ANALYSIS OF STOMACH CONTENTS OF DUGONGS STRANDED IN THE CENTRAL REGION OF THE GREAT BARRIER REEF PARK: MAY - AUGUST 2000

Ivan Lawler
Jessica Andre
School of Tropical Environment Studies and Geography
James Cook University

Introduction

The numbers of dugong carcasses retrieved along the eastern coast of Queensland have increased in recent years (e.g. Limpus *et al.* 2000). Some of this increase however, may be due to greater effort in the reporting and retrieval of carcasses. Some of these carcasses appear to have been animals in poor condition, indicating that reduced food availability or starvation may be implicated in the deaths. There has been concern that a large-scale loss of the seagrass resource along this coast has occurred and that this may lead to continuing mortality of dugongs (Mellors and Waycott 2000). Record rainfalls were recorded over the central GBR region during the wet season of 2000 and this may have had an impact on seagrass abundance. Such an event occurred in Hervey Bay in 1992 when flooding caused the loss of the majority of the bay's seagrass beds (Preen *et al.* 1995). After that event large numbers of dugong carcasses were recovered, most having died 6-8 months after the flooding (Preen and Marsh 1995). The majority were clearly emaciated and contained unusual material (algae, dead seagrass rhizomes, anoxic sediment) in their stomachs.

In dugongs, starvation or reduced food availability may be indicated by a number of factors:

1. Empty stomach - a lack of food in the stomach of a herbivore is a clear indication of its low availability.
2. Poor body condition with reduced fat stores
3. Substantial change in diet composition with increased proportions of low preference food items.
4. Reduction in the quality of food items in the stomach but normal species composition.

In this report we present data from the analysis of the stomach contents of 13 dugongs, stranded between Cardwell and Bowling Green Bay in 2000, to determine if there was a substantial change in diet composition.. Stomach contents were analyzed to determine the proportion of each type of food item consumed by the dugong . These were typically seagrass leaves and rhizomes but also included small amounts of algae and, in one case, mangrove leaves. Interpretation is aided by reference to the findings of necropsies performed on these carcasses. We conclude that reduced food availability and/or quality is unlikely to have caused widespread dugong mortality in this region in 2000.

Methods

Because dugongs masticate food finely, epidermal-cell characteristics are used for the identification of forage items. However, due to the size of some fragments, items can sometimes only be identified to the generic level (Johnstone and Hudson 1981). The method used here is the Weibel graticule technique (Channels and Morrissey 1981).

Each sample is spread onto a plastic tray and mixed until visually homogeneous. Eight fractions of digesta are taken and each is spread evenly on 8 separate slides with a spatula. Slides are first scanned qualitatively under a compound microscope (x40) in order to determine the food type present. Ten sites on each slide are then scanned quantitatively using the Weibel graticule. The first sample site is selected by moving the slide to a pre-determined coordinate on the microscope stage. A line transect is run parallel to the edge of the slide from this point. Five fields each 1 cm apart are viewed along this transect and another five fields are viewed along a parallel transect 1 cm from the first. The percentage volume of each component of the stomach sample is calculated by counting the number of end-points of the graticule lines intercepted by the respective components.

Because it is difficult to make the distinction between the rhizomes of the different species of seagrass, all rhizomes were grouped into one category.

There are 2 species of *Halodule* (*H. pinifolia* and *H. uninervis*) that can only be differentiated by the shape of their leaf-tips. The stomach contents however, mainly contained fragments of *Halodule* leaves and it was not possible to differentiate between the two species. When leaf-tips were found the species was recorded, but it was not possible to quantify the relative proportions of each within a sample because these were infrequent. A similar problem was encountered when trying to differentiate between *Halophila ovalis* and *Halophila minor*, as the two species have the same epidermal-cell structure. Data for these species are pooled because there were no characteristics that allowed distinction to be made.

Algae were present in several stomachs. Due to the fragmentation of the items, it was usually not possible to identify these to species or genus.

Results

Stomach contents from a total of 10 dugongs were available for analysis from dugong carcasses collected between 8th May and 30th August 2000, along the north-eastern coast of Queensland between Cardwell and Bowling Green Bay in 2000. Three other carcasses are included in discussion but were not analyzed as their stomachs were empty.

The condition and ages of the carcasses varied, from those very recently deceased to one that had been dead for up to five days. However, internal condition of most carcasses was generally acceptable (Table 1) and all stomach content samples collected could be analyzed.

There is little evidence from the stomach contents analysis *per se* to suggest that suitable foods were in limited supply (Table 2). The majority of stomach contents (85-98%) were identified as seagrasses. Significant quantities of algae were found in only three samples with the maximum slightly over 14% of the total. One sample had trace amounts of mangrove leaves. Between 13% and 67% of stomach contents were seagrass rhizomes, unable to be assigned to particular taxa. Of the remaining seagrass component, *Halodule* spp. dominated six samples (58-98%: dugongs 1,3,4,7-9), samples 10 and 11 were dominated by *Halophila* spp. (47 and 83% respectively) and *Zostera capricorni* dominated samples 5 and 6 (75 and 59% respectively).

Discussion

It is not possible from these results to determine whether limited availability of suitable food resources contributed to the deaths of these animals. Three animals were found with empty stomachs and thus starvation may be implicated. Two (#2, #12) had abscesses in their intestine that may have prevented eating. The third (#13) appeared to have suffered some severe physical trauma. In all these cases it is possible that these ailments caused the animals to stop eating, rather than limited access to a food resource. Of the remaining animals that had been feeding prior to death, five were recorded during the necropsy as being either in apparently good condition or having a reasonable thickness of blubber. This is not consistent with previous records of dugongs starving due to loss of seagrasses. In these cases deaths occurred months after the event, abnormal stomach content composition was recorded and the majority of carcasses were clearly emaciated (Heinsohn and Spain 1974, Preen and Marsh 1995).

Of the animals that had been eating prior to death, the composition of the stomach contents is well within the range of healthy animals recorded previously (Marsh et al. 1982). Two animals had high proportions of *Zostera capricorni* in their stomachs. This species is generally considered to be a non-preferred food item, but there is some apparent variation in its palatability depending on the leaf morph (the broad-leaved morph is avoided while the narrow form maybe eaten) and phenology (fruiting plants may be preferred) (Preen 1992). Thus the presence of large amounts of *Zostera* in only two out of the 10 samples can not be considered strong evidence of low availability of suitable food. Note also that the necropsy results for both these dugongs indicate that they were adequately nourished (Table 1).

The remainder of stomach samples were dominated by two species, *Halodule* and *Halophila*, considered to be preferred dugong food (Preen 1992). Two of these samples also had significant amounts of algae but not sufficient that the diet could be considered sub-optimal. Marsh et al. (1982) recorded percentages of algae in the stomach contents of apparently healthy dugongs of up to 13% (Groups 2 and 3, Table 2 in Marsh et al. 1982). This is in contrast to dugongs that were nutritionally stressed following the loss of seagrass resulting from Cyclone Althea that had stomach contents that were up to 89% algae (Groups 5 and 6, Table 2 in Marsh et al. 1982)(see also (Heinsohn and Spain 1974).

If the food type is appropriate for adequate dugong nutrition, then it is possible that the quality of the food is insufficient. No attempt has been made here to analyze the chemical characteristics of the stomach contents, for two reasons. Firstly, the nature of what constitutes good food for dugongs is poorly defined. The only trend being that preferred items are higher in nitrogen and lower in fibre, though there are exceptions to this (Lanyon 1991, Preen 1992, Aragones 1996). We do not know what the lower threshold is for nitrogen or any other nutrient so it is not possible to relate poor body condition to the quality of food in the stomach. The second reason that chemical analysis of stomach contents is not feasible is that it is further compounded by the effect of digestive fluids and the varying amount of time food is in the stomach and/or the dugong is dead before carcass retrieval. While there has been some variation in chemical composition recorded in some species eaten by dugongs, we feel it is unlikely that this is a reasonable explanation for the levels of dugong mortality experienced in 2000.

Finally, an aerial survey of inter-tidal seagrasses between the Cardwell region and Bowling Green Bay in late 2000 showed no indication of reduced seagrass abundance in key dugong habitats in the region (Mellors & Waycott 2000).

In conclusion, we do not feel there is sufficient evidence to attribute increased dugong mortality along the north eastern coastline of Queensland in 2000 to reduced food availability or quality. The data presented is insufficient to completely rule out the possibility, but it does not appear likely when combined with necropsy data and the limited information on seagrass abundance available..

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Table 1. Collection details and necropsy results for dugong carcasses from which stomach content samples were taken.

Sample id	Location	Date	Sex	Size (cm)	Carcass condition/age	Necropsy summary	Stomach contents
1	Lucinda	8/4/00	M immature	152	• good	• No obvious cause of death	Yes
2	Nelly Bay	4/6/00	F immature	129	• Poor externally • Good internally • Approx. 36h	• No obvious cause of death • Slight emaciation? • Stomach and intestine empty • Parasitic worm abscesses in small intestine	Nil
3	Geoffrey Bay	16/06/00	F immature	139/51.3 kg	N/A	• External ulcers consistent with poor condition • Cachexia of heart • Parasitic worm abscesses in small intestine • Cloudy fluid in fore-stomach	Yes
4	Goold Island	21/06/00	F immature	146.5	• Bloated • Skin flaking • Beginning to decompose internally • 36-48h	• Normal appearance internally • Normal parasite load	Yes
5	Pallarenda Beach	25/06/00	M immature	N/A	• at least 48h	• Tail missing – clean cut • External puncture wound on dorsal surface • Tusks missing • Thoracic/heart area more decomposed than remainder • Otherwise reasonable condition internally	Yes
6	Cocoa Beach	6/07/00	M immature	141	• at least 24h	• Unusually high number of barnacles • Blubber consistent with good condition • One nodule in lung • Enlarged lymph nodes noted	Yes
7	Cardwell	7/07/00	F immature	181.5	• good	• Unusual external depression, darkened area on lateral side of precaudal area • Blubber thick, but some cachexia of inner layer adjacent to muscle • Liver and kidney unusual • Heavy parasite load in lungs • Extreme cachexia of heart • Brain diseased – atrophied locally	Yes

Sample id	Location	Date	Sex	Size (cm)	Carcass condition/age	Necropsy summary	Stomach contents
8	Cardwell	12/07/00	M immature	187	N/A	• Poor condition – dorsal process evident • Cachexia of heart • Left lung showed pneumonia	Yes
9	Cardwell	1/08/00	F immature	164	good	• Poor condition – dorsal process evident • Deep depressions with darkened dermis on posterior flanks • Abscesses on neck • Numerous parasites in stomach, duodenum. Stomach contents watery • Cachexia of heart • Emphysema in lungs	Yes
10	Between Cape Ferguson and Cungulla	11/08/00	M adult	246	• poor • at least 48h	• Unusual contusions around throat and tail • Lungs in poor condition • Cachexia of the heart	Yes
11	Taylors Beach	18/08/00	F adult	285	• at least 24h	• Prominent external ulcers • Cachexia of inner blubber layer	Yes
12	Cleveland Bay	22/8/00	M immature	N/A	• at least 5 days	• Unusual joint disarticulation of missing flipper • Some indication of starvation • Parasitic worms in gut • Bloody fluid in abdomen and lung cavities • Lungs with pus-filled nodules	Nil
13	Cleveland Bay	30/8/00	M immature	166	• poor	• signs of heavy physical trauma of throat • diaphragmatic hernia (possible result of physical trauma) • Peritonitis	Nil

Table 2. Results of analysis of stomach contents for dugongs stranded along the north eastern coast of Queensland in 2000

Sample id	Total seagrass	Rhizome	Halodule sp.	Halophila ovalis/ovata	Halophila spinulosa	Zostera capricorni	Cymodocea serrulata	Syringodium isoetifolium	Mangrove	Algae	Algae present	Unidentified
1	98.04	34.22	63.39	0.26	0	0.17	0	0	0.23	1.3		0.35
3	92.94	67.86	23.06	1.07	0	0.3	0.65	0	0	6.7	Red algae (*Laurencia sp*.)	0.36
4	88.58	67.23	12.8	3.63	0	0.18	1.79	2.95	0	10.77	Brown algae (incl. *Sargassum sp*.), Red algae (incl. *Laurencia sp*.)	0.65
5	99.79	41.93	5.18	7.86	0	43.78	0.86	0.18	0	0.03		0.18
6	98.9	29.7	15.92	10.36	0.06	41.34	1.22	0.3	0	0.33		0.77
7	99.91	30.53	64.2	4.82	0	0.3	0	0.06	0	0.03		0.06
8	99.67	13.15	80.21	5.45	0	0.86	0	0	0	0.03		0.3
9	99.82	40	42.49	16.29	0	1.04	0	0	0	0.18		0
10	99.82	48.3	14.09	24.15	0	11.88	1.4	0	0	0		0.18
11	85.68	62.53	3.18	19.2	0	0.74	0.03	0	0	14.23	Brown algae	0.09