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A Method for Capturing Dugongs (*Dugong dugon*) in Open Water

Janet M. Lanyon,[1] Rob W. Slade,[2] Helen L. Sneath,[1] Damien Broderick,[1, 3]
John M. Kirkwood,[3] Duncan Limpus,[4] Colin J. Limpus,[4] and Tim Jessop[1]

[1]*School of Integrative Biology, The University of Queensland, St. Lucia, QLD, 4072, Australia*
[2]*Southern Cross Institute of Whale Research, Lismore, NSW, Australia*
[3]*Queensland Department of Primary Industries and Fisheries, Southern Fisheries Centre, P.O. Box 76, Deception Bay, QLD, 4508, Australia*
[4]*Environment Protection Agency, Brisbane, QLD, Australia*

Current Address: Conservation and Research for Endangered Species, San Diego Zoo, San Diego, CA, USA (TJ)

Abstract

We developed a method to rapidly and safely live capture wild dugongs based on the "rodeo method" employed to catch marine turtles. This method entails close pursuit of a dugong by boat until it is fatigued. The dugong is then caught around the peduncle region by a catcher leaping off the boat, and the dugong is restrained at the water surface by several people while data are collected. Our sampling protocol involves a short restraint time, typically < 5 min. No ropes or nets were attached to the dugong to avoid the risk of entanglement and subsequent drowning. This method is suitable for shallow, open-water captures when weather and water conditions are fair, and may be adapted for deeper waters.

Key Words: Dugong, *Dugong dugon*, capture technique, tagging, mark-recapture, wild population, marine mammal, Moreton Bay, Australia

Introduction

Throughout the dugong's (*Dugong dugon*) Indo-Pacific range, there have been marked declines in population sizes over the past few decades (Marsh et al., 1996, 2003). In many areas with small or declining populations, there is an urgent need to obtain location-specific data pertaining to populations, demography, life history, and movements. To date, all information regarding population structure and demography has been obtained through aerial surveys of coastal regions supporting dugongs. Life history parameters for dugongs have been ascertained through examination of carcasses recovered from harvests, drownings, or boat strikes. Research on dugongs has been conducted through a largely hands-off approach.

More recently, some telemetry and tracking data were obtained through deployment of VHF- and satellite-transmitters (Marsh & Rathbun, 1990; Preen, 1993) and time-depth recorders (Chilvers et al., 2004; Lanyon et al., unpub. data). This work has mostly involved the capture of small numbers of dugongs through a hoop-netting technique (Marsh et al., 1987; Marsh & Rathbun, 1990).

Very little information on the demographics of wild dugong populations has been obtained, mostly due to the perceived difficulty of capturing and manually handling large numbers of these animals. Capture of wild dugongs has been problematic due to their fully marine lifestyle, cryptic and secretive nature, often murky and remote habitat, and large body size (up to 400 kg). Initial attempts to capture dugongs using hoop-nets had limited success for various reasons (Marsh & Rathbun, 1990; Preen, pers. comm., 1997). Marsh & Anderson (1983) suggested that dugongs may suffer from capture stress, a potentially fatal form of myopathy.

Herein, we describe a method to capture dugongs in open water based on the "rodeo method" employed to catch marine turtles (Limpus & Walter, 1980). This method provides a quick, efficient, and safe way of capturing dugongs. Our sampling protocol involves a short restraint time, typically < 5 min, which provides an opportunity for deployment of tags, tracking, and monitoring devices and the collection of biological samples. The information gathered enables longer-term, hands-on investigations into population dynamics.

Materials and Methods

Study Site

This capture technique was developed in Moreton Bay, southeast Queensland, Australia. Central-eastern Moreton Bay contains extensive shallow,

subtidal (< 5 m at high tide) seagrass meadows, covering an area of 110.5 km^2 (Preen, 1993). Rous Channel runs roughly NE-SW through these sandbanks, dividing them into northern Moreton Banks and southern Amity Banks. These banks support a population of dugongs that has been estimated at between 850 and 1,000. At any one time, between 80% and 98% of the dugong population in Moreton Bay can be found on these banks. During the warmer months of the year (September to March), dugong herds of up to 300 individuals graze over the seagrass banks at high tide. On the ebb tide, dugongs move off the banks into adjacent deeper waters. In the cooler months (April to August), dugongs are usually more dispersed and are found in smaller groups or as scattered solitary animals (Lanyon, 2003). The warmer waters of Rous Channel, South Passage, and the nearby Pacific Ocean are also frequently inhabited by dugongs in the winter months (Preen, 1993; Lanyon et al., 2002; Lanyon, 2003). The eastern half of Moreton Bay has relatively clear water.

Locating Dugongs

Dugong captures are typically conducted in fair weather conditions—that is, no rain, winds ~ 10 to 15 kts, cloud cover < 6 oktas, and not close to dawn or dusk when the angle of the sun to the water is low and glare off the water is highest. On the day prior to most capture trips, aerial surveys were flown at an altitude of ~ 300 m over the eastern banks region to locate groups of dugongs. Locations of dugong herds (groups of ≥ 10 dugongs) were plotted using a GPS. At other times, we located dugongs by conducting a series of transects across the banks in a small boat. This is considerably less efficient because dugongs are more difficult to spot from a boat. Further, boats must be driven at nonplaning speeds to reduce the risk of collision with dugongs and turtles.

Capture trips were timed to coincide with daytime high tides when dugongs are over shallow subtidal or intertidal regions. We endeavoured to capture dugongs that were located in a water depth of < 1.3 m so that the capture crew could stand while handling the dugong during the restraint period. This was rarely possible in Moreton Bay because the principal dugong feeding areas are deeper than 1.5 m.

Vessel

Since the capture of dugongs involved pursuit, the vessel was capable of rapid acceleration, with a top speed of ≥ 25 kts, and was highly manoeuvrable. Further, the catch boat must have an exit point to one side of the bow for the catchers to enter the water rapidly. It is also preferable that there be easy entry points onto the boat for team members after the capture. The boat currently used for the Moreton Bay population study is a 5.3-m Naiad rigid inflatable with a centre console (Naiad Inflatables, New Zealand) and a 100-hp, four-stroke outboard motor. This vessel maintains speed and manoeuvrability with a crew of up to nine. The low inflatable sides provide easy entry and exit ports. If working with a smaller catch team (see "Personnel" below), a smaller, more manoeuvrable vessel may be used.

Personnel

The number of personnel required depended on the sampling protocol, water depth, and size of the animal. Capture teams of three to four were adequate for a shallow-water capture in standing depth water and/or for capture of calves or immature dugongs (< 220-cm body length) when tagging is the primary aim. However, a team of at least six people was required to capture, restrain, and sample adult dugongs when more detailed biological data were required or if capture was conducted in deep water. For the dugong population study, we deployed a team consisting of eight people: a boat driver/data recorder (who remained on the boat), four catcher-restrainers, a swimmer to ferry sampling equipment, a sampler, and a photographer. Having a team of multi-skilled personnel enabled roles to be exchanged throughout the day, alleviating the risk of catcher fatigue. Further, we ensured that all personnel were fully informed and trained for their tasks. It is also important that personnel are familiar with possible variations in the catch scenario so that they can be prepared to adapt catch protocol, if necessary.

Human safety was an important issue when handling adult dugongs, which can reach over 3 m in body length and 400 kg. All catchers and restrainers wear full 3- to 5-mm wetsuits and padded foam or leather rugby helmets to guard against contact injury with the animal and each other. Further, the primary catcher's wetsuit was modified to include extra protective 10-mm padding over the upper arms and chest region. All personnel need to be competent and strong swimmers with experience in handling large animals.

Capture Technique

Pursuit—When a dugong herd was located in shallow water, an individual dugong on the periphery of a herd was preferentially targeted for capture to minimize disturbance to the herd. The dugong targeted for capture was tracked by the catch boat and herded away from other dugongs. Whenever possible, the dugong was coaxed into shallower water and away from the deeper edge of the seagrass banks by keeping the boat situated

between the dugong and the deep water. Once the driver of the catch boat made visual contact with the dugong and commenced pursuit, the primary catcher moved into position at the starboard bow, with the other catcher-restrainers at the port bow. The crew kept the driver informed of the dugong's position with outstretched arms pointing in the animal's direction. All crew wore polarized sunglasses to aid in tracking the animal when it is below the water surface. Until the dugong surfaced for its second breath, the driver attempted to herd the dugong into shallower water and away from the herd, preventing its escape into deeper waters. Following the second breath, the driver positioned the boat so that the dugong was 1 to 2 m off the starboard bow (Figure 1).

Figure 1. Dugong surfacing to breathe; boat in capture position, with the primary catcher poised to jump.

During pursuit, breathing intervals of the dugong were monitored. The number of breaths from the start of the pursuit was counted and recorded. The dugong was allowed to surface and breathe at least twice prior to capture. We aimed to capture a dugong at the third or fourth surfacing event; however, if the animal had not responded to pursuit and still appeared to be strong and energetic, we waited for further breaths before attempting a catch. Individual dugongs were pursued for no longer than 10 min. If a successful capture did not take place at this time, the chase was abandoned to reduce the risk of the animal becoming exhausted. It is essential that the dugong be allowed to surface and take a breath just prior to capture since its natural tendency on capture is to dive.

Capture—Capture involves the primary catcher jumping from the starboard bow onto the dugong (Figure 2) and grasping it firmly around the peduncle region. This was done immediately after the animal took its third or fourth breath and had just started to dive. The primary catcher's arms were wrapped around the peduncle so that the dorsal surface of the flukes was held firmly against his chest. This reduced the effectiveness

Figure 2. Primary and secondary catchers jumping out of boat to catch a dugong

of the dugong's powerful tail thrusts and, thus, the risk of injury to the catcher. Along with the primary catcher, two to three catcher-restrainers also jumped in—one towards the rear of the animal to also grab the animal around the peduncle, and the other one or two handlers moving to support the front of the dugong by holding the pectoral fins. In the event that the primary catcher missed the animal or was not able to maintain a hold, the presence of the back-up catcher-restrainers increased the chances of a successful capture. As the primary catcher left the boat, the driver shut down the motor, and the remaining restraint and sampling personnel entered the water to assist in restraint and support of the animal.

Restraint (Sampling and Monitoring)—It is essential to keep the dugong's head at the water surface as much as possible. There were at least two restrainers supporting the anterior end at all times. If the dugong dove under water, these restrainers swam down and lifted its head back to the surface. To assist in keeping the dugong at the

Figure 3. Restraint of dugong at the water surface to allow unimpeded breathing by dugong; note use of foam pool noodle under pectoral region to provide flotation and support.

surface, one or two foam "pool noodles" (150-cm long and 7-cm diameter) were available to slip beneath its pectoral region (Figure 3).

The sampler commenced data collection immediately upon capture of the dugong while the dugong was being settled into the restraint period. During sampling, the supporters held the dugong so that it was able to bring its nares clear of the water and breathe. In the event that the dugong attempted to dive or roll, its body was righted and moved back to the surface. Respiratory rate and behaviour (movements, strength, etc.) were monitored closely by the restrainers at the head end.

Once sampling was completed, the release command was given by the sampler. All restrainers immediately released their hold of the dugong and moved out of the way. Breathing patterns of a released dugong were monitored for as long as the animal was in sight. In the case of those dugongs fitted with tracking devices, breathing cycles were recorded for 30 min after release.

Results

A total of 412 captures of dugongs were made using this technique from February 2001 up to May 2005 as part of the Moreton Bay population study. This included 360 different individual dugongs and 52 recaptures of previously tagged animals, and it also included 15 adult-calf pairs, with both animals in each pair caught sequentially. The calves were all at least 170-cm long and in at least their second year. Total time spent in pursuit, capture, and sampling of a dugong ranged from 4 to 18 min (mean = 9.23 ± 0.13 SE). Eighty percent of the dugongs were captured, sampled, and released within 7 to 11 min of initial sighting.

Pursuit times for individual dugongs ranged from 1 to 13 min (mean 4.9 ± 0.1). Only 1.3% of dugongs were pursued for >10 min. Most pursuits (81%) fell between 3 and 6 min. Eighty-five percent of all pursuits were about 6 min. Pursuits of < 2 min were rare, occurring only 4% of the time when a capture was effected prematurely to avoid losing an animal to nearby deep water channels. Only when dugongs continued to swim rapidly (15% of the time) were they pursued for longer than 6 min. When they did not flee from the boat at all so that they were not fatigued, or when they were not in a suitable position relative to the boat for capture at either the third or fourth breath.

All dugongs were pursued until they surfaced and breathed at least twice. Only 12.4% of dugongs were caught directly after the second breath. Most were caught after the third breath (41.2%), 23.6% after the fourth breath, 15% after the fifth breath, and 7% after the sixth breath. One dugong was caught after seven breaths, and one after eight breaths (0.4% each).

Intervals between successive breaths by a dugong under pursuit ranged from 10 to 210 s (i.e., up to 3.5 min). There was a tendency towards longer intervals between breaths at the start of a chase, with a decrease in successive dive times as the pursuit progressed (Figure 4). Mean duration of the time between the first dive and the first breath (89 ± 2 s) was markedly longer than for respiration intervals in subsequent dives (52 ± 2 s). Dive intervals between successive breaths after the fourth breath were not significantly different (Figure 4).

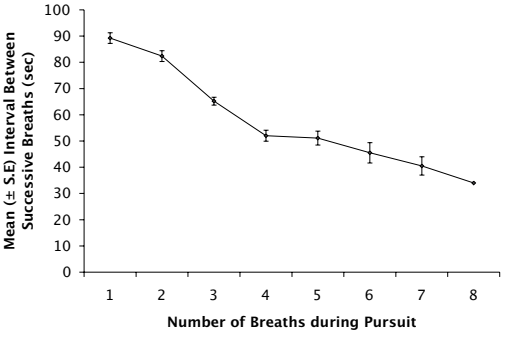

Figure 4. Mean (± SE) interval (sec) between successive breaths by a dugong pursued by boat prior to capture

Restraint times for dugongs after capture ranged from 1 to 9 min (mean 4.28 ± 0.08). In general, there was a correlation between time an animal was restrained and number and type of sampling procedures. Most dugongs (78%) were held between 3 and 5 min. Dugongs held for 5 to 6 min had a series of 6 to 8 body measures taken, as well as 4 tags applied, 1 skin biopsy, determination of sex and body condition, faeces sampled, and were photographed. Only 7% of dugongs were held for ≥ 7 min. Longer restraint times occurred due to sampling equipment failure (40% of the time), extra photo-recording and measuring of any existing injuries or unusual features (25%), implementation of a new sampling procedure (20%), or the animal being particularly difficult to hold (15%).

Most captures occurred after the peak of high tide when the majority of the dugongs were up over the seagrass banks. Depth of water in which dugongs were captured ranged from 1 m to > 5 m. Most captures (78%) occurred in water ≥ 2-m depth. Only 15% of captures occurred in adjacent, deeper (≥ 3 m) waters as dugongs were entering or leaving the seagrass beds. Although restraint and sampling were easier in shallow water, very few dugongs (4%) were caught in water of standing depth (< 1.3 m).

Discussion

The rodeo method has proven to be highly successful for open water capture of dugongs. Dugongs were first captured by one of us (DL) using this method in 1987, and the technique has been refined since 2001 as part of an investigation into the population dynamics of dugongs in Moreton Bay. More than 400 captures have been made in Moreton Bay alone using this method. This technique has been used subsequently elsewhere in Australian coastal waters, including Shark Bay, Western Australia (N. Gales, pers. comm.), Shoalwater Bay (Limpus & Limpus, unpub. data), and along the northern east coast of Australia (Chilvers et al., 2004). In fact, more dugongs have now been caught by this method in Australian waters than by all other methods.

The greatest advantages of this method are its simplicity, efficiency, and safety to the animal. Most dugongs can be captured, sampled, and released within 10 min of initial sighting. This is considerably faster than for previous operations where hoop-netting was practised (Marsh & Rathbun, 1990; Preen, 1993). Depending on the experience and skill levels of the catch team, a large number of measurements and sampling procedures can be made during restraint times of 5 min, even when in deep water. After the initial catch and once dugongs have settled down, we suggest that restraint times of up to 10 min pose no problem to the animal. For the small number of animals held for more than 7 min, there were no adverse effects to the animals, as far as we could tell, based on the animals' behaviours during and post-capture. Further, since this method does not involve hoops, nets, or any other type of capture or restraint device, there is no risk of the dugong drowning through entanglement. In contrast, open water capture methods using nets have proved to be problematic for dugongs and the related manatee (A. R. Preen, pers. comm., 1997; J. R. Reid & R. K. Bonde, pers. comm., 2006). The dugong's tendency to roll and dive away on capture or when encountering a net makes it particularly susceptible to entanglement. Further, having no restraint or flotation devices, such as stretchers, means that sampling can commence immediately upon capture.

All our tagged animals swam away strongly after release, with none showing apparent ill effects. Further, resightings of tagged animals in the same area in the days following capture suggest that the capture and tagging procedure was not sufficiently adverse an event to cause dugongs to leave the area. We now have recaptures of tagged dugongs over a 5-y period, with some animals recaptured in similar areas over successive years (Lanyon, unpub. data).

There have been no injuries sustained by dugongs during this capture and restraint procedure; however, in 1998, one adult female dugong died within 1 min of capture. The subsequent necropsy indicated that this animal had predisposing health problems, including existing heart myopathy, that led to heart failure. Further, excessive ulceration and epidermal spongiosis of the dorsum suggested excessive drying and solar damage that could only have occurred through aberrant surface swimming behaviour. Our observations prior to capture confirm that this was an unusual dugong. Pursuit of this animal did not elicit the usual flight response, and the animal continued to swim slowly at the surface for several minutes, taking only two breaths over a 9-min period, with a final breathing interval of more than 4 min, which is excessively long for a pursued animal and well outside the normal range (see "Results" section). There has been no other adverse incident to a captured or restrained animal during over 400 captures.

With appropriate training and protective gear, injuries to field workers were kept to a minimum. Injuries in the past consisted of minor bruising sustained during direct contact with the dugong (upper arms and chest), mostly withstood by the primary catcher as the dugong was initially grabbed. Since the introduction of protective chest armour and bicep pads, the incidence of bruising has declined markedly. A further way to reduce injury is to pursue a dugong until it is somewhat fatigued. An examination of dive durations during pursuit shows that breathing intervals of dugongs are longest early in the chase, and the interval between successive breaths declines with each successive breath. If breathing rate is indicative of fatigue level of an animal, we recommend capture when the rate of decline in breathing intervals slows after the third or fourth breath. Experience has shown that the capture of a dugong prior to its third breath is generally unsuccessful because the animal is too lively/strong and presents a greater physical danger to the primary catcher.

This technique worked best in areas with extensive shallows away from deep water areas. Success was enhanced by clear skies and calm weather. Moreton Bay, with its relatively clear waters in the eastern banks area, is ideal as are other inshore areas with extensive shallow banks (e.g., Shoalwater, Hervey, and Shark Bay). Although the technique worked best in water about 3-m deep with good visibility, it can be used in deeper waters. Difficulties in tracking dugongs occur in deep and/or murky water, however, and under suboptimal weather conditions.

In conclusion, we developed a safe, efficient, and practical method of capturing dugongs in the wild. During short restraint times, we were able to collect a large amount of data that will be the subject of future papers. With the right conditions, we captured, sampled, and released up to 14 dugongs in a single high tide period of 3.5 h.

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