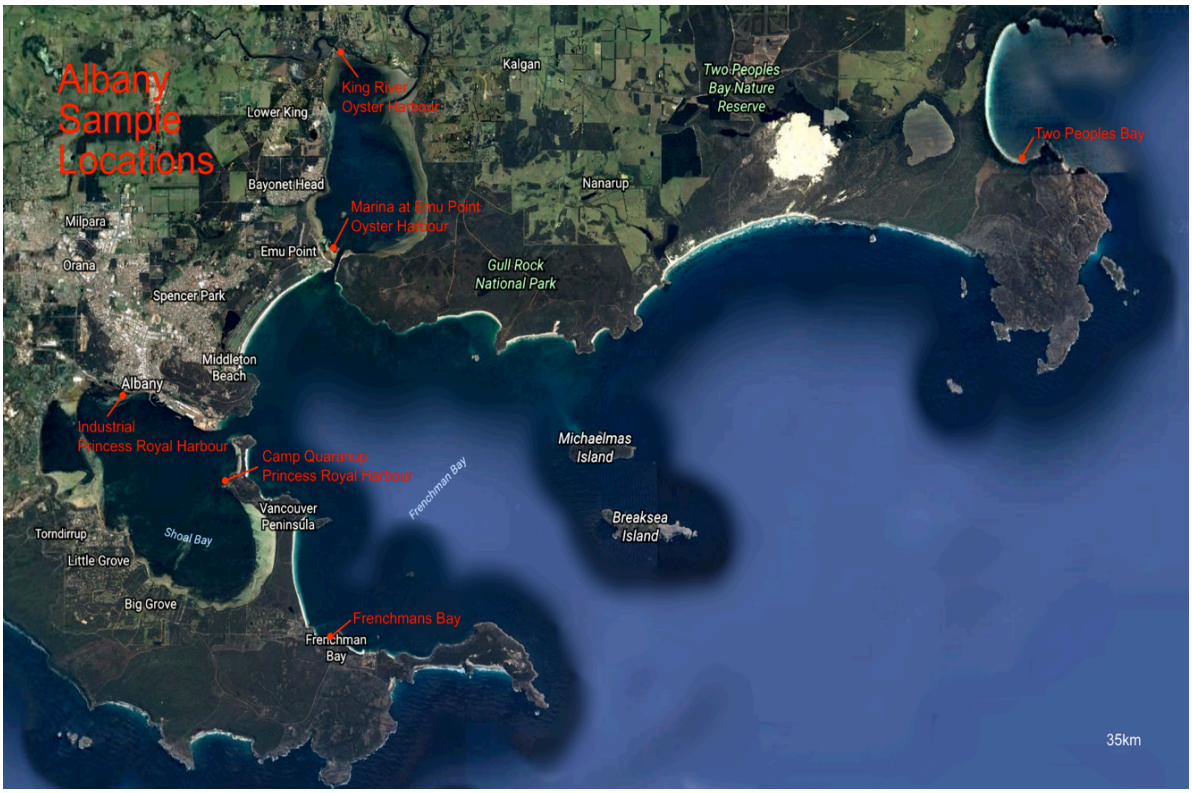

Figure 1. The locations of research. (Google Earth, 2017)

has experienced dredging in order to sustain a massive port which is situated near the city. There are two sites within this location namely Industrial and Camp Quaranup. Throughout 20th century, Industrial site has experienced a massive anthropogenic effect since it is located near the factories and industrial processing plant while Camp Quaranup has undergone anthropogenic impact from the dredging activities near the harbour. Oyster Harbour is a place which has estuarine system with some input of freshwater. In the 1850s, this place started to undergone degradation of water quality after the settlement of European (Serrano et al., 2016). There are two sites within this location, King river and Emu point (marina) or marina site. King river is impacted from the freshwater input from the river and run off from the farm land which is located near the site. King river is thought to be more impacted than the Emu point because the fresh water flows directly to it.

Between the 1940s and the 1970s, Frenchman bay was a location with nutrient input from human activities sources including ablution blocks and whaling stations. The last location of this research is Two Peoples Bay, and it was the most remote study area. There is a National Park around it and it has the least anthropogenical impact compared to the other three locations. However, in terms of natural impacts such as fetch and wave strike, this location is at the highest level on those threats.

Experimental design

Based on the site descriptions above, there were four sites considered anthropogenically impacted, i.e. King River, Emu Point, Camp Quaranup and Industrial. The other two sites, such as Two Peoples Bay and Frenchman Bay were categorized as less anthropogenically impacted sites. In order to test the hypothesis that the assemblage of benthic faunal in anthropogenically impacted sites is different from less impacted areas, three sediment sample cores and three sediment cores were collected by syringes in all six study sites.

Sampling technique

Three randomly coring activities with a

Table 1. Benthic faunal abundance found in six study sites. CQ: Camp Quaranup; EP: Emu Point; FB: Frenchman Bay; IND: Industrial; KR: King River and TPB: Two Peoples Bay

Faunal groups	Sites					
	CQ	EP	FB	IND	KR	TPB
Crustaceans	25	13	167	2	54	17
Amphipods	11	8	123	1	49	10
Isopods	2	0	22	1	0	3
Tanaids	9	1	19	0	1	4
Decapods	3	4	2	0	4	0
Other Crustaceans	0	0	1	0	0	0
Echinoderms	5	0	1	2	1	2
Asteroids	1	0	1	1	0	0
Ophiuroids	0	0	0	1	1	0
Holothuroids	4	0	0	0	0	2
Molluscs	39	1	12	20	22	0
Bivalves	12	0	1	6	9	0
Gastropods	25	1	3	14	12	0
Polyplacophorans	2	0	8	0	1	0
Worms	9	12	43	5	38	17
Polychaetes	9	10	41	3	19	17
Turbellarians	0	1	0	0	1	0
Sipunculid worms	0	0	2	0	0	0
Nemertean worms	0	1	0	2	18	0
Other	3	0	4	1	3	8
Sponges	0	0	0	0	1	1
Anemones	3	0	1	0	0	3
Ascidians	0	0	1	0	0	0
Bryozoans	0	0	0	0	2	0
Other fauna	0	0	2	1	0	4
Total	81	26	227	30	118	44

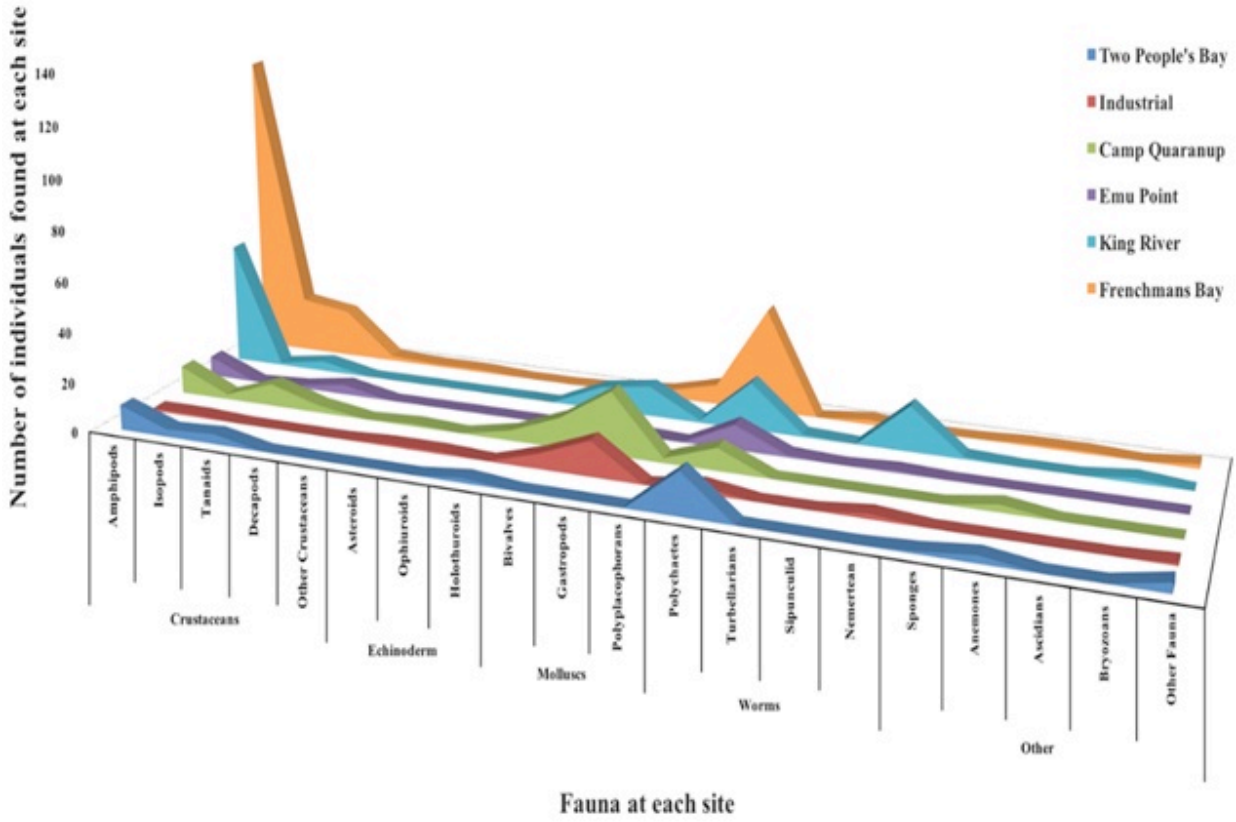

Figure 2. The number of group of benthic infauna found at each site

core (0.8m long and 0.09m in diameter, PVC with cap) were conducted to take the sediment and benthic faunal from the depth of 0.5m at each site. All materials in the core was put into labeled plastic bags and brought to the laboratory. Multilevel filters were used to filter the sediment. Benthic faunal found in the sediment were then identified using microscope and several marine invertebrates identification books (i.e., Parish and Jones, 1996; Edgar, 2000). The sample from each syringes was separated into percentage of grain size fractions.

Data analysis

Permutational ANOVA (PERMANOVA) statistical analysis was used to determine whether there was difference or similarity among six sites in terms of fauna assemblages. Since the replication at each site was not enough to produce a randomly generated distribution of pseudo- F scores, Monte Carlo simulations of the probability levels was used. Furthermore, to depict the ordination of similarity and differences among species groupings within each site, a CAP (Canonical Analysis of Principles coordinates) was implemented using Bray Curtis-similarity method. For the last data analysis, Distance based redundancy analysis (dbRDA) was used to investigate the environmental variables which affected the faunal assemblages in six study sites. PRIMER software was used to run all those statistical data analysis.

RESULTS

The abundance of infauna in each site was showed in Table 1 and Figure 2. Frenchman Bay has the highest number of faunal abundance, while Oyster Harbour-Emu Point has the lowest number of faunal abundance compare to the other five sites (Table 1 and Figure 2).

The results of PERMANOVA analysis with site as the one fixed factor found that there was statistically significant different of fauna assemblages in six sites (p<0.05). A pairwise test was executed to find out which sites were different and it was found that fauna abundance of Frenchman Bay was significantly different to Emu Point and Industrial(p<0.05) and Two peoples bay was significantly different to Industrial (p<0.05). Whereas the other sites were not significantly different among each other (p>0.05). In terms of faunal diversity, there was also no significant

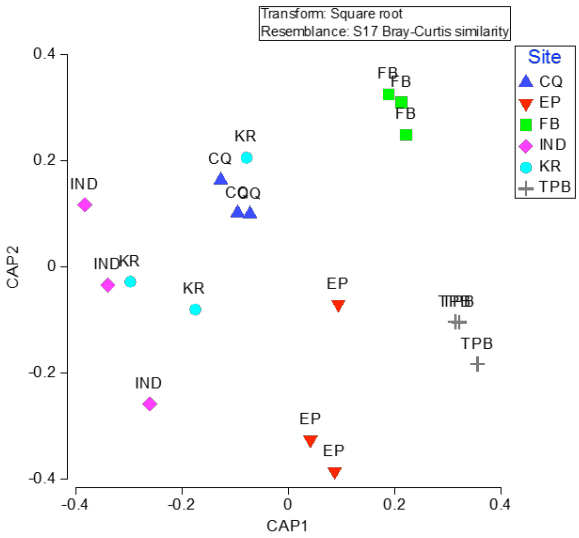

Figure 3. CAP analysis of six sites. CQ: Camp Quaranup; EP: Emu Point; FB: Frenchman Bay; IND: Industrial; KR: King River and TPB: Two People Bay.

different of faunal assemblages in all sites (p>0.05). To clearly display the ordination of site and the result of pairwise t-test, the CAP analysis was implemented using Bray Curtis-similarity (Figure 3)

It could be clearly seen in the Figure 3 that only three pairs of sites which had significant different in benthic faunal assemblages (p<0.05) *i.e*, Emu Point and Frenchman Bay; Frenchman Bay and Industrial; and Industrial and Two peoples bay.

Meanwhile, the result of marginal test showed that the regression of the benthic faunal assemblages on the variable "coarse sand" is statistically significant (p<0.05) and 19.7 % of the variation of faunal assemblages at each site could be explained by coarse sand. This means that the impact of coarse sand on benthic fauna assemblages was statistically significant. Furthermore, in order to investigate the impact of sand coarseness variable on the faunal assemblages at each site, Distance based redundancy analysis (dbRDA) was implemented and it was found that benthic faunal assemblages from Industrial was very different to the other assemblages and this correlated with the highest level of sand coarseness in Industrial compare to the other five sites (Figure 4).

DISCUSSION

The abundance of benthic infaunal was highest in Frenchman Bay, and this site was less anthropogenically impacted seagrass bed area and has high seagrass coverage. Meanwhile low abundance of faunal was found in Princess Royal Harbour-Industrial and Oyster Harbour-Emu Point which were anthropogenically impacted seagrass area and have low seagrass coverage. Therefore, the result was consistence with the hypothesis that the abundance of faunal assemblage in anthropogenically impacted will be different to less impacted area and this is supported by Borum et al. (2004) who stated that the coverage of seagrass has positive correlation with the abundance of faunal within the seagrass area. However, in terms of faunal diversity, there is no significant relationship between the seagrass biomass and the diversity of fauna since the diversity of faunal in all sites was almost the same.

Overall, Crustaceans had the highest abundance compared to the other benthic fauna such as Echinoderms, Molluscs and Worms in all study sites. This finding was in line with the results of a study conducted by Kikuchi (1968) which stated that Crustaceans were the most abundance group of fauna living in seagrass ecosystems at Tomioka Bay, Japan. The distribution of Worms was relatively equal at each site; the highest abundance was found at Frenchman Bay.

The level of sediment coarseness in Industrial was the highest among all sites. In consequence, the benthic faunal assemblage in Industrial was quite different to other benthic animals at the other five sites. For example, the number of Worms living in this site was the least compared to the other five sites. This might be because burrowing animal like Worms prefers to live within soft sediment.

In conclusion, less naturally and anthropogenically impacted seagrass meadow like Frenchman Bay had higher abundance of infaunal assemblage than anthropogenically impacted seagrass beds such as Princess Royal Harbor-Camp Quaranup, Princess Royal Harbour-Industrial, Oyster Harbour-King River and Oyster Harbour-marina (Emu point) and it had also higher faunal abundance than naturally affected site like Two peoples bay. Therefore, it was suggested that the management agencies of coastal areas in Albany such as "the Australian Marine Conservation Society" and "the Albany Waterways Management Authority" should be able to manage the society and industrial owners to reduce anthropogenic and industrial disturbances in the four sites which were impacted in order to sustain the life of faunal within the seagrass ecosystem.

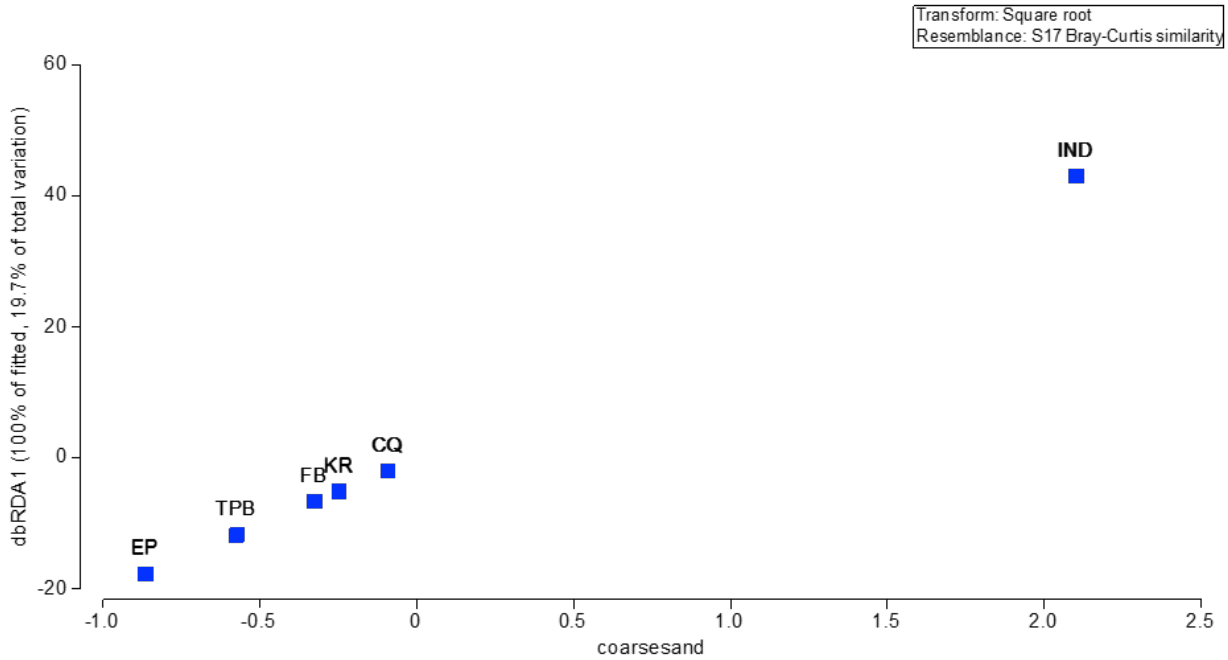

Figure 4. Distance based redundancy analysis (dbRDA) with one variable model (coarse sand). CQ: Camp Quaranup; EP: Emu Point; FB: Frenchman Bay; IND: Industrial; KR: King River and TPB: Two People Bay

Acknowledgement. This project was funded through School of Biological Science, The University of Western Australia and Indonesian Institute of Sciences (LIPI). We thank to Dr. John Statton, Dr. Jane Prince, Dr. Renae Hovey, Dr. Anne Breadly and students from School of Biological Sciences, The University of Western Australia for their help in field and laboratory.

REFERENCES

BORUM, J., DUARTE, C.M., KRAUSE-JENSEN, D. and GREVE, T.M. (2004) *European seagrasses: an introduction to monitoring and management*. A publication by the EU project Monitoring and Managing of European Seagrasses (M & MS) EVK3-CT-2000-00044. 88 pp.

BOSTROM, C., O'BRIEN, K., ROOS, C. and EKEBOM, J. (2006) Environmental variables explaining structural and functional diversity of seagrass macrofauna in an archipelago landscape. *Journal of Experimental Marine Biology and Ecology*, 335, 52-73.

BULLERI, F. and CHAPMAN, M.G. (2006) The introduction of coastal infrastructure as a Driver of Change in Marine Environments. *Journal of Applied Ecology*, 47(1), 26-35.

DUARTE, C.M., MIDDELBURG, J.J. and CARACO, N. (2005) Major role of marine vegetation on the oceanic carbon cycle. *Biogeosciences,* 2, 1-8

EDGAR, G.J. (2000) *Australian Marine Life: Plants and Animals of the Temperate Waters*. New Holland Books, 2nd Edition. 528 pp.

FOURQUREAN, J.W., DUARTE, C.M., KENNEDY, H., MARBA, N., HOLMER, M., MATEO, M.A., APOSTOLAKI, E.T., KENDRICK, G.A., KRAUSE-JENSEN, D., MCGLATHER, Y.K. and SERRANO, O. (2012) Global carbon stocks in seagrass ecosystems. *Nature Geosciences*, 5, 505-509.

GOOGLE EARTH (2017) *Map of Albany*. [online]. Google. Available from: https://www.google.com.au/maps/@-35.0302165,117.99234 52,25-091m/data=!3m1!1e3 [Accessed 16 May 2017].

HECK, K.L. JR., HAYS, C. and ORTH, R.J. (2003) Critical evaluation of the nursery role hypothesis for seagrass meadows. *Marine Ecology Progress Series*, 253, 123-136.

HEMMINGA, M.A. and DUARTE, C.M. (2000) *Seagrass ecology*. Cambridge University Press, UK. 298 pp.

KIKUCHI, T. (1968) Faunal list of the Zostera marina belt in Tomioka Bay, Amakusa, Kyusu. *Publ. Amakusa. Mar. Biol. Lab*. 1, 163-192.

MCKENZIE, L.J. and YOSHIDA, R.L. (2016) Seagrass-watch: *Proceeding of a workshop for*

monitoring seagrass habitats in the Mackay Whitsunday Natural Resource Management Region. QPWS Whitsunday information centre, jubilee pocket, Airlie beach, 16-17 July 2016 (Seagrass-watch HQ, Cairns). 68 pp.

NAGELKERKEN, I., ROBERTS, C.M., VAN DER VELDEG, DORENBOSC, H.M., VAN RIEL, M.C., COCHERET DE LA MORINIEREE, NIENHUIS, P.H. (2002) How important are mangroves and seagrass beds for coral-reef fi sh? The nursery hypothesis tested on an island scale. *Marine Ecology Progress Series,* 244, 299-305.

ORTH, R.J., TIM J.B., CARRUTHERS, WILLIAM, C., DENNISON, DUARTE, C.M, JAMES, W., FOURQUREAN, KENNETH, L., HECK, J.R., HUGHES, A.R, KENDRICK, G.A., JUDSON, W., KENWORTHY, SUZANNE O., SHORT, F.T., WAYCOTT, M. and WILLIAMS, S.L. (2006) A Global Crisis for Seagrass Ecosystems**.** American Institute of Biological Science. *Bio Science*, 56(12), 987-996.

PARISH, S. and JONES, C. (1996) *First Field Guide To Australian Marine Life*. Australian Press. 56 pp.

SERRANO, O., LAVERY, P., MASQUE, P., INOSTROZA, K., BONGIOVANNI, J. and DUARTE, C.M. (2016) Seagrass sediments reveal the long-term deterioration of an estuarine ecosystem. *Global Change Biology*, 22(4). doi:10.1111/gcb.13195.

WAYCOTT, M., DUARTE, C.M., CARRUTHERS, T.J.B., ORTH, R.J., DENNISON, W.C., OLYARNIK, S., CALLADINE, A., FOURQUREAN, J.W., HECK, K.L., HUGHES, R.A., KENDRICK, G.A., KENWORTHY, J.W., SHORT, F.T. and WILLIAMS, S.L. (2009) Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proceeding of the Natural Academy of Science of the United States of America*, 106(30), 12377-12381.

Received: 20 December 2018
Accepted: 15 March 2019