ESTABLISHING A MARK-RECAPTURE PROGRAM FOR DUGONGS IN MORETON BAY, SOUTH-EAST QUEENSLAND.

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This paper reports the commencement of the first mark-recapture program for a dugong (*Dugong dugon)* population. Moreton Bay, south-east Queensland supported a *D. dugon* population of more than 800 individuals in 1996 and is close to an urban centre, Brisbane. Several features of this population make a mark-recapture program feasible: a large resident population concentrated over a small and predictable area, a relatively clear water habitat, animals regularly exposed to boating traffic, and an efficient capture method. Fifty-four *D. dugon* were captured using the 'rodeo' method and tagged. Tags applied included a long-term dorsal PIT tag, a titanium turtle tag, fluke notch and temporary paint stick mark. For each *D. dugon*, body length, anal girth and gender were recorded. *D. dugon* were biopsied for genetic (microsatellite) analysis. Faecal samples were obtained for reproductive hormone assays. This program has the potential to yield information on trends in population size and distribution, population dynamics, mating strategies, social structure and general health of the population. This is the first season of a long-term project.

Key words: dugong, *D. dugon*, population dynamics, mark-recapture, tagging, marine mammals

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DUGONGS (*Dugong dugon*: Sirenia) are long-lived marine mammals with slow and highly variable reproductive and recruitment rates (Marsh *et al*. 1984; Marsh 1995). Management strategies for *D. dugon* throughout their tropical-subtropical range have incorporated life history parameters obtained principally from analysis of carcasses from tropical regions (Marsh 1995). However, the biased and opportunistic nature of carcass analysis is such that life history parameters that have been routinely applied to dugong populations may not always be appropriate (e.g., Kwan 2001). Furthermore, it is reasonable to expect that life histories of *D. dugon* in non-tropical regions (with a more pronounced seasonality) may be different to those in the tropics. Recent apparent declines in *D. dugon* populations globally and along the eastern Australian coast (Marsh *et al*. 1996) have further highlighted the need for reliable regional information concerning population structure, trends and life histories.

Tagging programs can provide valuable information on the life histories of large long-lived free-ranging mammals (Eberhardt 1985; Lebreton *et al*. 1992). The Florida manatee (*Trichechus manatus latirostris*) has been the subject of a long-term tagging program established in the late 1970s, to document movement patterns and reproductive traits (Reid *et al*. 1991, 1995; Rathbun *et al*. 1995). More recently, a mark-recapture approach has been applied to these data and is yielding detailed information on age and gender-specific survivorship (Eberhardt and O'Shea 1995; Langtimm *et al*. 1998), as well as population genetics (Garcia-Rodriguez *et al*. 1998; Garcia-Rodriguez 2000). No longitudinal data comparable to that available for *T. m. latirostris* is available for *D. dugon*. Until recently, attempts to capture *D. dugon* using methods such as hoop-netting (e.g., Marsh and Rathbun 1990; Preen 1993) have met with limited success (A.R. Preen, pers. comm.; pers. obs.). However, we have now developed a method for rapid capture and handling of *D. dugon* that allows us to catch the large numbers necessary for the development of a mark-recapture program.

Moreton Bay, south-east Queensland supports the southern-most *D. dugon* population on the east Australian coast. This population lives close to the thermal and nutritional limits for this species (Preen 1993; Lanyon and Morrice 1997) so that if a thermal or latitudinal gradient exists, we might expect life history parameters here to be most different to those in the northern tropics. Aerial surveys conducted over 1994-1996 inclusive have established a minimum population count of 857 individuals, based on an uncorrected high-tide census in the clear water habitat of the eastern banks, and have confirmed seasonal distribution patterns (Lanyon and Morrice 1997; Lanyon in press). In summer, more than ninety-five percent of the Moreton Bay population aggregate on the shallow eastern seagrass banks, whilst in winter they are more dispersed, moving up to several kilometres offshore into warmer oceanic waters. Several features of the Moreton Bay *D. dugon* population make a mark-recapture program feasible. These include a large resident population concentrated over a small and predictable area, a relatively clear water habitat, animals regularly exposed to boating traffic, and an efficient capture method.

The broad aims of this tagging program are to apply artificial tags/marks to individual *D. dugon* and collect data on parameters pertaining to populations (including adult survivorship, age structure, recruitment rates), individuals (including reproductive status and growth rates), social structure (including intra-population genetics and mating strategies) and general health of the Moreton Bay *D. dugon* population. Life history parameters obtained from this study will be examined in relation to those obtained using other techniques including carcass salvage (Boyd *et al*. 1999). Trends in population size and distribution will be examined in association with on-going aerial surveys. In this paper we describe the capture method and general approach for data collection.

MATERIALS AND METHODS

Study site

Moreton Bay, south-east Queensland, is adjacent to Brisbane, a city with a human population of more than one million, and the fastest growing urban centre in Australia (Fig. 1). Central-eastern Moreton Bay contains extensive shallow (< 5 m at high tide) sandbanks covering an area of 110.5 km^2 and supporting seagrass meadows (Preen 1993). Rous Channel runs roughly NE-SW through these sandbanks dividing them into northern Moreton Banks and southern Amity Banks. During this first season, *D. dugon* were captured at Coonungai Bank on the northern Moreton Banks, a *D. dugon* 'hotspot' identified from aerial survey (Lanyon and Morrice 1997; Lanyon in press).

Sampling and tagging program

Following a pilot study in 1999, *D. dugon* tagging was conducted over three weeks in summer 2001. Based on a minimum population count of 850 animals in 1996 (Lanyon and Morrice 1997), our objective was to catch and tag 210 animals (~25% of the population) over the first two seasons (after Caughley and Sinclair 1994).

Dugong dugon herds were located during boat transects across the Moreton Banks. Adults on the periphery of herds were targeted for capture. *D. dugon* were captured using a modification of the turtle rodeo technique (Limpus and Walter 1980). Capture was concentrated on the rising tide when the *D. dugon* were feeding over the shallow banks, water over some parts of the banks was shallow enough to stand in and the incoming water was relatively clear. The targeted individual was pursued closely by the capture boat and a record was kept of pursuit duration and surfacing intervals. The capture boat was positioned so that immediately following the animals's third breath, a catcher could leap onto its back and grasp the peduncle. At least three additional personnel immediately jumped into the water to assist in restraint. *D. dugon* were restrained at the surface for periods of 2-5 min whilst samples were collected and tags were applied. A pair of foam pool noodles were slipped under the anterior of the animal's body to provide extra flotation (Fig. 2). (An expanded version of the catch protocol is available from JML upon request and will be published at a later date).

For each *D. dugon* we recorded gender, body length (snout to fluke notch length), anal circumference, and general body condition. Tissue samples included a skin scraping from the dorsum for genetic (microsatellite) analysis, a biopsy punched from the trailing edge of the fluke and to the right of the fluke notch for genetic / carbon isotope / pollutant and/or *Lyngbya* analysis, and a faecal sample for reproductive hormone assay. Several tags were applied to each *D. dugon* including a temporary dorsal paintstick mark (to identify short-term resights), a titanium turtle tag applied to the left of the fluke notch, and a Trovan PIT (Passive Integrated Transponder) tag injected into the upper left dorsum near the shoulder (Fig. 3).

RESULTS AND DISCUSSION

Capture

A total of 54 *D. dugon* was tagged and biopsied, comprising 16 individuals during the pilot study and 36 individuals during the three week sampling

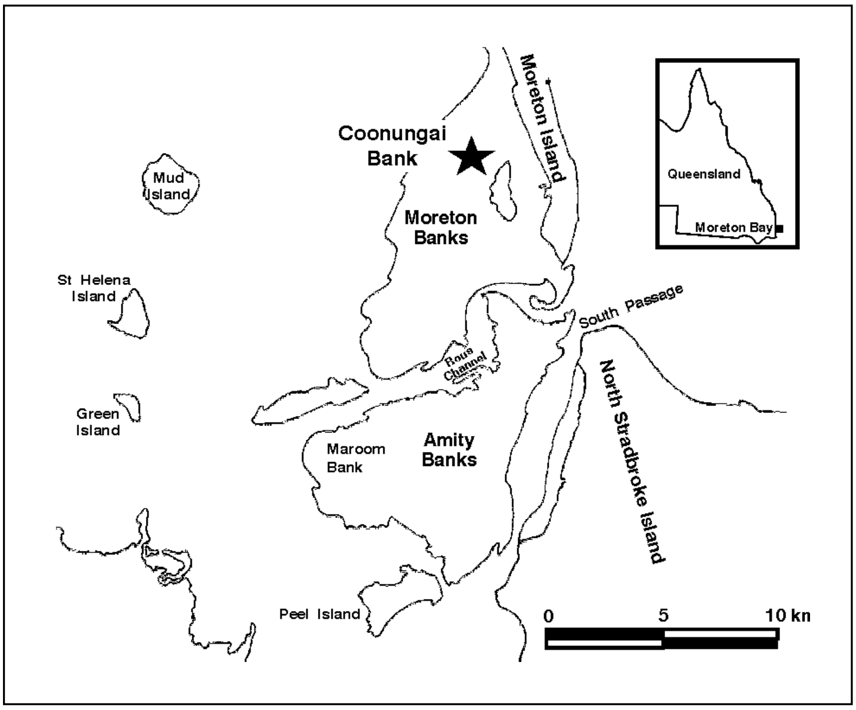

Fig. 1. Map of eastern Moreton Bay showing position of the capture site, Coonungai Bank.

Fig. 2. Dugong supported at the water surface during sampling

Fig. 3. Injecting a PIT tag into the dorsum of a dugong.

period. The sex ratio of known-gender individuals was 1:1 (n = 49) and body length ranged from 180 – 290cm (i.e., second year calf to adult). Weather conditions were good on only four days out of the three weeks. On the other days, conditions were marginal to poor with a Beaufort sea state of 3-5, cloud cover 5-8 oktas and frequent rain. This made sighting and pursuit of *D. dugon* difficult so that capture rate was adversely affected. We anticipate higher capture rates under favourable weather conditions. This capture technique has a processing time that is considerably faster than for operations where hoop-netting was practised (e.g., Marsh and Rathbun 1990; Preen 1993) and is suitable for both shallow and open-water capture.

The 36 *D. dugon* caught during the three week period were part of three large herds (> 30, > 50 and > 100) located on the Coonungai bank. These herds remained in the same locations ± 1 km throughout the sampling period. A number of smaller groups and solitary *D. dugon* were also found scattered throughout the region. Pursuit and capture of *D. dugon* over the sampling period did not appear to affect distribution or size of the herds in the region. Further, pursuit and capture of individuals did not appear to affect other *D. dugon* in the region, which continued to feed uninterrupted, even when the pursuit boat passed close by.

During the three week sampling period, six out of 36 (17%) of the tagged *D. dugon* (plus one scarred but untagged animal) were resighted at the same locations in the days following capture. One tagged *D. dugon* was sighted in the same location on three consecutive days. This suggests that capture and short term restraint does not cause *D. dugon* to move out of an area.

Tagging

A series of artificial tags was applied to each *D. dugon* so that individuals could be identified at subsequent recaptures. Furthermore, at least two tag types were applied to each *D. dugon* because tag retention times are largely unknown. Unlike manatees whose natural and inflicted boat scars form the basis of a photo-identification catalogue (Beck *et al*. 1982; Beck and Reid 1995), *D. dugon* are not suitable candidates for photo-identification. Their less approachable nature, frequently murky habitat and propensity to acquire additional scarring through social interactions with conspecifics on a seasonal basis suggests that photo identification would be logistically difficult and unreliable (contrary to Anderson 1995).

An ideal artificial tag for a *D. dugon* would be one that uniquely marks an individual and is retained for the life of the animal. In addition, a highly visual tag would make resighting without physical recapture a possibility. Possible candidates include highly visual freezebrands and spaghetti tags but these have proved to be unsatisfactory on manatees (Irvine and Scott 1984; R. Bonde, pers. comm.) and freezebrands are aesthetically and ethically unacceptable to high profile and vulnerable species such as the *D. dugon*. The long term tag we have chosen is a PIT tag. Trials on *T. m. latirostris* have found that PIT tags injected subcutaneously in the neck/shoulder position have a long life (several years at least), are stable and do not migrate appreciably through the tissue (R. Bonde, pers. comm.). Further, this high position facilitates scanning of an animal in water. However, since these tags are not immediately visible and require a dedicated scanning device, we have trialled additional and multiple visual tags on *D. dugon*. These include plastic cattle ear tags (with large prominent numerals) and titanium turtle tags applied to the trailing edge of the fluke. Turtle tags can be seen on the flukes of swimming *D. dugon*, however animals have to be recaptured in order to read the tag number. In contrast, cattle ear tags have a greater chance of being read without having to capture the animal. A small number of each of these three tags have already been applied to *D. dugon* in Moreton Bay, and one subsequent recovery of a tagged carcass suggests tag retention times of at least four years (C.J. Limpus, pers. comm.). We plan to use cattle ear tags on subsequent captures. To miminise the number of physical recaptures of an individual per sampling season, a short-term unique season-specific visual tag is also necessary. We have used paintsticks (thick oil based crayons) with a life of 3+ days (Irvine and Scott 1984; this study). As additional short-term tags, we also intend to trial non-toxic marine paint, and spaghetti tags since these may be retained for longer periods of up to a fortnight (N. Gales, pers. comm.).

This paper reports the establishment of the first mark-recapture program for *D. dugon* and results from the first season of data collection. We intend for this to be a long-term program and to yield information on life history and population dynamics appropriate for dugong management. Further, we intend to refine our capture and tagging procedures to ensure that we maximise high quality data collection whilst minimising disturbance to the animals.

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