Sediment and nutrient dynamics in coastal intertidal seagrass of north eastern tropical Australia

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Abstract

In this thesis, I aimed to assess the interactions between the sediment structures and the nutrient environments of tropical seagrasses inhabiting intertidal meadows within the central region of the Great Barrier Reef World Heritage Area. I first surveyed 11 intertidal seagrass meadows and created an inventory of their sediment, nutrient, and seagrass parameters. This investigation revealed that the porewater nutrient environments of these meadows were low in a global context and below the critical values (60–100 μM NH_4^+ and 10 μM PO_4^{3-}) that have been suggested as being limiting to seagrass growth. The biomass of these meadows was also low, with below ground biomass (roots and rhizomes) constituting the largest fraction (c. 60%) of the total biomass. In contrast, the concentration of plant tissue nutrients (%N and %P) recorded for *Halodule uninervis* and *Halophila ovalis* were higher than those (1.8%N and 0.2%P) calculated by Duarte (1990) as the thresholds distinguishing between seagrass meadows that would respond to nutrient enhancement from those meadows that would not.

I then examined the following four aspects of the generally accepted views concerning seagrass ecosystem function for a variety of locations spanning >500 km of coast: i) that the presence of seagrass regulates sediment structure and nutrient environment; ii) that the abundance of seagrass modifies sediment structure; ii) that seagrass abundance is affected by its sedimentary nutrient environment; and iv) that plant tissue nutrients reflect their sedimentary nutrient environment. I found that the presence of the structurally small seagrasses I examined did not regulate sediment structure and nutrients. Additionally at this scale, seagrass abundance did not appear to moderate sediment structure, or be influenced by sediment nutrient levels, which in turn were not reflected in the concentrations of plant tissue nutrients. The most salient outcome from these investigations was the significance of geographical location on the properties I studied, indicating the important influences of the local environment (physical, chemical and nutrient) on local populations of seagrass.

The relationships between the abundance of the seagrass and the plant tissue nutrients to the sediment nutrients may have reflected the time of year (July, Southern Hemisphere winter) in which these investigations were undertaken. Consequently I examined intra-annual variation within two locations to establish the effects of season on seagrass

abundance, tissue nutrients, growth and sediment nutrients. I found that the ambient nutrient levels, seagrass abundance, plant tissue nutrients and plant growth parameters within the two *Halophila ovalis* meadows sampled, differed between the months selected to represent a seagrass senescent season and a growing season. In general, sediment nutrients were greater during the month representing the senescent season, whilst seagrass abundance and growth were greater during the month representing the growing season.

With this knowledge, I designed an experiment that investigated the response of sediment nutrients and seagrass of the two *Halophila ovalis* meadows to additions of Osmocote® fertilizer. These experiments highlighted the complexity of field experimentation because of the inability to control environmental parameters. Despite the positive and relatively consistent response of sediment nutrients to the additions of fertilizer, the response of *Halophila ovalis* varied according to location, season and experimental manipulation. *Halophila ovalis* at Bolger Bay (characterized by clay mineralogy) showed P limitations during the senescent season (August), with no significant response during the growing season (November). In contrast, *Halophila ovalis* at Picnic Bay (carbonate sediments), displayed no significant response to additional nutrients during the senescent season, but displayed primary N limitation with secondary P limitation during the growing season. The significant responses were relative to the experimental control and not the ambient field control, indicating the need to examine past experimental evidence in relation to how the fertilizer was added and the type of control used to compare the response.

Overall, intertidal seagrass meadows that are characterized by structurally small species in this region do not conform to the generally accepted views on seagrass, sediment, and nutrient interactions. These tropical meadows are substantially influenced by seasonal cues. The predominant effect of location also indicates the importance of the local environmental/geographical history to which the seagrass meadow has been subjected. This result was highlighted by the nutrient enrichment, where the two different meadows displayed opposing patterns of nutrient limitation despite their proximity Overall my results suggest that a broad-brush management approach to the research and management of seagrass habitats in this dynamic and environmentally variable region is inappropriate.

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Contents

Statement of access ... **iii**
Abstract ... **v**
Acknowledgements ... **vii**
Contribution of others ... **x**
Contents ... **xi**
List of figures ... **xviii**
List of tables ... **xxi**
Statement of sources ... **xxv**
Chapter 1 General introduction ... **1**
1.1 Seagrass biology ... 3
1.2 Seagrass form and function ... 4
1.3 Queensland seagrasses ... 5
1.4 Disturbance and seagrass ... 6
1.5 The effect of excess nutrients on seagrass ... 8
1.6 Nutrients in the Great Barrier Reef Lagoon (GBRL) ... 9
1.7 Seagrass and nutrients ... 12
1.8 Thesis aims and outline ... 14
Chapter 2 General materials and methods ... **23**
2.1 Introduction ... 27
2.2 Sampling ... 27
Determining the chemical environment of sediments ... 28
Nutrients ... 28
Porewater ... 28
Sample collection ... 28
Chemical determination of dissolved inorganic nutrients ... 28
Sediment ... 29
Sample collection ... 29
Nutrient extraction and chemical determination of adsorbed exchangeable nutrients ... 29
Nutrient related chemical parameters ... 29
Redox potential (Eh) and pH ... 29
Calcium carbonate and organic content ... 30
Determining the physical environment of the rhizosphere ... 30
Sediment grain size analysis ... 30
Particle size density ... 31
Porosity ... 31
Determination of seagrass parameters ... 32
Plant production ... 32
Biomass ... 32
Shoot density ... 32

Plant tissue analysis 32
2.3 Experimental design 33
2.4 Statistical methods 33
Data sets 33
Data transformation and outlying data 33
2.5 Study sites 34
Study area 34
Site selection 35
Chapter 3 A biogeochemical inventory of intertidal coastal seagrass meadows in the central region of the Great Barrier Reef World Heritage Area (GBRWHA) 43
3.1 A biogeochemical inventory. 47
Nutrient related parameters 47
Sediment nutrients 48
Seagrass 50
Biomass 50
Plant tissue nutrients 51
3.2 Overview of the study region 52
Are seagrasses of this region, N or P limited? 53
Chapter 4.0 An evaluation of the accepted concepts of ecological processes in seagrass environments with respect to coastal intertidal seagrass communities in north-east Australia. 65
Summary 67
4.0.1 Introduction 69
Subchapter 4.1 Testing the sediment-trapping paradigm of seagrass: Do seagrasses influence nutrient status and sediment structure in tropical intertidal environments in the central region of the Great Barrier Reef World Heritage Area? 71
4.1.1 Introduction 75
4.1.2 Material and methods 76
Study Area 76
Sediment structure 77
Grain size analysis 77
Chemical analyses 77
Porewater nutrients 77
Adsorbed nutrients 77
Calcium carbonate and organic content 77
Calculation of nutrient pools 78
Statistical methods 78
4.1.3 Results 78
Location characterization 78
Sandy locations 79
Sediment structure 79

Sediment nutrients 79
Muddy locations 80
Sediment structure 80
Sediment nutrients 80
Total nutrient pools 81
4.1.4 Discussion 82
4.1.5 Conclusions 83
Subchapter 4.2 Putting ecological processes in seagrass communities into context: Do north-east Australian intertidal seagrass communities conform? 91
4.2.1 Introduction 95
4.2.2 Materials and methods 97
Study sites 97
Experimental design 97
Sampling 98
Nutrients 98
Porewater-dissolved inorganic nutrients 98
Adsorbed–extractable inorganic nutrients 98
Physico chemical environment of the sediments 98
Seagrass 98
Statistical methods 98
4.2.3 Results 100
Concept 1: Seagrass abundance affects sediment structure 100
Halodule uninervis 100
Zostera capricorni 100
Halophila ovalis 100
Concept 2: Sediment nutrients (chemical parameters) affect seagrass abundance 101
Halodule uninervis 101
Zostera capricorni 101
Halophila ovalis 101
Concept 3 Sediment nutrients are reflected in seagrass plant tissue nutrients 102
Halodule uninervis 102
Zostera capricorni 102
Halophila ovalis 102
4.2.4 Discussion 103
Concept 1: Is sediment structure affected by seagrass abundance? 103
Concept 2: Is plant abundance affected by sediment geochemistry? 106
Concept 3: Do plant nutrient tissues reflect their chemical environment? 108
Seagrass-environment interactions 110
4.2.5 Conclusions 111
Subchapter 4.3 Intra-annual variation within two tropical intertidal meadows of the seagrass *Halophila ovalis* 121
4.3.1 Introduction 125

4.3.2 Material and methods 126
Study site description 126
Sampling design 127
Abiotic environment 127
Nutrients 127
Porewater nutrients 127
Sediment nutrients 128
Seagrass 128
Seagrass growth 128
Statistical methods 128
4.3.3 Results 129
Abiotic differences between locations 129
Sediment nutrients 130
Intra-annual differences in nutrient status between locations 130
Adsorbed nutrients 130
Porewater nutrients 130
Intra-annual differences in nutrient status within location 130
Bolger Bay 130
Sediment nutrients 130
Adsorbed nutrients 130
Porewater nutrients 130
Picnic Bay 131
Sediment nutrients 131
Adsorbed nutrients 131
Porewater 131
Seagrass parameters 131
Intra-annual differences in seagrass status between locations 131
Biomass 131
Shoot number 132
Plant nutrients 132
Plant growth 132
Intra-annual differences in seagrass status within location 133
Bolger Bay 133
Biomass 133
Shoot number 133
Plant nutrients 133
Plant growth 133
Picnic Bay 134
Biomass 134
Shoot number 134
Plant nutrients 134
Plant growth 134
4.3.5 Discussion 135
4.3.6 Conclusions 137
Chapter 5.0 Evaluating the biogeochemical status and responses to nutrient enhancement of the sediments and plants in two *Halophila ovalis* meadows 153

5.0.1 Introduction to the nutrient enhancement experiment 157
5.0.2 Material and methods for enhancement experiment 160
Site description 161
The experiments 162
Experimental design 162
Justification of levels of fertilizer used 163
Fertilizer application 163
Sampling 164
Porewater—dissolved inorganic nutrients 164
Sediment—extractable inorganic nutrients 164
Seagrass 164
Physical environment 164
Statistical methods 164
5.0.3 An examination of Osmocote® behaviour in the marine environment 166
Subchapter 5.1 Assessing the mineralogy of two intertidal seagrass meadows of *Halophila ovalis* 173
5.1.1 Introduction 177
5.1.2 Material and methods 178
Mineralogy 178
Statistical methods 179
5.1.3 Results 179
Between bay scale: mineralogical differences between location for each experiment 179
Within bay scale: mineralogical differences between experiments within locations 180
Quadrat scale: mineralogical differences within experiments 180
5.1.4 Discussion 181
Mineralogical differences between bays 181
Mineralogical differences within bays 181
Mineralogical differences between quadrats 182
Differences in sediment regimes 182
5.1.5 Conclusions 183
Subchapter 5.2 Evaluating the response of sediment nutrients to Osmocote® additions 189
5.2.1 Introduction 193
5.2.2 Material and methods 194
Sampling sediment nutrients 194
Porewater—dissolved inorganic nutrients 194
Sediment–extractable inorganic nutrients 194
Physico chemical environment of the sediments 194
Statistical methods 194
5.2.3 Results 195
The response of sediment nutrients to enhanced nutrients 195
N additions 196

Porewater and adsorbed NH_4^+, NO_2^- + NO_3^- 196
P additions 196
Porewater P 196
Adsorbed P 196
PO_4^{3-} (Bray) 196
PO_4^{3-} (bicarbonate) 197
5.2.4 Discussion 197
Nitrogen 198
Phosphorus 200
Phosphorus in the marine environment 201
Nutrient processes in clay sediments–Bolger Bay 202
Nutrient processes in carbonate sediments—Picnic Bay 202
Geochemical processes 203
Biological processes 204
5.2.5 Conclusions 204
Subchapter 5.3 Evaluating the response of *Halophila ovalis* to nutrient enrichment 211
5.3.1 Introduction 215
5.3.2 Material and methods 216
Sampling seagrass parameters 216
Statistical methods 217
5.3.3 Results 217
Plant production parameters 217
Bolger Bay 217
Experiment 1: Seagrass senescing, May–August 217
Experiment 2: Seagrass growing: August–November 218
Picnic Bay 219
Experiment 1: Seagrass senescing May–August 219
Experiment 2: Seagrass growing, August–November 219
Plant tissue nutrients 220
Bolger Bay 220
Experiment 1 and Experiment 2 220
Picnic Bay 220
Experiment 1: Seagrass senescing, May–August 220
Experiment 2: Seagrass growing, August–November 221
Tissue percent nitrogen (%N) 221
Tissue percent phosphorous (%P) 221
5.3.4 Discussion 222
Implications for interpreting other studies 224
Implications for future work 225
5.3.5 Conclusions 225
Chapter 6 General discussion 239
Rationale and objectives of this study 241
Location (geography and environmental history of the site) as the most important influence on the presence, distribution and abundance of intertidal seagrasses in the central region of the GBRWHA 242

Recognizing the importance of species-specific functions and forms..... 243
Revisiting the importance of seasonality to seagrasses..... 244
Halophila ovalis—nutrient sponge!..... 246
Controls and key processes of intertidal meadows of structurally small seagrasses in this region 249
Future directions for management and research of intertidal seagrasses in the central region of the GBRWHA..... 250
List of references..... 257
Appendix A–Reprint of Published Paper from Subchapter 4.1. 279
Appendix B–Statistical outcomes of analyses in Chapter 4. 281
Appendix C–Statistical outcomes of analyses in Chapter 5. 283

List of figures

Figure 1.1 Seagrass functional form model depicting the existing seagrass genera along a continuum from structurally small seagrass to structurally large species including their hypothesized distribution, ecophysiology and ecological interactions (Walker *et al*. 1999). 17

Figure 1.2 A map of Queensland showing the delineation of the Great Barrier Reef World Heritage Area, the location of the Great Barrier Reef and the extent of the Great Barrier Reef Lagoon (Source: www.reefed.edu.au). 18

Figure 1.3 A conceptual model of the interactions between wind stress, wind-driven coastal currents, the inner lagoon, frontal zone (the zone characterized by the depth limit of wind driven resuspension and cross-shelf distribution of terrigenous sediments that constrain and produce the nutrient rich sediment layer within the inshore region of the Great Barrier Reef Lagoon (redrawn from Furnas 2003). 19

Figure 2.1 Schematic diagram of the sampling equipment used for the relevant parts of the nutrient pool and the nutrients determined and extracted from the porewater nutrient pool and the adsorbed nutrient pool (modified from Udy and Dennison 1996). 37

Figure 2.2 Illustration of the *in situ* sediment sipper, depicting its two stage filtration system, and placement in the rhizosphere for the collection of porewater. 38

Figure 2.3 Triggering the vacuum in the field of the *in situ* sediment sipper by pulling up the plunger on the syringe. 39

Figure 2.4 The locations of eleven intertidal seagrass meadows (open circles) investigated in this study, within the central region of the Great Barrier Reef World Heritage Area..... 40

Figure 3.1 (facing) A graphical summary of the biogeochemical inventory of 11 intertidal seagrass meadows across the central region of the Great Barrier Reef World Heritage Area. The mean results for seagrass biomass, plant tissue nutrients, percent carbonate and organic content, a generalized sediment grain size profile and sediment nutrients (adsorbed and porewater) are plotted in reference to the location of the meadow studied. Each seagrass species is represented by a different colour..... 56

Figure 4.1 Plot of the first two axes based on Principle Component Analysis of intertidal areas (locations) categorised by sediment types (muddy or sandy). Axis 1 reflects sediment grain size, while Axis 2 is based on sediment nutrient levels..... 85

Figure 4.2: a) Fine silt at sand locations for vegetated and unvegetated sites, **b)** very fine silt at muddy locations for vegetated and unvegetated sites, **c)** adsorbed NH_4^+ at muddy locations for vegetated and unvegetated sites. Means and standard errors presented. Vegetated = open; unvegetated = closed. The patterns observed here are representative of the patterns observed for all grain size and nutrient analyses. 86

Figure 4.3 The relationship between very fine silt and below ground biomass across the locations characterized by *Halodule uninervis* in the central region of the Great Barrier Reef World Heritage Area..... 113

Figure 4.4 The different sediment structures measured of the two locations characterized by *Halophila ovalis*; Bolger Bay and Picnic Bay, Magnetic Island, central region of the Great Barrier Reef World Heritage Area (means and s.e. displayed). 113

Figure 4.5 The negative relationship between below ground biomass of *Halodule uninervis* and porewater NH_4^+ for the different meadows characterized by *Halodule uninervis* within the central region of the Great Barrier Reef World Heritage Area..... 114

Figure 4.6 The relationship between the three biomass components (leaf, rhizome and root) of *Halophila ovalis* and adsorbed NH_4^+, demonstrating the different responses to increasing adsorbed NH_4^+ at the two sites, Picnic Bay and Bolger Bay, Magnetic Island, central region of the Great Barrier Reef World Heritage Area..... 114

Figure 4.7 A graph of the plant tissue nutrients of the different seagrass components of *Zostera capricorni* from two locations, Ellie Point and Windy Point, characterized by *Zostera capricorni* within the central region of the Great Barrier Reef World Heritage Area, demonstrating similar trends in plant nutrient levels (means and s.e. displayed)..... 115

Figure 4.8 Map of Magnetic Island, off the coast of Townsville (open circle), Queensland, Australia with the locations of Picnic Bay and Bolger Bay indicated by solid circles. 139

Figure 4.9: Schematic diagram of sampling design for all samples taken (note: not to scale), quadrat location assigned haphazardly..... 139

Figure 4.10 Sediment particle grain size distributions for Bolger Bay and Picnic Bay. Note that this graph has been presented previously in Chapter 4.2 as Fig.4.4. (mean and standard errors presented). 140

Figure 4.11 Intra-annual variation of sediment nutrients between Bolger Bay and Picnic Bay at different times of the year for **a)** adsorbed nutrients and **b)** porewater nutrients. (Mean and standard error presented). Where a number is displayed above a bar this represents the mean nutrient value of that bar which is beyond the scale of the y axis. Where no cross bar appears on top of the standard error line it means that the standard error was beyond the scale of the Y axis. 141

Figure 4.12 A comparison of the intra-annual variation in seagrass density measures between and within Bolger Bay and Picnic Bay for **a)** seagrass biomass and **b)** shoot density. (Mean and standard error presented). 142

Figure 4.13 A comparison of the variation of plant tissue nutrients between and within the locations, Bolger Bay and Picnic Bay, for **a)** percent tissue N and **b)** percent tissue P. (Mean and standard error presented, where there are no standard errors, only a single sample was taken)..... 143

Figure 4.14 A comparison of intra-annual variation in plant growth parameters between and within the two locations, Bolger Bay and Picnic Bay for **a)** rhizome extension per meristem **b)** leaf production per meristem, **c)** apical meristem production. 144

Figure 5.1 A conceptual flow chart of the scope and organization of the nutrient enhancement experiment conducted at Bolger Bay and Picnic Bay over two seasons. 169

Figure 5.2 A schematic diagram of the experimental design for both nutrient enhancement experiments at each site, three replicate blocks, parallel to shore in a randomised block design (N.B. Not to scale)..... 169

Figure 5.3 Differences in the four categories of mineral phase (mean ± se) between Bolger Bay and Picnic Bay, Magnetic Island, Queensland, Australia, during Experiment 1 (May–August 1995) and Experiment 2 (August–November 1995). 185

Figure 5.4 The effect of N fertilizer additions at Bolger Bay and Picnic Bay during Experiment 1 (seagrass senescing, May–August) and Experiment 2 (seagrass growing, August–September) for: **a)** porewater NH_4^+, **b)** porewater $NO_2^- + NO_3^-$ and **c)** adsorbed NH_4^+ (KCl extracted). Note different scales on the Y axes. Means and standard errors are displayed. Where a number is displayed above a bar this represents the mean nutrient value of that bar which is beyond the scale of the y axis. Where no cross bar appears on top of the standard error line it means that the standard error was beyond the scale of the Y axis. 207

Figure 5.5 The effect of P fertilizer additions at Bolger Bay and Picnic Bay during Experiment 1 (seagrass senescing, May–August) and Experiment 2 (seagrass growing, August–September) for: **a)** Porewater PO_4^{3-}, **b)** adsorbed $PO_4^{3-}{}_{(Bray)}$ and **c)** adsorbed $PO_4^{3-}{}_{(bicarbonate)}$. Note different scales on the Y axis. Means and standard error are displayed. Where a number is displayed above a bar this represents the mean nutrient value of that bar which is beyond the scale of the y axis. Where no cross bar appears on top of the standard error line it means that the standard error was beyond the scale of the Y axis. 208

Figure 5.6 Significant plant production responses to additions of Osmocote® at Bolger Bay and Picnic Bay for during Experiment 1 and Experiment 2 for **a)** leaf biomass, **b)** rhizome biomass, **c)** root biomass and **d)** shoot density. Note different scales on the Y axis. Where no cross bar appears on top of the standard error line it means that the standard error was beyond the scale of the Y axis. 229

Figure 5.7 Significant plant tissue %N responses to additions of Osmocote® at Picnic Bay during Experiment 1 and Experiment 2 for: **a)** leaves, **b)** rhizomes, **c)** roots, **d)** whole plants, **e)** meadow nutrient status ($gN_{seagrass}\ 0.25\ m^{-2}$). Note different scales on the Y axis and inset graph. 231

Figure 5.8 Significant plant tissue %P responses to additions of Osmocote® at Picnic Bay during Experiment 1 and Experiment 2 for: **a)** leaves, **b)** rhizomes, **c)** roots, **d)** whole plants, **e)** meadow nutrient status ($gN_{seagrass}\ 0.25\ m^{-2}$). Where a number is displayed above a bar this represents the mean nutrient value of that bar which is beyond the scale of the y axis. Where no cross bar appears on top of the standard error line it means that the standard error was beyond the scale of the Y axis. 233

Figure 6.1: A graphical model representing the different phases of nutrient uptake and plant growth with increasing nutrient supply (loosely based on Smith and Loneragan 1997). Two measures are presented, the tissue nutrient content and the plant growth rate. 253

Figure 6.2 Values of % leaf N and % leaf P for plants of *Halophila ovalis* from Cleveland Bay North Queensland, spanning 26 years from a variety of literature sources and this thesis. a) was sampled in 1969 (Birch 1975); b) was sampled in 1984 (Lanyon 1991); c) this thesis, survey data for *Halophila ovalis* locations sampled in 1994 (Chapter 3); d) this thesis, experimental nutrient enhancement data including samples subjected to fertiliser additions during the senescent season sampled in 1995 (Chapter 5); and e) this thesis experimental nutrient enhancement data including sampled subjected to fertiliser additions during the growing season sampled in 1995 (Chapter 5). Each box represents the range of leaf tissue nutrient concentrations obtained from the literature or in this thesis from the minimum value to the maximum value recorded, with the cross bar representing the average of all values. Background lines represent the trends in fertiliser application in the Burdekin River catchment since 1925 (adapted from data in Pulsford 1996), for both nitrogen (N, pale) and phosphorous fertilizer (P, dark). 254

Figure 6.3 A conceptual diagram of the processes that form and limit growth of intertidal seagrass meadows of structurally small species in the central region of the Great Barrier Reef World Heritage Area based on the results of this thesis. During the growing season (lower panel) plants grow faster and become nutrient limited (N limitation) but have warmer temperatures and few days exposed at low tide during the day. During the senescent season, temperature is lower, there are more frequent and stronger winds causing increased turbidity and the plants are exposed at low tide during the day and may become light stressed. 255

List of tables

Table 1.1 Values for porewater nutrients in seagrass beds around the world. 20

Table 1.2 Values of seagrass tissue nutrients for leaf, rhizome and root taken from the literature (ambient values only used). 21

Table 2.1 Parameters used throughout this study grouped into data sets. 41

Table 2.2 The location of eleven intertidal seagrass meadows investigated in this study. Longitudes and latitudes (WGS 84), predominant seagrass species with average percent cover, as determined by a visual estimate within 0.25 m^{-2} quadrats at each location. 41

Table 3.1 A comparison of the chemical environment of the eleven intertidal seagrass meadows surveyed within the central region of the Great Barrier Reef World Heritage Area. (Seagrass species and total biomass are also presented as a reference to the type of seagrass meadow at each location; means ± s.e.) 57

Table 3.2 Biomass, porewater and adsorbed nutrients levels at locations in the central region of the Great Barrier Reef World Heritage Area (means, ±s.e. and ranges (in parentheses) are presented)[1] 58

Table 3.3 Biomass data (mean and s.e.) for dominant species within the monospecific stands of the seagrass beds surveyed for the central region of the GBRWHA. 59

Table 3.4 Means and standard errors of plant tissue nutrients and their molar ratios for each of the seagrass species sampled from intertidal meadows within the central region of the Great Barrier Reef World Heritage Area. 60

Table 3.5 A comparison between porewater nutrient levels from this study and literature values for porewater nutrients in seagrass beds around the world characterized by location and sediment type. 61

Table 3.6 A comparison of plant tissue nutrients and their molar ratios for seagrass species investigated in this study with literature values characterized by plant component. Where values have been included from fertilization experiments, ambient values only are displayed. - = no value quoted in the literature. 62

Table 3.7 A presentation of the evidence that suggests which nutrient may be causing limitation of seagrass growth on a regional scale based on the sediment and plant nutrient critical levels and molar ratios I recorded for the intertidal seagrass meadows of the central region of the Great Barrier Reef World Heritage Area 63

Table 4.1 Categorization of intertidal seagrass beds within the central region of the Great Barrier Reef World Heritage Area (values are mean ± s.e.). 87

Table 4.2 Concentrations of sediment nutrients (means ± s.e.) recorded for each location at unvegetated (unveg) and vegetated (veg) sites at each of eight locations in the central regions of the Great Barrier Reef World Heritage Area. 88

Table 4.3 The results of two series of ANOVAs (one for locations with sandy substrates and for one locations with muddy substrates) for comparing the differences between the vegetated and unvegetated sites at these locations. 89

Table 4.4 A comparison of N and P nutrient pool ratios between vegetated and adjacent unvegetated areas, with a within bed comparison of plant nutrients and sediment nutrient ratios. 90

Table 4.5 The locality of each of the eleven intertidal seagrass meadows within the Central region of the Great Barrier Reef World Heritage Area that were assessed

with respect to the ecological functioning, July 1994. Locations are grouped by seagrass species and an indication of seagrass density (percent cover per 0.25m^{-2} quadrat) at each location is displayed. 116

Table 4.6 The model structure of the MANOVA analyses that evaluated the concept of seagrass abundance affecting sediment structure within the rhizosphere of each seagrass species. 116

Table 4.7 Summary of the outcomes of the MANOVA analysis investigating the relationship between location and *Halodule uninervis* abundance (biomass and shoot density on sediment structure, highlighting the significant ANOVA result (bold) for the dependent variable 'very fine silt' for those meadows characterized by *Halodule uninervis* within the central region of the Great Barrier Reef World Heritage Area. 117

Table 4.8 Summaries of the outcomes of the MANOVA analysis investigating the influence of location and *Zostera capricorni* abundance (biomass and shoot density on sediment grain sizes (sediment structure) for those intertidal seagrass meadows characterized by *Zostera capricorni* within the central region of the Great Barrier Reef World Heritage Area. 117

Table 4.9 Summaries of the outcomes of the MANOVA analysis investigating the relationship between location and *Halophila ovalis* abundance (biomass and shoot density) and sediment grain sizes (sediment structure) in the central region of the Great Barrier Reef World Heritage Area (significant outcomes in bold). 118

Table 4.10 The model structure of the analyses that evaluated the concept of sediment nutrient and nutrient related parameters (chemical environment) of the meadow rhizosphere influencing the abundance of the seagrass present. 118

Table 4.11 The significant outcomes of the MANOVA and ANOVA analyses that investigated the influence of location and the significant chemical parameters (% organic content and porewater NH_4^+) on the seagrass abundance parameters (of biomass and leaf density respectively) of *Zostera capricorni* within the rhizospheres of seagrass meadows characterized by *Zostera capricorni* within the central region of the Great Barrier Reef World Heritage Area. 118

Table 4.12 The significant outcomes of the MANOVA and ANOVA analyses that investigated the influence of location and the significant chemical parameters (adsorbed NH_4^+ and porewater $NO_2^- + NO_3^-$) on the seagrass abundance parameters (of biomass and leaf density respectively) of *Halophila ovalis* within the rhizospheres of seagrass meadows characterized by *Halophila ovalis* within the central region of the Great Barrier Reef World Heritage Area....119

Table 4.13 The model structure of the MANOVA analyses that evaluated the concept of seagrass tissue nutrients reflecting their nutrient environment within the rhizospheres of each seagrass species investigated from intertidal seagrass meadows within the central region of the Great Barrier Reef World Heritage Area....119

Table 4.14 The significant outcome for the univariate variable of % leaf P from the MANOVA analysis of plant tissue nutrients for *Halodule uninervis* and its relationship with location and the chemical environment of the rhizospheres of intertidal seagrass meadows characterized by *Halodule uninervis* within the central region of the Great Barrier Reef World Heritage Area....119

Table 4.15 Summary of significant outcomes of my evaluation of the three concepts on ecological processes for meadows of *Halodule uninervis*, *Zostera capricorni* and *Halophila ovalis* in the central region of the Great Barrier Reef World Heritage Area....120

Table 4.16 Statistical differences in abiotic parameters between Bolger Bay and Picnic Bay. 145

Table 4.17 Measurements of sediment nutrients (mean ± s.e.) for the two different times of the year (representative of the different seasons) at Bolger Bay and Picnic Bay. 145

Table 4.18 Differences in the levels of sediment nutrients between the two locations (Bolger Bay and Picnic Bay) at different times of the year representative of the different seasons. 146

Table 4.19 Intra-annual differences in sediment nutrients, adsorbed and porewater at Bolger Bay. 147

Table 4.20 Intra-annual differences in sediment nutrients at Picnic Bay. 147

Table 4.21 Summary of statistically significant results for plant parameters between the two locations Bolger Bay and Picnic Bay during the different months that were chosen to be representative of the different seasons. N.B. Due to the high number of analyses performed, 5% of tests would be expected to be significant based on chance alone. 148

Table 4.22 All plant parameter measurements (means and s.e.) for both locations Bolger Bay and Picnic Bay during different months that were chosen to be representative of the different seasons. 149

Table 4.23 Summary of statistically significant results for plant parameters at Bolger Bay during the different times of the year that were chosen to be representative of the different seasons. 150

Table 4.24 Summary of statistically significant results for plant parameters at Picnic Bay during the different times of the year that are representative of the different seasons. 151

Table 5.1 Summary of previously published nutrient enhancement experiments on seagrass beds globally. 170

Table 5.2 Timing of the fertilization experiments conducted at Bolger Bay and Picnic Bay, Magnetic Island, Queensland Australia, during May–August 1995 (Experiment 1) and August–November 1995 (Experiment 2). 172

Table 5.3 Experimental treatments for the nutrient enhancement experiment conducted at Bolger Bay and Picnic Bay, Magnetic Island, Queensland, Australia, during May–August 1995 (Experiment 1) and August–November 1995 (Experiment 2) showing fertilizer combinations, the presence or absence of lifting treatment, and the corresponding codes used in statistical analysis. 172

Table 5.4 Fertilizer loads used in the experiment conducted at Bolger Bay and Picnic Bay, Magnetic Island, Queensland Australia, during May–August 1995 (Experiment 1) and August–November 1995 (Experiment 2), and the equivalent loading m^{-2} and ha^{-1} for each fertilizer. 172

Table 5.5 List of mineral phases identified by X-ray diffraction for the minerals detected at Bolger Bay and Picnic Bay, Magnetic Island, Queensland Australia, during May–August 1995 (Experiment 1) and August–November 1995 (Experiment 2). 185

Table 5.6 Outcomes of statistical analysis for mineralogical differences detected at the 'between bay scale' (Bolger Bay and Picnic Bay, Magnetic Island, Queensland, Australia) during Experiment 1 (Seagrass senescing, May–August 1995) and Experiment 2 (seagrass growing, August–November 1995). 186

Table 5.7 Summary of previously analysed physical and chemical parameters that constitute the sediment regimes of Bolger Bay and Picnic Bolger Bay, Magnetic Island, Queensland, Australia. 186

Table 5.8 Outcomes of statistical analyses for mineralogical differences detected between experiments ('within bay scale') at Bolger Bay and Picnic Bay, Magnetic Island,

Queensland Australia, during May–August 1995 (Experiment 1) and August–November 1995 (Experiment 2). 187

Table 5.9 Outcomes of statistical analyses for each mineralogical phase within Quadrats/Treatment between Experiment 1 (seagrass senescing, May–August 1995) and Experiment 2 (seagrass growing, August–November 1995) at Bolger Bay and Picnic Bay, Magnetic Island, Queensland Australia, respectively. 187

Table 5.10 Summaries of statistical analyses of sediment nutrients responses to applications of Osmocote® conducted at Bolger Bay for Experiment 1: (May–August 1995) and Experiment 2 (August–November 1995), and Picnic Bay, Experiment 1 (May–August 1995) and Experiment 2 (August–November 1995), Magnetic Island, Queensland, Australia, highlighting the statistically significant treatment term and the response of the parameter to that term.....209

Table 5.11 Summary of responses by plant abundance parameters to applications of fertilizer for each location during Experiment 1: seagrass senescing, May–August and Experiment 2: seagrass growing, August–November for Bolger Bay and Picnic Bay. 234

Table 5.12 Summary table of plant tissue nutrient responses to applications of fertilizer at Picnic Bay during Experiment 1: seagrass senescing, May–August and Experiment 2: seagrass growing, August–November. 236

Table 5.13 Summary of significant results for each experiment at each location for plant production and plant tissue nutrients. 238

Statement of sources

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

Jane E Mellors	31 August 2003 Date