INTERACTIONS BETWEEN DUGONGS AND SEAGRASSES IN A SUBTROPICAL ENVIRONMENT

by

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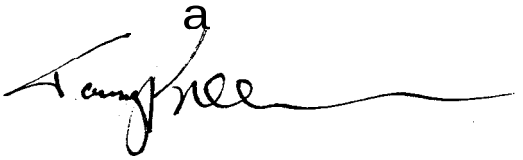

Anthony Preen

Declaration

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 Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

Anthony Preen

Dedication

to

Pam Preen
John Warlters
Margaret Thorsborne
Arthur Thorsborne

ABSTRACT

This study investigated the ecology of dugongs in Moreton Bay, a 1400 km² embayment in sub-tropical south-east Queensland (27.5° S, 153.3° E). The dugongs' distribution, movements, home range, habitat selection, feeding, diet and food preferences were examined in relation to the seagrass and physical resources. I considered the ways in which dugongs affect the seagrasses and the significance of the dugongs' role in the seagrass system.

Seagrasses were quantitatively mapped in two study areas, encompassing 133 km² of seagrass. Seven species of seagrass formed 15 recognised communities, which collapsed into five community-groups. Communities dominated by species of Halophila were the most widespread, covering 51% of the total area of seagrass, but they were characterised by low biomass, and accounted for only 9% of the total standing crop of seagrass (total = 12,808 tonnes dry weight). In comparison, communities dominated by Zostera capricorni (broad-leaf morph) occupied only 38% of the area of seagrass, but contained 75% of the seagrass standing crop.

The annual, above-ground production of seagrass within the study areas was estimated to be 41,728 tonnes dry weight. Zostera capricorni, the dominant species in terms of biomass (57.5% of total above-ground standing crop), accounted for 34% of the total, while the species of Halophila accounted for 36.6%, despite representing only 20.5% of above-ground standing crop.

The distinct seasonality of Moreton Bay was highly correlated with pronounced changes in seagrass abundance. There was a distinct summer/autumn peak in the abundance of most species. Zostera capricorni alone had a winter/spring growth period. Averaged across all species, shoot density, above-ground and below-ground biomass changed by factors of 1.9, 2.3 and 2.3, respectively, between seasons of minimum and maximum abundance.

Based on 28 aerial surveys, I estimate a Moreton Bay population of 600 dugongs. During spring and summer the dugongs were relatively sedentary, however, during winter the dugongs undertook regular migrations between the feeding areas inside the Bay and the oceanic waters east of the Bay (15-40 km round-trip). By riding the flood and ebb tides in and out of the Bay, the dugongs could exploit the temperature differential of up to 5" C between areas. Sometimes they spent as little as 1.5 hr, during the top of the tide, feeding in the Bay. Some dugongs stayed in the warm water outside the Bay for days at a time in winter.

Thirteen dugongs occupied an average range of 64 km² during the periods they were satellite-tracked (mean = 50 days). Within their home range, some dugongs sequentially used distinct sub-ranges, in which they concentrated their activities for periods of up to 35 days.

Some areas were rarely, if ever used by dugongs, while other areas were

persistently used. The dugongs favoured areas of low biomass, dominated by Halophila species. Almost all of the avoided areas were dominated by Z. capricorni. Of the 8,504 dugongs sighted on seagrass during aerial surveys, 76% were in areas dominated by Halophila. Likewise, 75% of locations from tracked dugongs, that were from seagrass habitats (n = 773), were from Halophila dominated areas. Dugongs feeding in areas dominated by Z. capricorni broad frequently grazed selectively, avoiding patches of Z. capricorni. Excluding the contribution of Z. capricorni broad, the mean biomass where dugongs were sighted and where tracking fixes occurred was 21.2 g DW/m^2 and 15.3 g DW/m^2, respectively. In comparison, communities dominated by Z. capricorni broad typically contained 100-200 g seagrass/m^2.

Based on the nutritional composition of the dugongs' preferred species (H. ovalis ≥ H. uninervis thin > H. spinulosa ≥ S. isoetifolium > Z. capricorni broad), it is apparent that they select primarily on the basis of high nitrogen and low fibre content. They may also select for high soluble carbohydrate content during spring, when they fed on fruiting Z. capricorni (thin-leaf morph).

Most feeding sites were in water 1.5-2.5 m deep at the time of feeding. The dugongs did not select feeding sites on the basis of sediment compaction nor mean grain size, however, they tended to avoid areas containing a high level of shell in surface sediments. In such places the dugongs adjusted their feeding technique to minimise the amount of sediment processed, by cropping primarily the leaves. This so-called **surface** grazing was also employed when the rhizome mat (usually of Z. capricorni) was particularly dense. Usually, however, the dugongs **furrow** grazed, removing shoots, rhizomes and roots.

Grazing dugongs removed 85.6% of shoots, 90.8% of above-ground biomass, 58.5% of rhizome biomass and 25.1% of root biomass from along feeding trails. Total biomass (above- plus below-ground) was reduced by 53.1% along feeding trails, or 65.2% excluding sites dominated by Z. capricorni.

Due to the differential digestion of seagrass species, the analysis of faecal samples revealed little about the dugongs' seagrass diet. However, it confirmed that algae are not normally eaten in significant amounts. Other evidence suggested that dugongs may actively avoid some algae (Caulerpa species, and some epiphytic species).

The faecal analysis revealed that ascidians are a significant component of the diet of dugongs in Moreton Bay. The stalks of the small colonial ascidian S. pulchra occurred in 69% of samples and comprised 29% of their wet weight (excluding material that passed through a 500 μm sieve). Mantles of solitary ascidians were found in 27% of samples and made up 20% of their bulk. Overall, ascidians were in 73% of samples and comprised 26% of the bulk of all samples. Comparable values for samples analysed from dugongs from tropical Australasia were 6.2% occurrence and 0.04% abundance. At least one dugong from Moreton Bay also fed on a colonial polychaete. There is little doubt that the dugongs fed selectively on the ascidians and polychaetes.

Dugongs in Moreton Bay often graze in large herds. Half the dugongs seen during aerial surveys were in herds of 140 or more. Grazing can reduce the abundance of seagrass by as much as 95% over large areas (40-75 ha). However, small tufts of seagrass remain as an ungrazable reserve (110-120 shoots/m^2 in a H. ovalis meadow), and recovery is rapid once all grazing ceases. In this regard the disturbance to seagrass meadows caused by grazing dugongs differs to that caused by sedimentation, water scour, disease or other die-offs.

Intensive grazing by large herds of dugongs can have significant effects on seagrass meadows. This so-called **'cultivation' grazing** can alter the species composition, age structure and nutrient status of seagrass meadows. Relatively high biomass, mid-sera1 stage communities can be converted to ones of low-biomass and early seral stage. H. ovalis is advantaged at the expense of Z. capricorni broad. This change of species results in a meadow-wide increase in nitrogen concentration and decrease in fibre levels.

Dugongs in Moreton Bay probably suffer particular nutritional stresses, especially during winter, due to (1) the limitation of nitrogen availability, due to seasonally low levels of nitrogen content and seagrass abundance and **(2)** the effect of cold water temperatures. They counter these winter stresses by (1) regularly migrating to an oceanic area outside the Bay and **(2)** by maximising the quality of their diet by (a) selectively feeding in communities and patches of favoured, nutritionally superior seagrasses, (b) by feeding on invertebrates and (c) by 'cultivation' grazing.

By concentrating their grazing in favoured regions, dugongs may alter the composition of seagrass communities over large areas (several km^2). Grazing by dugongs is likely to be responsible for some of the spatial heterogeneity of seagrass communities on the eastern banks in Moreton Bay.

In favoured areas, dugongs may consume on the order of 28% of the **total** seagrass production. This compares with consumption levels of <3-10% of **above-ground** production only by other grazers (invertebrates, fish, waterbirds; excluding atypical populations of urchins). Previously, little attention has been paid to the role of large herbivores, such as sirenians and green turtles, in the energy flow through seagrass systems. Consequently, our understanding of the functioning of these systems has been based on the assumption that large herbivores do not consume a significant proportion of production, and therefore, do not play a major role in the ecology of the systems. As a result of this study, I question that assumption.

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[1] formerly the bodacious Anne-Marie Watt