Palau *Dugong dugon* Awareness Campaign 2010-2011

by

Coral Reef Research Foundation

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"I ♥ Mesekiu"

Liberté Egalité Fraternité
REPUBLIQUE FRANCAISE

palau pacific resort

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NECO MARINE dive-tour

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Executive Summary

The dugong (*Dugong dugon*) population within the Republic of Palau is geographically and genetically the most isolated in the world and is considered one of those most threatened with extirpation. It is listed on Appendix I under the Convention of Migratory Species of Wild Animals (CMS) and the Convention on International Trade in Endangered Species (CITES).

The Dugong Awareness Campaign in 2010-2011 involved outreach activities, fisher surveys and scientific observations. Outreach included distribution of educational materials to schools, regular newspaper press releases regarding illegal poaching and occurrence of dead dugongs, awareness messages on local TV stations, life-sized dugong statues/carvings for display and as special presidential gifts to foreign dignitaries, and a poster contest. Underwater and aerial photos taken during the campaign are being used worldwide by UNEP/CMS, SPREP, NGOs and other agencies for education and conservation. Palau signed the Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats throughout their Range (UNEP/CMS Dugong MOU) at the First Signatory State Meeting of the UNEP/CMS Dugong MOU in Abu Dhabi in October 2010. The launch for the regional 2011 Pacific Year of the Dugong campaign took place in Palau in March 2011. Aerial surveys of dugongs were conducted during both tourist and dedicated research helicopter flights, with data from flights used to construct a grid along the flight lines where locations of dugong sightings were recorded. Over 38 boat, kayak and snorkel surveys of dugongs were also conducted.

The true status of the Palau's dugongs is not well known. Helicopter surveys covered only about 4% (260 km^2) of the potential dugong habitat (considered to be 6.457 km^2 - the area within 10 km of the outer reef). During surveys, 912 dugong were sighted on 192 flights (mean 4.75 per flight). On 50% of flights only 1-3 dugongs were sighted with larger numbers (30 or more) seen on only a few occasions. The population is actively breeding (53 calves were seen on 6% of the total flights), but it is unknown whether this is at a level sufficient to maintain the population. Observations validated reports from fishermen about dugong rest areas in Malakal Harbor close to the commercial port and areas of small boat traffic. The Ngederrak Conservation Area south tip was the only area identified as an important foraging site, where confirmed feeding trails were documented.

A dangerously uncertain level of mortality continues to occur with high concern for the long term survival prospects of dugongs in Palau. An estimated 5-15 dugongs are still deliberately killed for food each year despite laws prohibiting the capture, possession and sale of dugong. Dugongs found dead without obvious relationship to hunting have also occurred. Accurate data are hard to acquire as there may be numerous deaths of dugongs that are not generally known or reported. With a total population of only a few hundred animals the species may be decreasing at an unsustainable rate. Fortunately the dedicated survey flights have verified that numbers of dugongs are still present in some areas, and verified the importance of the Malakal Harbor and nearby surrounding areas as important dugong habitat and nursery grounds. The locations with relatively large numbers of sightings are now well documented and resurveys in the future will be more comparable to past work. Continued studies on the longer term, combined with a strong stance from the national and regional agencies, are needed if the welfare and survival of dugong is to be assured.

1.0 Introduction

1.1 Dugongs in Palau

The Republic of Palau is a small island nation in the western Pacific located approximately 1000 km east of the southern Philippines and 800 km north of the western half of New Guinea island (approximately $7^{o}30'N$; $134^{o}24'E$). The main Palau island group has one large basaltic island (Babeldaob - 400 km^2 in area) and hundreds of smaller limestone islands forming a complicated archipelago inside a surrounding barrier and fringing reef. The area inside the reefs (lagoon) covers close to 1,000 km^2. The country has 16 political states of which 10 are on Babeldaob; an 11^{th}, Koror, is the commercial and population center of the country and three others are island entities within or close to the main island/reef complex. The final two states are oceanic islands located up to 500 km southwest of the main group. Total human population is just over 20,000 people with 80% of those residing in Koror State.

Palau has highly diverse shallow water marine communities (Colin 2009). The main island group is surrounded by a barrier reef system on the north, west and south with a fringing reef system on the east. Inside the barrier reef is an extensive lagoon that covers twice the area of land and is no deeper than 50 m. The climate of Palau is tropical with high air and water temperatures and high humidity throughout the year. The average annual rainfall is 375 cm, with the dry months being February through April.

The dugong, *Dugong dugon* (Muller 1776), or "mesekiu" in Palauan, is a marine mammal belonging to the order Sirenia, family Dugongidae (Fig. 1). They are herbivorous and strictly marine with their diet consisting almost exclusively of seagrass. Dugong are long lived, perhaps up to 73 years (Marsh 1995), with adult females believed to reach sexual maturity between 7 and 17 years of age (Marsh and Kwan 2008). The reproductive rate is low with a gestation time around 13 months; only a single calf is normally produced which is then suckled for up to 18 months. Time between calving is between 3 to 7 years (Marsh et al 2002, Marsh and Kwan 2008). Population models indicate that even with the most optimistic combinations of life-history parameters (e.g. low natural mortality and no human-induced mortality) a dugong population is unlikely to increase more than about 5% per year. Thus even a slight reduction in adult survivorship can have dramatic effects on the population (Marsh et al 2002). This

effect is greatly exacerbated when the population is small in terms of number of viable breeding adults (Marsh 1995).

Figure 1. The dugong, *Dugong dugon*, ("*mesekiu*" in Palauan) is an iconic member of Palau's marine community with important cultural roles. The population in Palau is the most isolated in the world and is one of the most highly threatened with extinction. This photo of a family group taken during helicopter surveys is a rarely-seen sight and provides hope that with proper protection and management the dugong will continue to survive, as they have for thousands of years in Palau.

The dugong population in Palau has a long and culturally important history. There are legends that document dugong and their involvement to Palauan culture and they have been heralded as a 'flagship' species for Palau. Palau is the only country in Micronesia where there is a permanent population of dugongs, although there have been occasional sightings in Yap and Guam (Nishiwaki et al 1979). The closest known permanent dugong populations to Palau are found in Indonesia (800 km to the south) and the Philippines (1000 km to the west) (Nishiwaki and Marsh 1985), with recruitment from these areas to Palau (or the reverse) being unlikely (Marsh 1995).

The Palauan population is in both a geographic and genetic sense perhaps the most isolated dugong population in the world (Marsh et al 2002). In addition to their isolation, at the First Signatory State Meeting on the UNEP/CMS Dugong held October 2010 in Abu Dhabi, Dr. Helene Marsh, the world's

leading authority on dugongs, stressed that Palau's population was one of the two most threatened dugong populations in the world (the other is Okinawa, Japan). Dugongs are listed on Appendix I under the Convention of Migratory Species of Wild Animals (CMS) and the Convention on International Trade in Endangered Species (CITES), with exception of the Australian populations which are on Appendix 2 of CITES.

1.2 The "I ❤ Mesekiu" *Dugong dugon* Awareness Campaign 2010-2011

The "I ❤ Mesekiu" *Dugong dugon* Awareness Campaign took place in Palau in 2010-2011. The overall project engaged in a wide variety of outreach activities, in addition to the surveys, anecdotal and scientific observations reported here.

These activities included:

- Distribution of outreach and educational materials to all local schools on Palau (posters, stickers, baller bands and a 45 page dugong booklet- Appendix I).
- Regular local newspaper press releases to draw attention to ongoing illegal poaching activities and finding of dead dugongs - eleven instances were reported in 2010 alone (Appendix II).
- Daily awareness messages and photography on local TV stations for a two year period.
- Life-sized dugong statues/carvings displayed in the Palau capitol building, and given as presidential gifts to foreign dignitaries to call attention to the Palau dugong. An eight foot tall carving of a dugong with calf was presented by Palau to Taiwan for their centennial celebration and is now displayed in the presidential palace in Taipei.
- Underwater and aerial photographs taken of Palau dugongs during this campaign by Mandy Etpison have since been used by UNEP/CMS, SPREP, Dr. Helene Marsh and several other local and international NGOs and agencies for dugong conservation efforts and educational materials worldwide.
- Palau attended the First Signatory State Meeting of the UNEP/CMS Dugong MOU in Abu Dhabi in October, 2010 and signed the Memorandum of Understanding on the Conservation and Management of Dugongs and Their Habitats Throughout their Range.
- CNN International featured the campaign and Palau dugongs in an August 2011 Eco Solutions segment: "Protecting Palau's Dugongs."

- The launch for the regional 2011 Pacific Year of the Dugong campaign took place in Palau in March 2011 with support from SPREP and UNEP, coordinated by Palau Campaign partners and the government of Palau. This regional campaign included national efforts in Australia, PNG, Solomon Islands, New Caledonia, Vanuatu, and Palau.
- The campaign co-sponsored a workshop held in April 2011 by the Bureau of Marine Resources for all local, national and state enforcement agencies to improve cooperation and address the many enforcement challenges.

In October 2010 when Palau became a signatory state to the UNEP/CMS Dugong MOU, Palau was declared a Marine Mammal Sanctuary by President Johnson Toribiong. However, since then the proposed Dugong Protection Act, which was passed in 2011 by the Palau National Congress, has been referred back to congress by the President and is still pending. This bill calls for increased penalties and jail time for dugong poachers relative to the current legislation. Since the existing dugong legislation was enacted in 2002, no rules or regulations have been put in place to facilitate enforcement efforts by national and state agencies.

1.3 Dugong Aerial Surveys

In addition to the activities described above, the campaign also aimed to gain further knowledge of dugong habitat use, behavior and distribution throughout Palau's waters. This was achieved through aerial helicopter surveys, augmented by in-water observations from boats, kayaks and snorkeling. These surveys and their results will be described in the sections below.

2.0 Methods

2.1 Surveys

Aerial surveys for dugong were conducted from October 2010 to March 2011 using a Palau-based helicopter (four-place Bell Jet Ranger, Palau Helicopters Inc.) whose pilot had 11 years of flying experience in Palau. He was intimately familiar with shallow water marine habitats and able to spot dugongs easily. The pilot had also conducted two previous dugong surveys in Palau (Smith 2003, Kitalong 2008), as well as one in Australia.

Two types of surveys were conducted: 1. tourist flights and 2. aerial surveys focusing solely on dugong. Regular tourist flights over the islands and reefs of Palau were flown (as often as several times a day) with three routine routes from a landing area on Malakal Island. They ranged from 15 min (approximately 25 km distance) to 50 min (approximately 150 km), each covering different areas with some overlap (Fig. 2). Generally the route would be flown at approximately 120 km/h at an altitude of 200 m. In clear weather the pilot had a field of view of approximately 4 km^2, with the only obstructed view being directly behind. On tourist flights, the pilot was the only observer. Data sheets were filled out by the pilot after each tourist flight. Tourist flights were not recorded when dugongs were not seen.

Secondly, aerial surveys focusing solely on dugong sightings were conducted from September 2009 to November 2010 (14 dedicated flights), and again from November 2010 to March 2011 (eight dedicated flights). The dedicated dugong survey flights were carried out with between one to three observers and one pilot. Initial spotting of dugongs was usually made by the pilot, due to his level of experience and familiarity with where he had previously seen dugongs. The observers took additional data and photographed dugongs. On dedicated survey flights the pilot would generally follow a route that took the helicopter to areas where dugongs were commonly seen. If some individuals were spotted, the helicopter would deviate on its flight path to approach close enough to get photographs using cameras with telephoto lenses showing the number and sizes of individuals, while maintaining sufficient distance that dugongs would not dive or appear to flee from the noisy presence of the helicopter. Once a group was documented with photos, the survey would move on to other areas. If the return flight path brought the helicopter relatively near to where dugongs had been seen earlier, the observers would attempt to revisit the same group (and such were noted as likely the same individuals so as not to be counted twice).

During this same period, over 38 boat, kayak and snorkel surveys were also conducted, where dugongs were photographed *in situ* and data gathered on their behavior. Six different resting places initially observed during flights were snorkelled regularly.

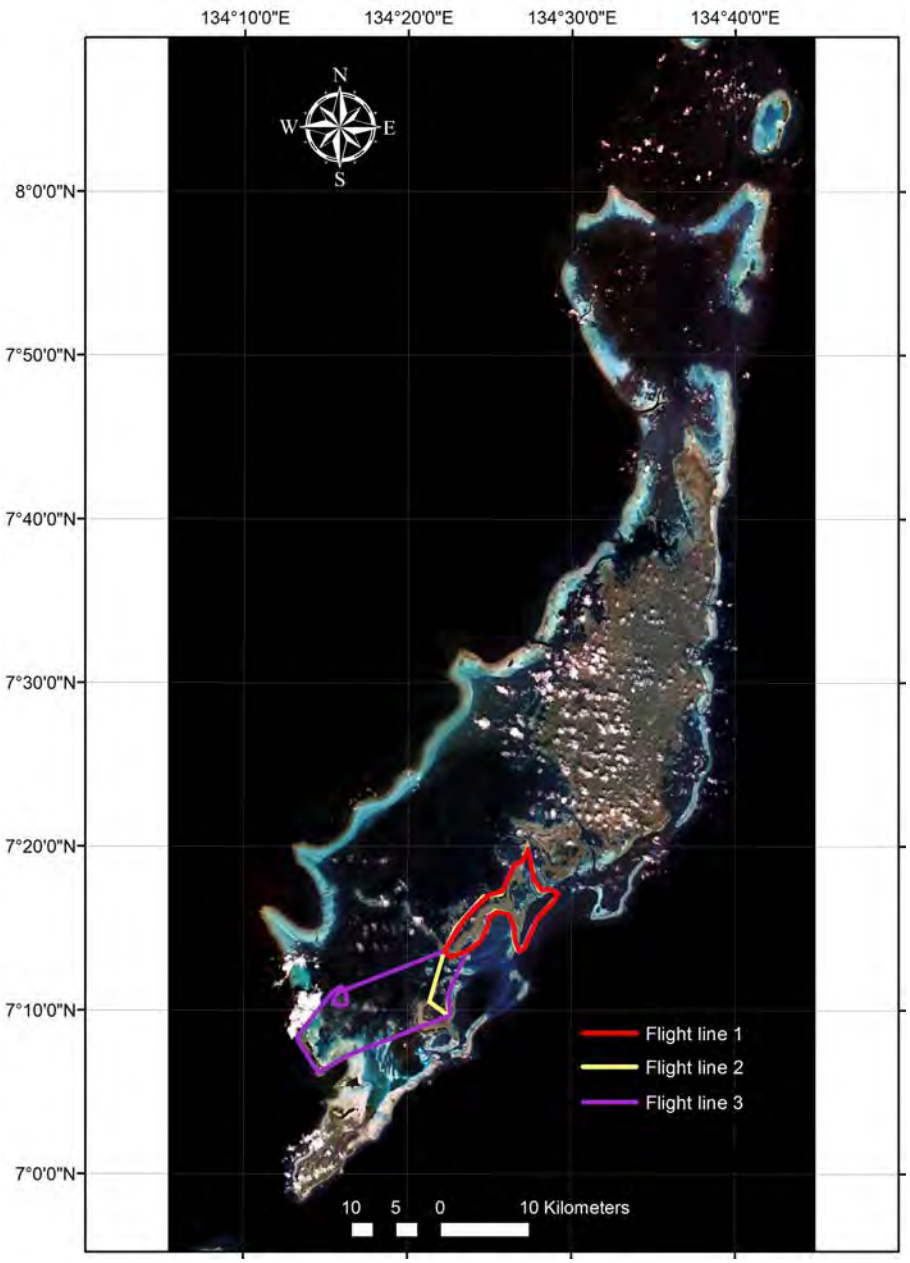

Figure 2. Satellite image of the main Palau Island group showing the three typical flight lines of tourist helicopter flights during which dugong sightings were recorded.

The data in this report were tallied to give two values: 1. number of individual dugongs seen and 2. number of dugong sightings, ie. number of flights where one or more dugongs were seen. On a given flight, the pilot and/or observers took care to determine only the total number of dugongs seen per flight, trying not to double count any individual and therefore not breaking down dugong numbers into groups if more than one group was seen. It was usually impossible (with only a few exceptions) to identify individual dugongs from the air, as they often lack any distinguishing markings evident from

the air or from photographs. Dugongs sighted on different flights (sometimes less than an hour apart) undoubtedly were often the same individuals, hence data from only a single flight were used to estimate total numbers of individuals in a given area. Data were recorded on a "Dugong Sighting Form" (Appendix III) post flight by the pilot. Flights with multiple observers aboard had data entered as a consensus of the total number seen; the information present in aerial photos taken during the flight was also used as confirmation in this case. The data were collated in a spreadsheet and entered into a graphical information system (ArcGIS version 9.3) as point data. Tide phase and lunar state were other variables used in the analysis.

2.2 GIS Analysis

Using the most common flight lines (Fig. 2) as a starting point, an array of 1 km^2 cells was constructed (Fig. 3) that delineated the area where the pilot and observers were likely to have seen dugongs during surveys, and data on their occurrence was assigned to these cells after flights. The 3 flight lines were constructed with a 1 km buffer zone added around the flight line (to approximate the relative field of view where dugongs could be sighted). A 1 km^2 grid was overlaid on the buffered flight line grid (see Fig. 3), which resulted in several hundred 1 km^2 cells.

The locations of dugong sightings were plotted in the 'general' vicinity (usually within a 1 km square cell); their location should be regarded as only an approximation as specific GPS points of sightings were not recorded. To quantify the distribution of the sightings and allow future analysis, 4 polygons were constructed around 4 areas, or sites (Fig. 4), that were representative of the observation areas detailed on the sighting form and were refined based on conversations with the pilot. The sightings were then assigned to specific cells within a site based on information from the pilot and from the sightings forms (Appendix III). After assessing how many points fell within each site, a random point generator was applied on the applicable points to constrain the data and to ensure that there was no bias on the plotting of the points within each specified polygon (site). Once the points had been assigned randomly within the polygons they were displayed as graduated symbols, representing number of dugongs seen, ranging from the smallest points (1 to 3 animals) to the largest points (21 to 40 animals). While imperfect, this method did provide a reasonable way to ensure that there was no spatial bias introduced when plotting the sightings, due to the lack of precise location data. The

distribution of observations within each 1 km^2 cell determined which sites, if any, had concentrations of sightings.

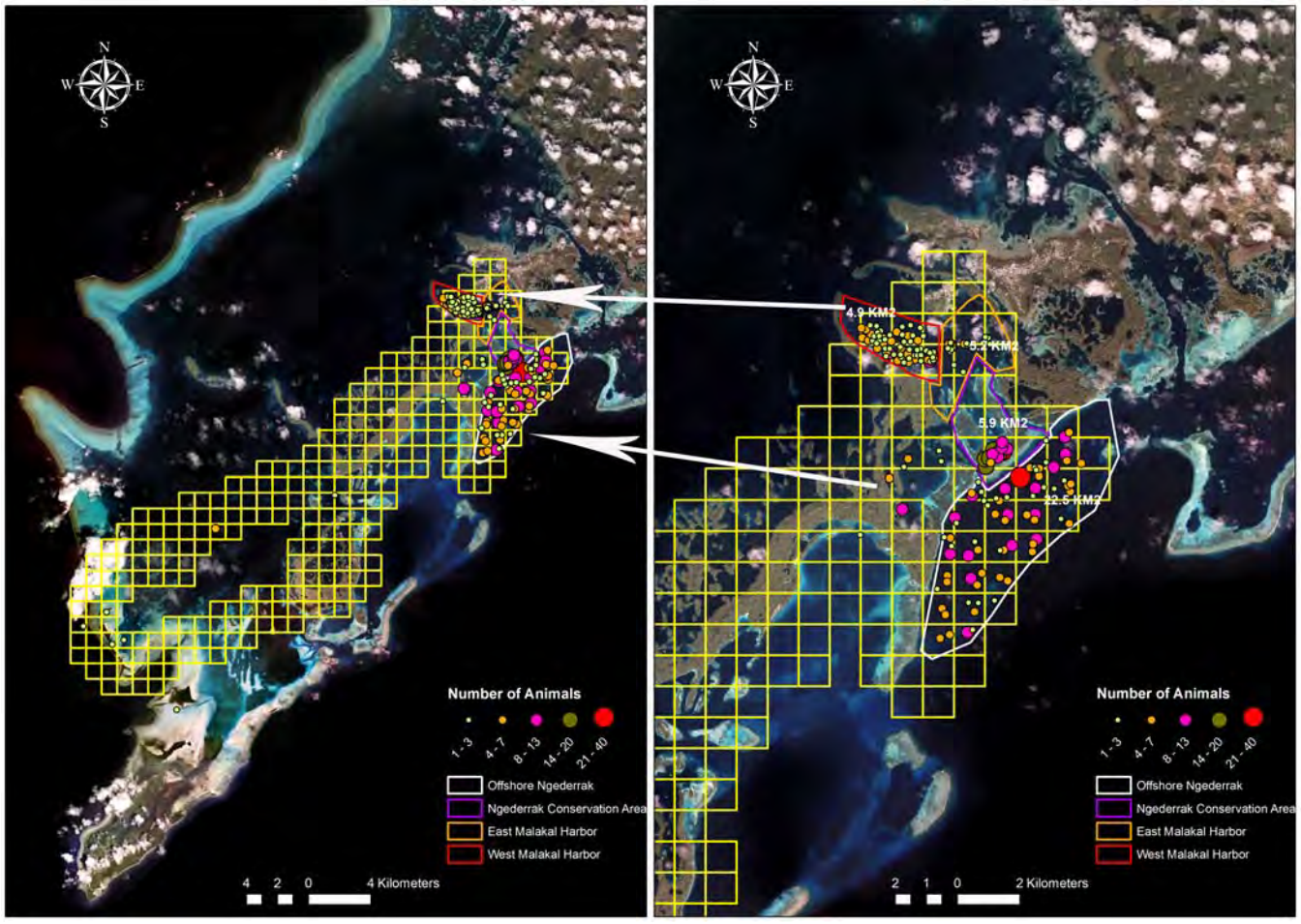

Figure 3. (Left) One kilometer square cells (including buffer zone) located along the flight lines most commonly flown, with the number of dugongs per group indicated by colored circles. (Right) Enlargement of the Malakal Harbor area showing 1 km squares with the 1 km sighting distance (buffer zone) indicated either side of the flight track. The occurrence of dugong sightings is indicated by colored circles, showing numbers of individuals per sighting.

In order to compare the area of the existing flight lines relative to the total area potentially available to dugongs throughout, the water area of Palau from north to south in the main island group (Kayangel to Anguar, including a distance of 10 km from the outer reefs) was determined. This distance seaward of the reef was somewhat arbitrary, but has a large effect on the total area of habitat; previous research in Australia has identified dugongs up to 58 km off shore (Marsh and Saalfeld 1989). However, because of the steep outer slope and lack of shallow habitats seaward of outer reefs in the study area, it was considered unlikely that dugongs would normally be found at any greater distance seaward of the outer reefs.

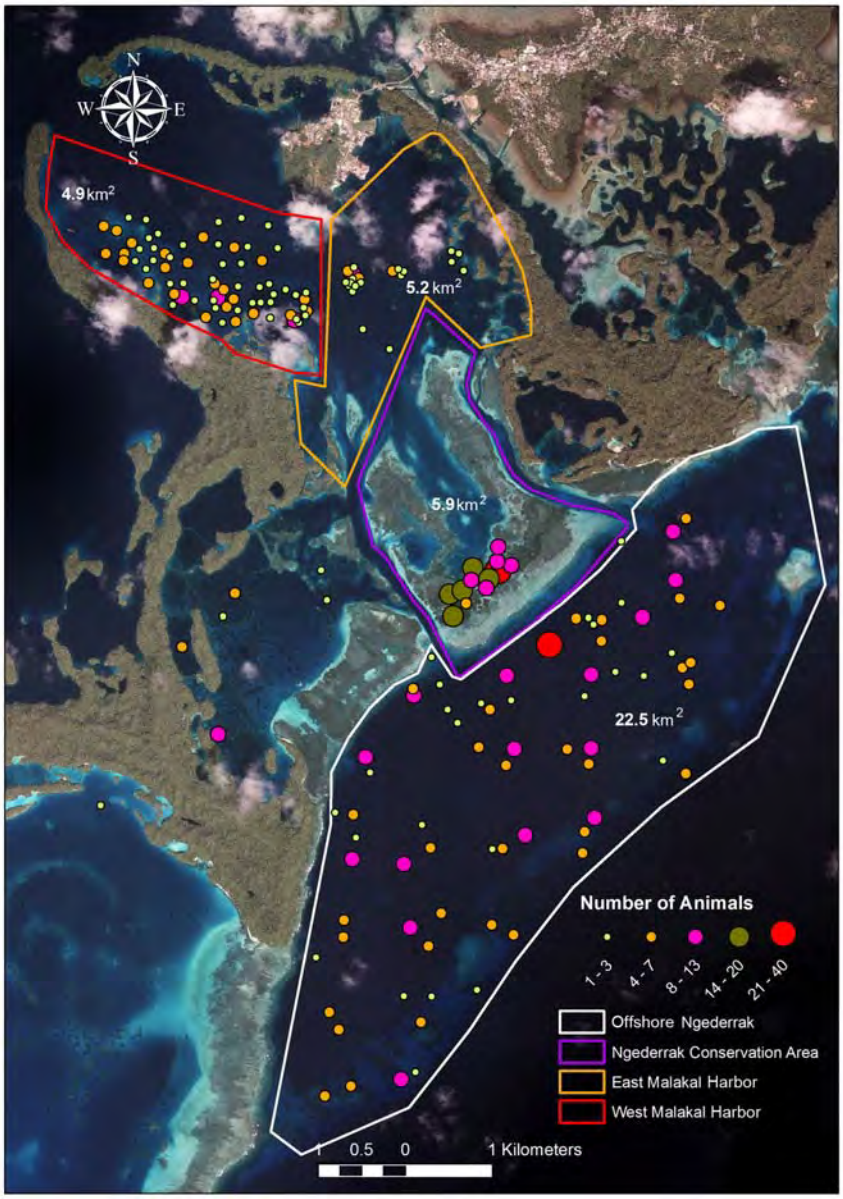

Figure 4. Map of the four sites represented by area polygons near Malakal Harbor with 95% of all dugong sightings. Sites: Offshore Ngederrak, Ngederrak Conservation Area, East Malakal Harbor & West Malakal Harbor.

Bathymetric maps of the 4 sites were prepared using a Triangulated Irregular Network (TIN) model from data (x,y,z) gathered during a 2004 LIDAR (Light Detection And Ranging) survey of channels and harbors of Palau by the US Naval Oceanographic Office. Raw data were converted into point file data, which was then interpolated into a raster format using an Inverse Distance Weighting process within the GIS software. Contour bathymetric maps were then created to allow visualization of the underwater topography (eg. Fig. 7).

3.0 Results

3.1 Aerial Surveys and Distribution of Dugongs

The total habitat area within 10 km of the outer reef of Palau was calculated to be 6,457 km^2, while the area covered by the three helicopter flight lines totaled 292 km^2, and thus comprised only 4 % of the total potential habitat (Figs. 2 & 3). During the surveys, 912 dugongs were recorded on 192 flights, taking place on 140 days, with a mean observation of 4.75 dugongs per flight (see Table 1 summary). Only 1-3 dugongs were generally seen on a flight (50% of all flights). On only two flights, large numbers of dugong (up to 30+) were seen. Fifty three calves were seen (6% of total flights), always accompanied by the mother. The 912 dugongs recorded over 140 days represents multiple sightings of the same animals, and in no way represents a dugong population in Palau of 912 animals.

Table 1. Summary of dugong sighting data in Palau during aerial surveys in 2010-2011. Sites: ON - Offshore Ngederrak, NCA - Ngederrak Conservation Area, EMH - East Malakal Harbor, WMH - West Malakal Harbor & Other - see Figure .

Site Name	Area (km^2)	No. of flights dugongs were sighted	Number of sightings per km^2	Number of dugongs per sighting Mean (min/max)	Total number of all dugongs seen*	Total number of calves seen*
ON	22.5	77	3.42	5.1 (1/30)	396	15
NCA	5.9	12	2.03	15.6 (5/40)	187	2
EMH	5.2	18	3.46	3.7 (1/9)	66	8
WMH	37	71	1.92	3.1 (1/10)	220	24
Other	221.4	14	0.06	3.1 (1/10)	43	4
Total or Mean	292	192	2.18	4.75 (1/40)	912	53

*Total number of dugongs and calves seen over 140 days; many of the same individuals were seen on multiple days. This number does NOT imply Palau has a dugong population of 912 individuals.

Of the 292 1 km^2 cells within the buffered flight line, dugong sightings were assigned to 40. Of these, 34 cells fell within the confines of the Malakal area which equates to 95% of all the sightings (see Figs. 3 and 4). Of these sightings (Fig. 4), 41% were located in the site designated Offshore Ngederrak; 6% were within the Ngederrak Conservation Area, 11% were in the East Malakal Harbor site, and 37% were in the West Malakal Area site. The remaining 5% were located elsewhere along the flight line.

3.2 Tidal and Lunar Influence

Palau has a semi-diurnal tide with maximum amplitudes of almost 2 m. Many areas of shallow marine habitats become emergent, or nearly so, at spring low tides (Colin 2009). Some of the seagrass beds known to be dugong feeding habitat fall into this category, so tidal state undoubtedly plays a role in

influencing dugong daily activity. Additionally deep channels adjacent to shallow flats serve as conduits for exchanging water between ocean and lagoon and have strong (up to 2-3 m sec^{-1}) currents which may be exploited by dugongs during movements.

Comparison of tidal stage with sightings data superficially appear to indicate a possible relationship with increased sightings and higher numbers of dugongs seen at times near high tides (Fig. 5). The greatest number of individuals seen occurred in the period from two hours either side of high tide in Malakal Harbor. Comparing lunar phase to individuals observed, there appear to be possible trends with higher numbers seen on the quarter moon (both first quarter and last quarter, see Fig. 6). The quarter moons represent periods of neap tides, and reduced tidal current in channels and across the reefs, so potentially they may influence the activities of dugongs at that time. However, tourist flight data were not gathered in a random or precise manner, making over analysis of the limited information highly questionable. The possible relationships described are offered only to provide a suggestion of work that needs to be examined more rigorously in the future.

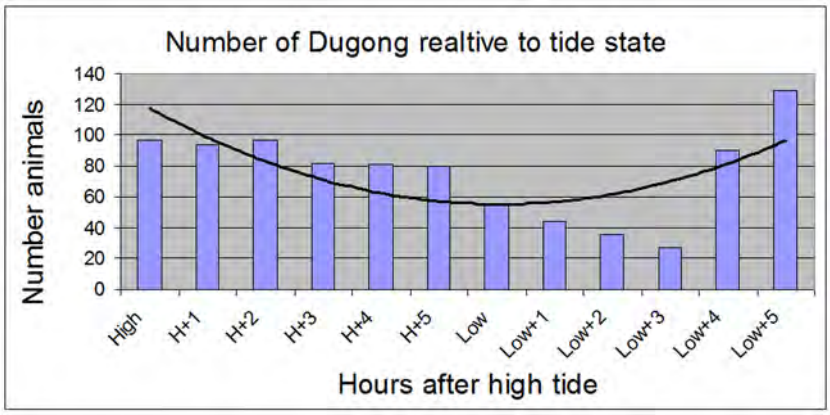

Figure 5. Number of individual dugongs observed compared to time of high and low tides. The fitted black line represents the trend in the overall data.

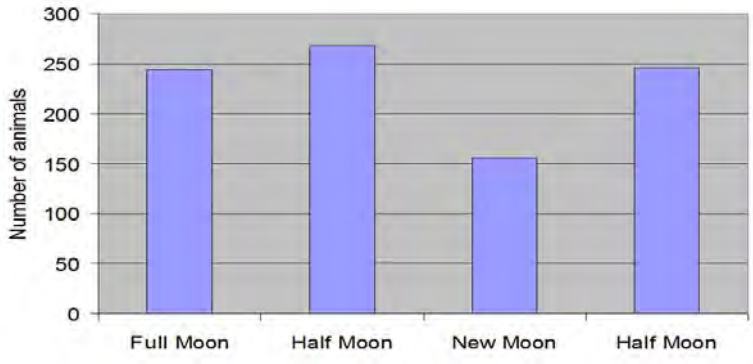

Figure 6. Comparison of lunar phase with number of individual dugongs observed.

3.3 Bathymetry and Site Characterization

Bathymetric maps were prepared for each of the 4 sites outlined in Figure 4. These allowed comparisons of the occurrence of dugong sightings with site bathymetry and geomorphology.

Ngederrak Conservation Area, a protected area since 2001, covers approximately 5.9 km^2 and abuts both the deeper East Malakal Harbor to its west and Offshore Ngederrak seaward to the east (Fig. 4 & Fig. 7). Deep channels (north and south) run along its sides. In this area, habitat types have been mapped using an automated classification (Collins 2010). The area accounted for only 6% of all the sightings recorded, however one of these sightings was comprised of over 30 animals. The area has extensive seagrass beds and is 10 m or deeper on all sides, possibly to allow an escape should the animal feel threatened when feeding. The habitats of Ngederrak Reef are varied (Fig. 7) with abundant sea grasses.

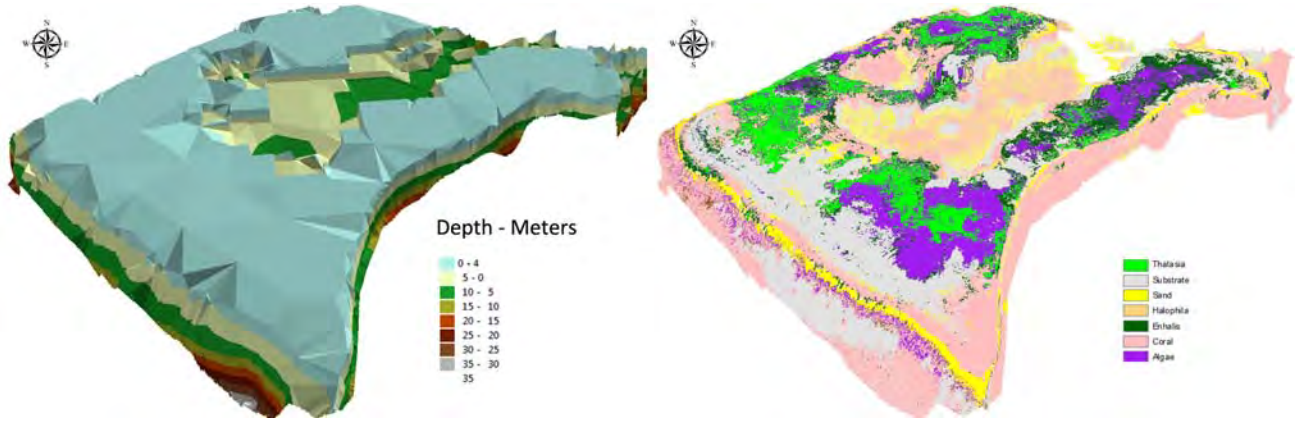

Figure 7 (Left) TIN bathymetric model of the Ngederrak Conservation Area. (Right) Habitat map of the Ngederrak Conservation Area showing areas with sea grasses (*Thalassia, Enhalis*).

The second site, Offshore Ngederrak, abuts the seaward side of the Ngederrak Conservation Area (Fig. 4 & Fig. 8), is significantly deeper than the other three sites, and had a large number of dugong sightings. It is protected from westerly winds by Ngederrak and Lighthouse Reefs and from easterly winds and swell by the eastern barrier and "Sunken Barrier Reef." The depth between the Ngederrak Conservation Area and the Sunken Barrier Reef can reach nearly 70 m (Colin 2009) and seaward of this the depths plummet quickly to oceanic depths. The Offshore Ngederrak site contained 41% of all dugong sightings over the study period and is also where mating behavior was observed from the helicopter. One of the sightings in this area was of over 30 dugongs in a single group (a subset of this particular group can be seen in Figure 1).

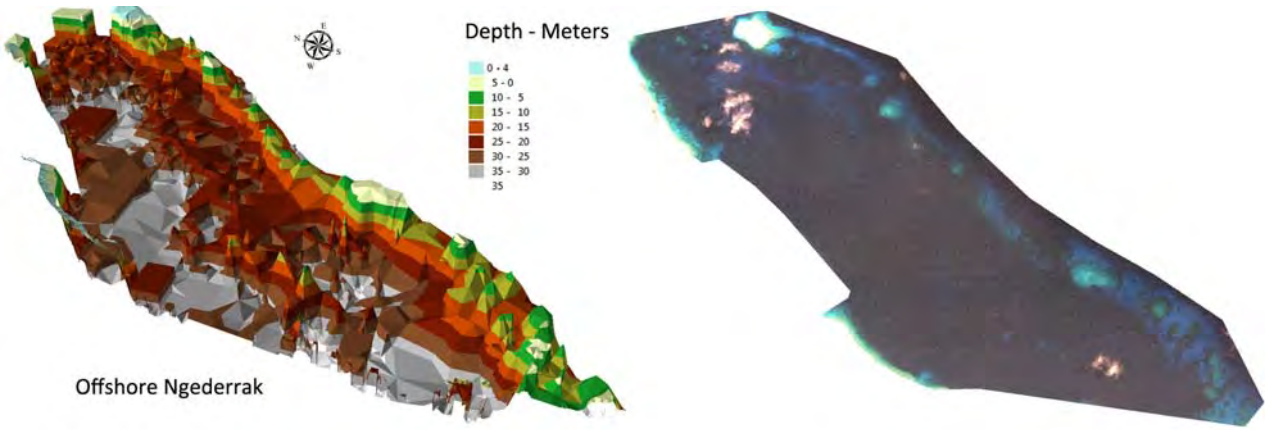

Figure 8. (Left) TIN bathymetric model of Offshore Ngederrak. (Right) Equivalent satellite image of the Offshore Ngederrak site showing the distribution of shallow reefs (light colored patches).

East Malakal Harbor is located abutting the Ngederrak Conservation Area and the West Malakal Harbor site (Fig. 4 & Fig. 9). This area accounted for 11% of the dugong sightings. This site has many areas of 'pinnacles' with deeper water surrounding them, providing potential resting areas for dugongs in the deeper water. Resting behavior has been observed on several occasions from the helicopter as well as by snorkeling and from kayaks. While there does not appear to be any food source immediately within the confines of this site, food is available in close proximity (less than 2 km) at both Ngederrak Conservation Area and West Malakal Harbor.

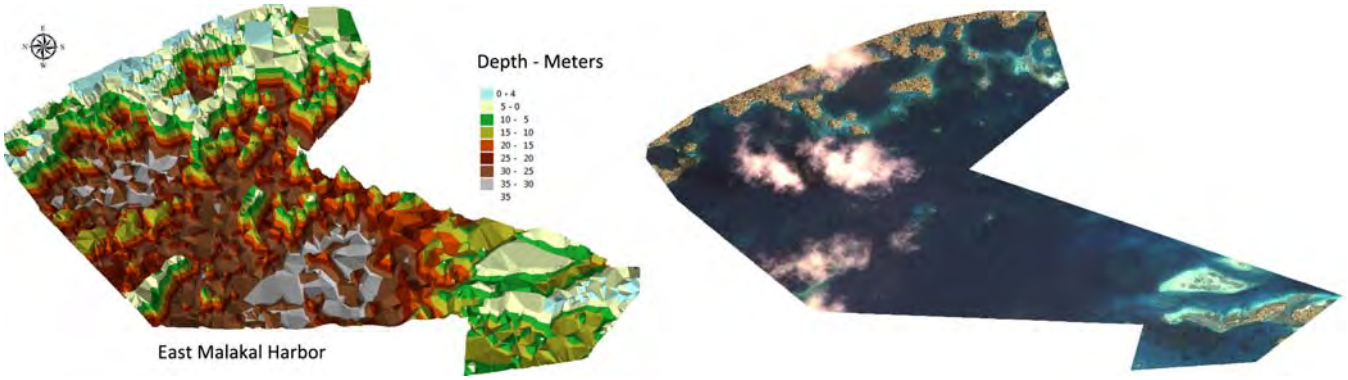

Figure 9. (Left) TIN bathymetric model of East Malakal Harbor. (Right) Satellite image showing equivalent area of the East Malakal Harbor site.

West Malakal Harbor was the second most significant site in terms of number of sightings, accounting for 37% of all dugong sightings (Fig. 4 & Fig. 10). The area has extensive shallow waters with access to deeper water to the north-east throughout its extent. Through in-water validation by SCUBA, it was

determined that the area does contain seagrass, *Halophila* spp., though not in great abundance when compared with the Ngederrak Conservation Area.

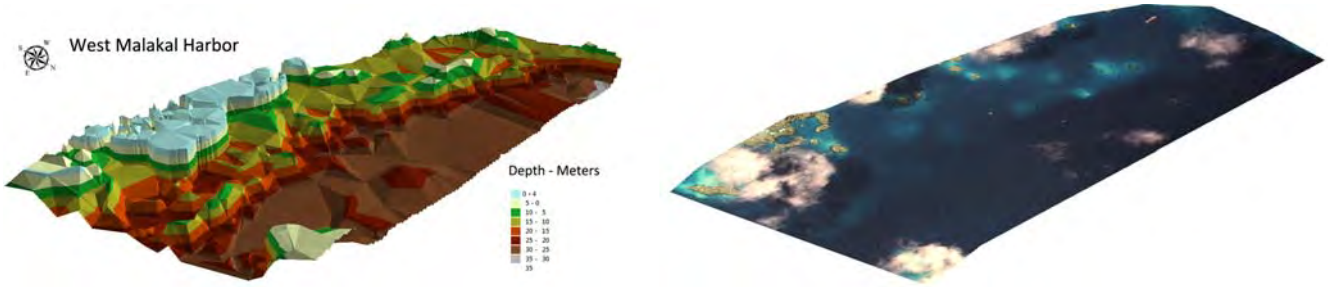

Figure 10. (Left) TIN bathymetric model of West Malakal Harbor. (Right) Satellite image showing the equivalent area of the West Malakal Harbor site.

3.4 Observations of Life History of Dugongs in Palau

The project provided new information on aspects of the life history of dugongs in Palau. One important discovery from aerial photos was the large numbers of dugong feeding trails in the Ngederrak Conservation Area (Fig. 11), and potentially other areas. The dugong feeding trails in the seagrass beds on Ngederrak Conservation Area were confirmed by visiting the site, and observing and photographing these same feeding trails underwater. Such photographs, with appropriate "ground truthing," can provide a broad perspective of dugong feeding, and using historical photos, changes in feeding patterns may be assessed.

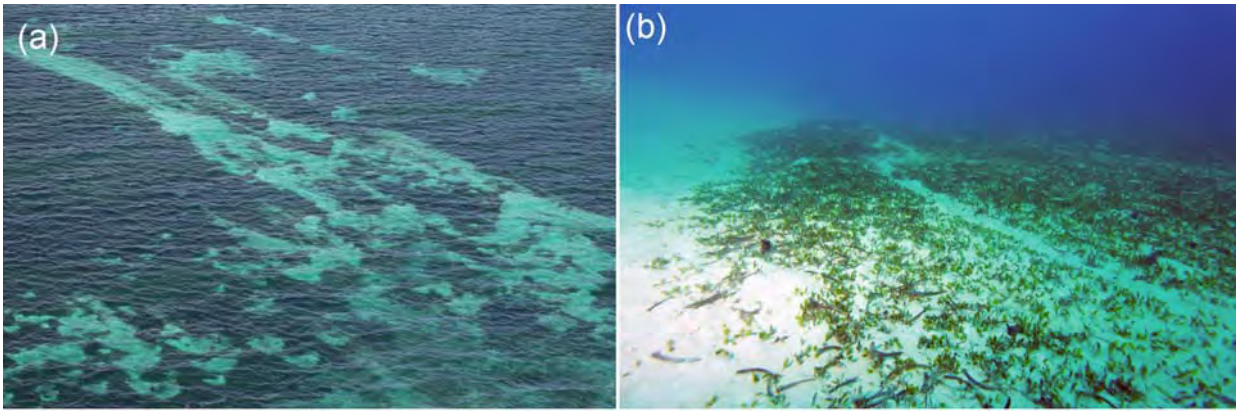

Figure 11. (a) Feeding trails of dugong can cut broad swaths through a dense seagrass bed, such as shown here of the Ngederrak Conservation Area. (b) Underwater view of dugong feeding trails.

A variety of social interactions were also observed from the helicopter. These include movement onto shallow feeding areas, probable feeding of groups and relationships of mothers and calves to other individuals (Fig. 12). The advantages of using a helicopter, as opposed to a fixed wing aircraft which must continually fly forward, are evident in the detailed photos of groups of dugongs over shallow water at the Ngederrak Conservation Area.

Aerial observations were also used to validate reports from fishermen about resting areas where dugong "hang out" without feeding (Fig. 13). Six “resting areas” have been identified in the Malakal Harbor area, surprisingly close to the commercial port and in areas with significant small boat traffic. All six presumed ”resting areas” have a similar reef morphology: a shallow reef area adjacent to a sandy bottom (where the dugongs actually rest) of moderate depths (9-12 m), dropping off into deeper water (30 m).

Figure 12. Feeding activities of groups of dugongs in shallow water in the Ngederrak Conservation Area were observed from the helicopter during dedicated surveys. (a) A group of seven dugongs moving in shallow water. (b) A group of multiple dugongs submerged, possibly feeding. (c) A group of dugongs over reef. (d) A mother and calf in the feeding area indicating such pairs likely remains close together when feeding.

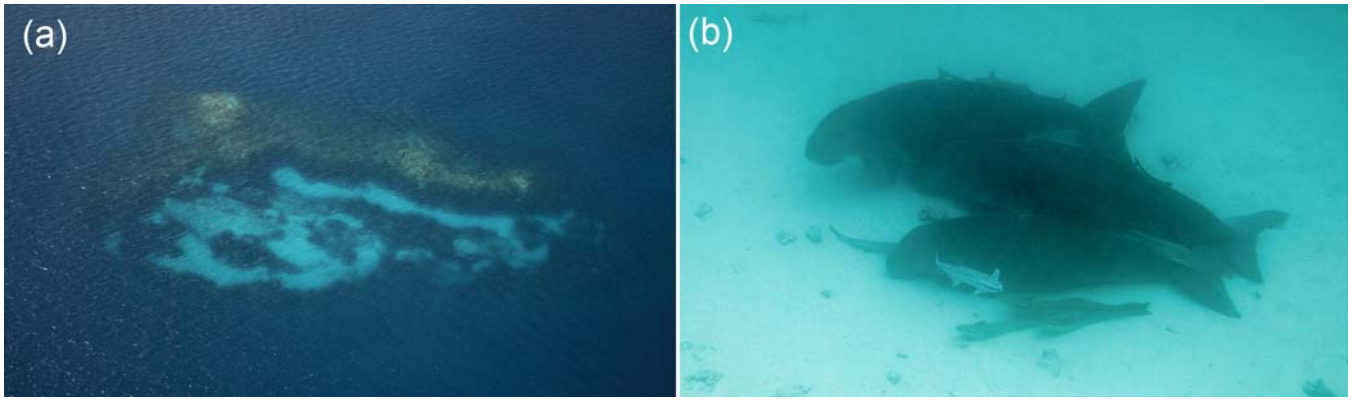

Figure 13. (a) This shallow reef (aerial photo) in Malakal Harbor is a known "resting area" for dugongs; they may remain in the area for hours, often "resting" on the sandy bottom. (b) Underwater photo of three dugongs "resting" close to one another in mid-day.

Present observations indicate dugongs in Palau tend to dive when they hear an outboard boat approaching. Given the known number of dugongs found in Malakal Harbor and its high boat traffic, this reaction to boats is probable, as boat strikes of dugong in the harbor area are rare.

The behavior of dugongs in deeper water is quite interesting. Based on sightings, dugongs are believed to regularly transit between the Sunken Barrier Reef area of the Offshore Ngederrak site to the shallow Ngederrak Conservation Area and other nearby sites (Fig. 14). They move in groups over water that is relatively rough and as much as 70 m deep without any areas of seagrass. Offshore Ngederrak, where mating has been seen (below), does not have any shallow feeding areas and it is not know if dugongs frequent these areas at times outside of feeding periods.

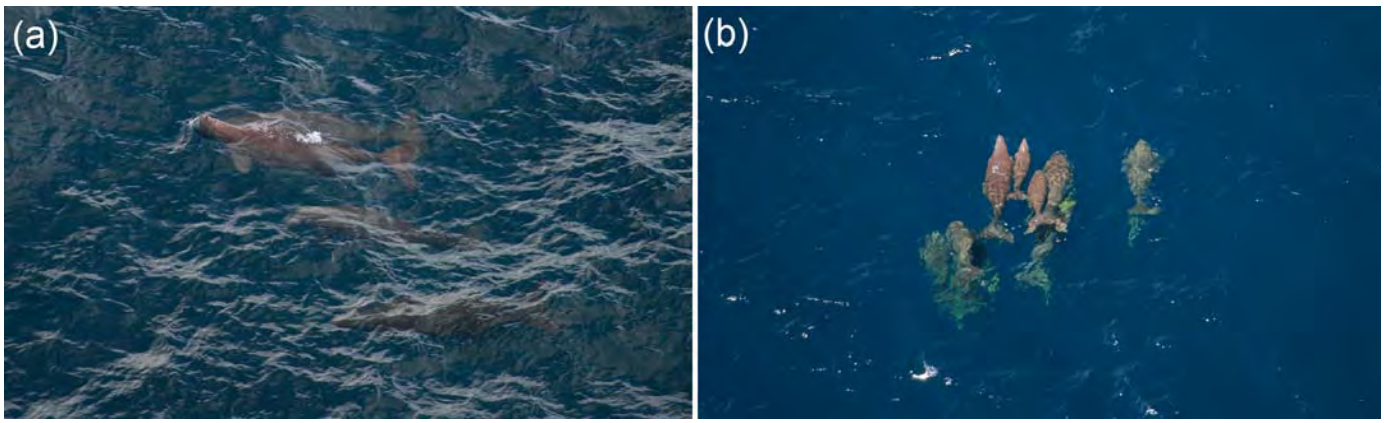

Figure 14. (a) Dugongs on the surface in deep water often occur in the area near the "Sunken Barrier Reef", a few km offshore of their feeding grounds (shallow reefs with large seagrass beds). The water in such areas is often relatively rough, compared to protected coastal lagoon areas. (b) This group of apparently 9 individuals, plus a number of remoras, was found over deep water (at least 60 m depth).

As indicated previously, mating behavior was photographed on four days in 2010 (Fig. 15). At the Offshore Ngederrak site: 30 Aug 2010 at 10:15 AM (high tide, 2 days before quarter moon), 1 Oct 2010 (quarter moon), 8 Oct 2010 (new moon); and near Malakal Harbor on 28 Nov 2010 at 12:45 PM (high tide, 1 day before quarter moon). Group mating, known from other geographic locations, was not seen. Actual mating was seen in two separate pairs of animals. During the courtship males were seen swimming upside down and flapping their tail on the surface, known as lob-tailing. Marsh et al (2011) describe the mating of dugongs in detail. The photographs of dugong mating from Palau are of such high quality that they have been used in a variety of publications. The use of a helicopter allows detailed images such as these to be taken, which would be impossible from a fixed wing aircraft.

Figure 15. Mating behavior of dugongs was photographed for the first time in Palau in 2010. It was observed on three occasions near the Sunken Barrier Reef and once near Malakal Harbor.

4.0 Discussion

4.1 Aerial Surveys

Because flights were concentrated in the area just south of the town of Koror, the flight lines and dugong observations were not random. The data can provide information on the occurrence of

dugongs within the areas regularly overflown, but little can be said regarding the majority of the marine areas of Palau that were not part of these surveys. For example, the lagoon north and west of Babeldaob, as well as the small lagoon to its southeast, represent about 85% of the lagoon area of Palau and approximately 55% of the fringing and barrier reefs. Virtually no surveys have ever been done in these areas for dugongs, although dugong populations are known to fishermen and poachers.

Previous surveys dating back over 30 years (Table 2) also found dugongs in close proximity to Malakal Harbor. It is not possible to directly compare numbers, however, between surveys due to differences in type of aircraft, survey methods and level of observer experience. The present survey provides greater documentation of locations of dugongs observed, which should aid in making future surveys more comparable.

Table 2. Comparison of flight details for eight aerial surveys (1 - Brownell et al (1981), 2 - Rathbun et al (1988), 3 - Marsh (1995), 4 - Smith (1998, unpublished data), 5 - Smith (2003, unpublished data), 6 - Smith (2003), 7 - Kitalong (2007) (Heli = helicopter).

Year	1977[1]	1978[2]	1983[3]	1991[4]	1998[5]	2003[6]	2007[7]	2009-2010	2011
Dates	Dec 2-3	Dec 11-15, 17-18	Aug 19, 21-24, 26	Aug 5-8	Oct 26, 29-30	Mar 8-10	Sep 5-7, Nov 29	Oct - Dec	Jan-Mar
Tidal Phase	Neap outgoing	Spring	Spring	Spring - incoming	Neap	Neap outgoing	Neap incoming	All	All
Aircraft Type	low wing	high wing	high wing	high wing	high wing	high wing	Heli	Heli	Heli
No. of observers	4	usually 3	3	4	03-Jun	usually 5	4	usually 2	usually 2
Observer experience	High ?	High ?	High ?	Very high	low	low-med	low-very high	very high	very high
Altitude (m)	275	275	150-300	275	244	198	208	200	200
Air speed (kph)	120-130	115-145	170	200	204-213	185-204	137	120	120
Sea state	n/a	Fair - excellent	Beaufort 0-2	Beaufort 1-3, 5	Beaufort 2-3	Beaufort 1-3	Beaufort 1-3	Varied	Varied
Cloud cover	n/a	<5-100%	0-80%	Generally overcast	30-75%	25-75%	0-100%	Varied	Varied
Observation time (min.)	304	1013	905	469	367	535	370	14 flights	8 flights

4.2 Site Profiles

The four sites found to have regular occurrence of dugongs differ from one another, and may be important in different aspects of dugong behavior and activity. The areas are relatively close to each

another, and dugong can easily swim from one area to another in periods of a few hours at most. From present sighting data it is apparent that the Malakal Harbor area (East and West), Ngederrak Conservation Area and the deep water seaward of this, Offshore Ngederrak, continue to be important residence and feeding areas for dugongs in Palau. The characteristics of each area will be briefly examined and then the four sites compared.

Ngederrak Conservation Area

This is a shallow platform (Fig. 7) bounded on all sides by water 15 m or deeper. Because of its shallow nature, the benthic habitats have been mapped and there are distinct boundaries between major types of habitats (Fig. 7). The south corner of Ngederrak Reef is evidently an important feeding area for dugongs, as indicated by the presence of probable feeding trails in shallow sea grass beds (Fig. 11). The exact shape, location and area of these feeding trails have changed over periods of days to months, indicating active feeding has been occurring during the survey period. Low level aerial photos dating back to 2006 also indicate the presence of feeding trails. Earlier aerial photos and satellite images do not have sufficient resolution, hence no information can be garnered from these sources. Note that at spring low tides the sea grass areas would be very shallow (and exposed to air in some areas of the site), making it impossible for dugong to forage or even swim through these areas at or near low tides. Whether dugong occurrence at these sites is correlated with mid- to high tides could be a subject for future investigation.

Why this site has remained an important foraging area for dugong is an interesting question. Through previous studies of the Malakal area (Davis 2003, Collins 2010) it is known that Ngederrak Conservation Area has extensive seagrass meadows of *Thalassia* spp. and *Halophila* spp., the preferred food of dugongs. In addition to aerial photo evidence, *in situ* field work has identified many feeding trails within the conservation area and the ground work has been laid for continued detailed monitoring of these feeding trails.

These presumed active feeding grounds at Ngederrak also have a close proximity to the deeper water at the front of the reef, as well as the channels to the sides. Other areas of Ngederrak Reef may also support feeding and similarly have deeper water close by the sea grass beds. One potentially important result of the present studies is that aerial sightings were limited to the southern shallow corner (Fig. 4).

While these sightings are not conclusive evidence for a preference of dugongs to occur in this area, it does indicate this area should be carefully monitored in future aerial surveys or, perhaps, through other means such as remote cameras or alternate survey methods.

Offshore Ngederrak

The site designated Offshore Ngederrak contained the greatest number of sightings throughout the study period. It is essentially a deep water basin, reaching about 70 m depth close to the Ngederrak/Lighthouse Reef front, then gradually sloping upward to a sill reef (called the "Sunken Barrier Reef" - see Colin 2009) with 6 to 15 m depths at its seaward edge (Fig. 8). However the area is believed to contain little to no available food sources for dugongs (seagrasses). It is the deepest of the four sites detailed here and many of the sightings were made of individuals and groups adjacent to shallow reef patches that occur on the Sunken Barrier Reef. Figures 3 and 4 may not show an accurate representation of the distribution of dugongs within this site because much of it is open water where the pilot/observers were not able to place the position of dugongs relative to a reef or other landmark.

Most of the sightings in this site were generalized by the pilot as resting behavior on the surface. As the water is deep in much of this area, if a dugong dives it quickly becomes invisible to an observer in an aircraft, hence only those dugong on the surface would be easily seen. The dugong observed around the sunken reefs did not appear to be swimming in any specific direction with any speed. As was indicated for the Ngederrak Conservation Area, where sea grass beds are too shallow for foraging at low tides, perhaps these offshore areas represent resting areas where dugong remain during periods of low tides when feeding is not possible. This Offshore Ngederrak site is, however, close to the extensive seagrass beds located on the fore-reef of the Ngederrak Conservation Area, a distance of about 3-5 km. Dugongs could cover this distance in perhaps as little as 10-15 minutes.

Importantly, this area is the only location where mating behavior of dugongs was observed. Mating was photographed from the helicopter on three occasions in October and November 2010, and was observed on several other occasions by the pilot: always a single pair of dugongs, and always at the same location. The photos were shown to Dr. Helene Marsh who confirmed the mating behavior,

which has previously only been known and photographed from Thailand. Only group mating (3 or more individuals) has been observed to date in Australia (Marsh pers. com.).

East Malakal Harbor

The East Malakal Harbor site, another area with numerous sightings, does not conform to the same topography (see Fig. 9) and habitat type as the other three areas. It is characterized by large areas of deep water (15-35 m depth) with areas of shallow reef and sediment bottom scattered throughout the area. While the total number of sightings in the area is smaller than any of the other three sites, the greatest number of sightings here were recorded close to a reef rising from approximately 34 m deep with a sandy substrate to within 11 m of the surface. There are sand channels within the reef and all around there is the potential for escape to deep water. Dugongs have been regularly photographed and observed resting on the bottom here, and in several nearby spots with similar topography, from 2009-2011. These may represent traditional meeting and/or resting points (Fig. 13)

West Malakal Harbor

The West Malakal Harbor site has moderate to shallow depths and is bounded by rock islands along much of its extent (Figs. 4 & 10). Numerous dugong sightings were made in this area, often relatively close to the rock islands (Fig. 4). It appears that seagrass foraging habitat is possibly present in this area. A number of SCUBA dives made at this site to establish the habitat type indicated areas with *Halophila* seagrass (though not in great density); however, no beds of *Thalassia* were found over the course of three dives. Potentially the area is used for resting. The bathymetry in the areas investigated was shallow, with sandy bottoms, but within close proximity to deeper water (see Fig. 10).

Other areas of the southern lagoon

As Figures 2 and 3 indicate, flights were occasionally made from Koror to areas in the southern lagoon, as far south as the Ngemelis reef complex. Dugongs were only seen sporadically during these flights, with several sightings made along the inside and outside of the islands between Blue Corner and New Drop Off (Fig. 3). While far from definitive, it is likely that dugongs are not as common in the Ngemelis area as they are in the proximity of Malakal Harbor.

4.3 Daily Activity Patterns

Surveys were conducted only between 8:00AM and 5:00PM, as this was the time the helicopter made flights, hence there are no data for periods outside of these times. In 2010 campaign interviews, former dugong hunters said they would hunt resting dugongs during the full moon at around 9 PM when the moon was out, and wait for dugongs to surface around known resting sites. At certain times the dugongs came close to shore at night near mangrove areas; the fishermen believed they were feeding on sea cucumbers. Sheppard et al (2009) noted in Australia a propensity for dugongs to come close to shore in the evening and at night, perhaps as a result of the decrease in boat traffic. During interviews, fishermen in Palau stated that they see more dugongs late in the evening and at sun rise (Kitalong 2008).

Due to our data collection methods, the average number of dugongs per flight was equivalent to the average group size of dugongs. While most dugong surveys found only moderate numbers of individuals, two surveys were unusual in the number of dugong seen. On 20 October 2010 and 28 November 2010, groups exceeding 30 individuals were seen. Despite these large groups, the average group size of Palau dugongs, 4.75 animals per group, was similar to that from aerial surveys of dugongs in the Lease Islands, Indonesia, where the mean group size observed was 2.5 to 3.0 animals (De Iongh et al 1998).

4.4 Foraging Locations

The south corner of the Ngederrak Conservation Area was the only confirmed area identified as an important foraging site. This location has dense seagrass of preferred species over a sizeable area, and deeper water is close by. Depth data indicates it is unlikely that dugong could forage in this area during the lowest tides, and this factor might potentially affect their daily activity patterns.

The association of feeding grounds with nearby deeper waters has been noted for other dugong populations. Chilvers et al (2004) believed that dugongs in Australia preferred feeding areas adjacent to deep water, potentially for escapes when threatened by tiger sharks (*Galeocerdo cuvier*), a known predator. The Palauan dugong population may be exhibiting a similar choice in feeding habitats relative to natural predation, and potentially even from learned responses to human hunting pressure.

The majority of the sightings were within close proximity (within ~2-3 km) to extensive seagrass beds located within the Ngederrak Conservation Area. However, current remote sensing work has shown that the area of seagrass on the fore reef of the conservation area has significantly decreased between 2001 and 2010 (Paul Collins, unpublished data). This ongoing work aims to quantify this habitat loss and also evaluate if there has been any significant shift in habitat types within this period. This will have implications for the dugong population as previous studies have shown that a local population can experience a significant decline due to extreme weather events that cause a die off of the seagrass beds (Marsh and Lawler 2006). While this change in habitat type appears to be a gradual decline and not related to an extreme weather event, if the seagrass beds within the conservation area continue to decline there will be less available food source. This may facilitate a shift to other areas in Palau where there is available food, or a decline in the overall population. In addition, studies of the dugong population in the Torres Strait Islands concluded that the life history and reproductive rate of female dugongs are adversely affected by seagrass loss, with less births during times of less available food source which could have a severe impact upon a population like that of Palau, assumed to be relatively small (Marsh and Kwan 2008).

While the Ngederrak Conservation Area contains the most extensive seagrass beds within the survey area it is surprising that this area only accounted for 6% of the overall dugong sightings. This may be a reflection of the area being a potentially significant feeding ground, as studies in Australia by Sheppard et al (2009) have concluded that dugongs prefer to visit shallow feedings areas which are closer to shore late in the afternoon and the evening. As the helicopter was not operational during these hours, no data is available for these times.

5.0 Conclusions and Future Work

Previous surveys in Palau have highlighted the precarious position that the dugong population occupies in terms of its long term viability, and have highlighted the need for legislation and actions that will aid in the protection of this isolated local population (Marsh 1995, Davis 2003, Kitalong 2008). The findings presented in this report provide similar cautions about the long term prospects for the survival of dugongs in Palau. During the present survey period, several instances of active dugong hunting and mysterious deaths of dugongs have both occurred. Despite laws prohibiting the capture, possession and sale of dugong meat and body parts, a dangerously uncertain level of mortality continues to occur.

In the 2010-2011 interviews with fishermen and dugong poachers, it was estimated that between 5-15 dugongs are still deliberately killed each year for food. The fishermen do not fear prosecution, despite the penalties associated with dugong hunting or capture, due to a lack of enforcement. The potential gain, with prominent politicians and businessmen ordering the meat, is as much $2,500 per dugong. If just the known deaths of dugongs in Palau are considered (and there may well be more deaths that are not known or reported), with a likely total population of only few hundred animals in Palau, the population may not be sustained and may be decreasing at an uncertain rate.

While some of the data presented in this report show what appear to be trends (such as differences in the number of dugongs seen with tide or lunar phase) the assumption that such trends are fact is not warranted given the limitations of how the data were collected. Because most observational flights were not dedicated to gathering data, but rather information was gathered on an "ad hoc" basis on tourist flights, there are very few absolute conclusions that can be drawn from the type of information available.

On a more positive note, the limited number of dedicated survey flights made as part of this campaign provided a wealth of new information on the occurrence of dugongs, their movements, and aspects of their life history, much more than had been obtained from any previous survey. The photographs taken are an equally important achievement; some photos are unique (such as mating photos) and are attracting interest and attention from dugong researchers and conservationists worldwide. They are a valuable tool in raising awareness for a rarely-seen marine mammal.

The dedicated flights produced valuable data that can be replicated in future efforts for comparison. The data show that a "significant" number of dugongs are still present in the survey areas. In addition, the defined flight paths allow for future comparison of numbers observed, as long as surveys are conducted during the same tidal and lunar phases. The four sites are now documented and can be compared in any future aerial work. In the absence of a survey aircraft, the campaign has also indicated numerous areas where continued information can be gathered on dugong biology in Palau.

In addition to increasing knowledge of dugong biology, another important element in any overall evaluation of the size and future of the Palau dugong population would be to map all of Palau's seagrass beds using highly-accurate remote sensing technologies (Collins 2010). In addition to the habitat mapping, if accurate bathymetry were obtained it would allow analysis, within a GIS System, that could identify areas conforming to a similar profile as the four sites described herein (eg. access to deeper water coupled with proximity to an abundant food source). These areas could then be 'ground truthed' to verify if feeding trails were present, and through this systematic process other potentially important dugong areas could be identified. This research could provide data for consideration by national and regional governmental bodies when determining new protected areas.

The use of a helicopter for surveys over a period of many months has provided valuable insight into the Palau dugong population. The slower speed of a helicopter, relative to fixed wing aircraft, allows more careful inspection of areas, and a helicopter's ability to stop, hover, and turn sharply are all positive factors in obtaining high quality data and photographs. It is unfortunate that Palau no longer has a "resident" helicopter, and in the future it appears only "helicopters of convenience" (such as those found on military vessels or super-yachts) may be available for surveys.

It is clear that during the surveys a population on the order of 30 to 50 animals was documented at one time within the sites most intensively surveyed. It has established that the remaining population is actively breeding, as a total of 53 calves were seen (over 140 days - some calves may have been seen more than once during the survey), as well as photographing females with young on numerous occasions (Fig. 16). The importance of Malakal Harbor and nearby areas as dugong habitat and nursery grounds must not be overlooked.

To date there has not been a prolonged and scientifically rigorous study of the Palau dugong population. Most studies have been short in terms of their temporal range and there has been little concerted effort by national government agencies to develop, implement or fund any long term studies. This needs to change if the long term welfare and survival of this enigmatic animal is to be assured. There have been some excellent recent examples of dedicated conservationists securing funding for awareness campaigns and studies such as the one presented here. However, as has been

highlighted, quite often these lead to more questions that need answering, which requires further scientific study.

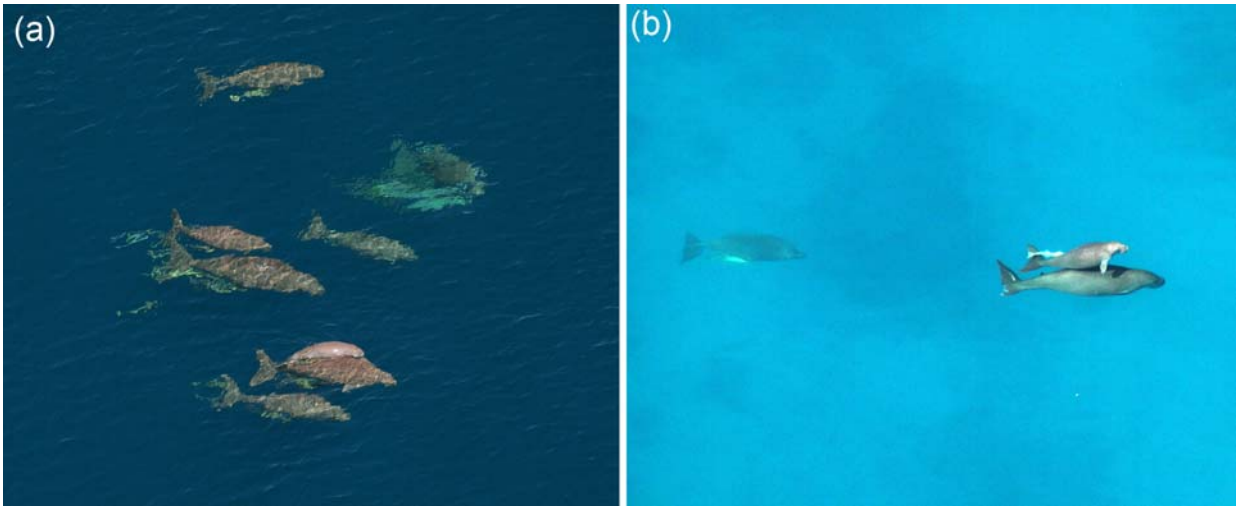

Figure 16. The occurrence of dugong calves in Palau is an encouraging sign, however, their populations build very slowly (estimate 5% a year in the absence of hunting pressure). Hunting and other mortality can easily prevent the population size from increasing and cause it to decrease rapidly. Dugong calves are known to cling to, or ride on, their mother's backs, as seen in (a) and (b).

If the dugong population in Palau is to survive and hopefully increase in the future, there needs to be greater ownership of the effort, funding, research and reporting of findings. This will require a strong stance from the national and regional agencies, as well as external expertise which can be translated into capacity building for aspiring Palauan researchers. Palau will be a much poorer place if it loses this critically endangered species through a lack of commitment, expertise and funding for further research.

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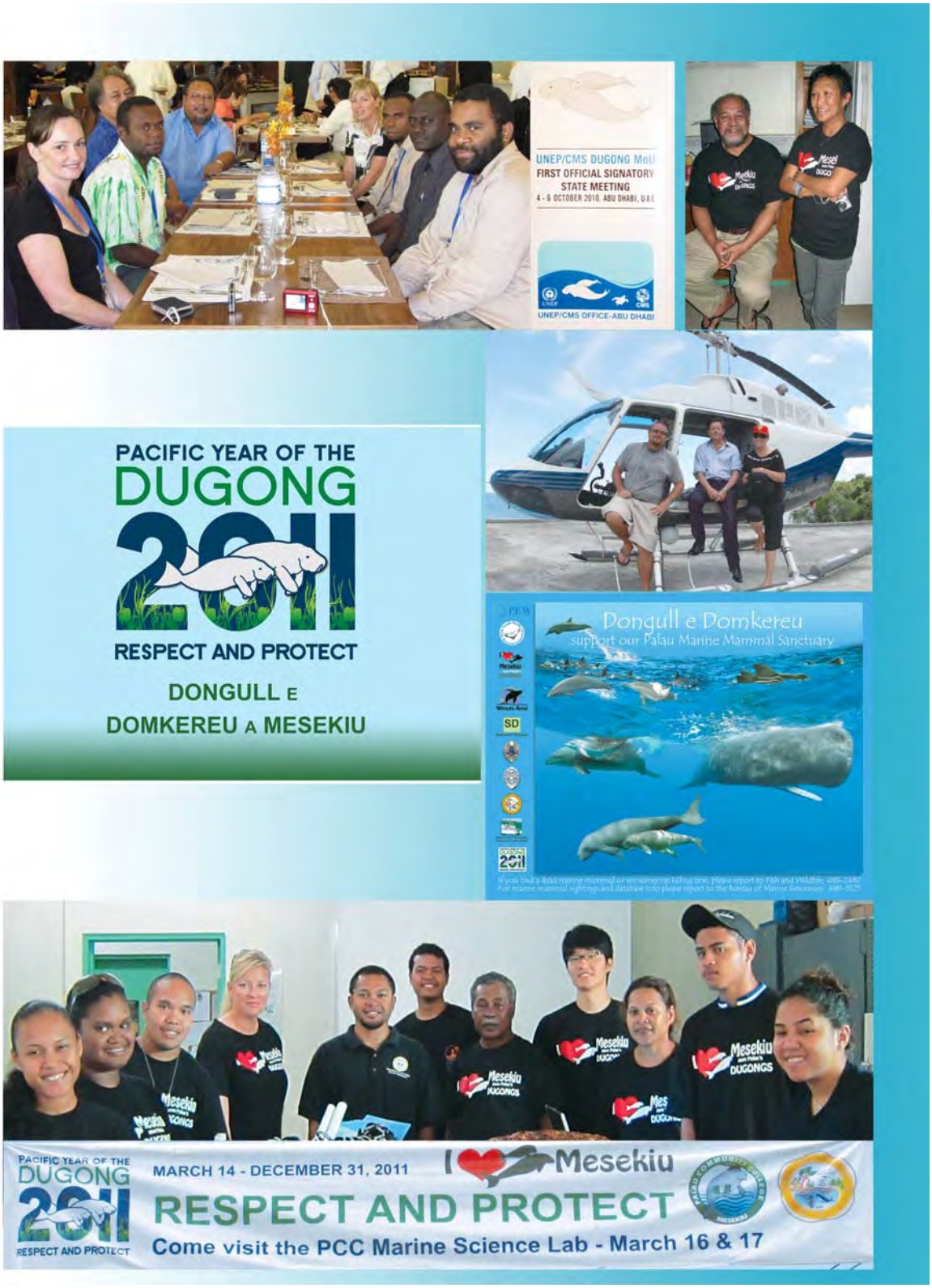
Appendix I. Educational and Promotional Materials from Dugong Awareness Campaign



Appendix I. Educational and Promotional Materials from Dugong Awareness Campaign

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who is killing them?

$5,000.- REWARD

for information
leading to the arrest and conviction of
persons responsible for the recent killings
of Dugongs/ Mesekiu in the waters of
Ngardmau, Koror and Airai

Call
488- 2487 or **488- 2423**

Bureau of Public Safety
Division of Fish & Wildlife Protection

I ♥ Mesekiu
save Palau's
DUGONGS

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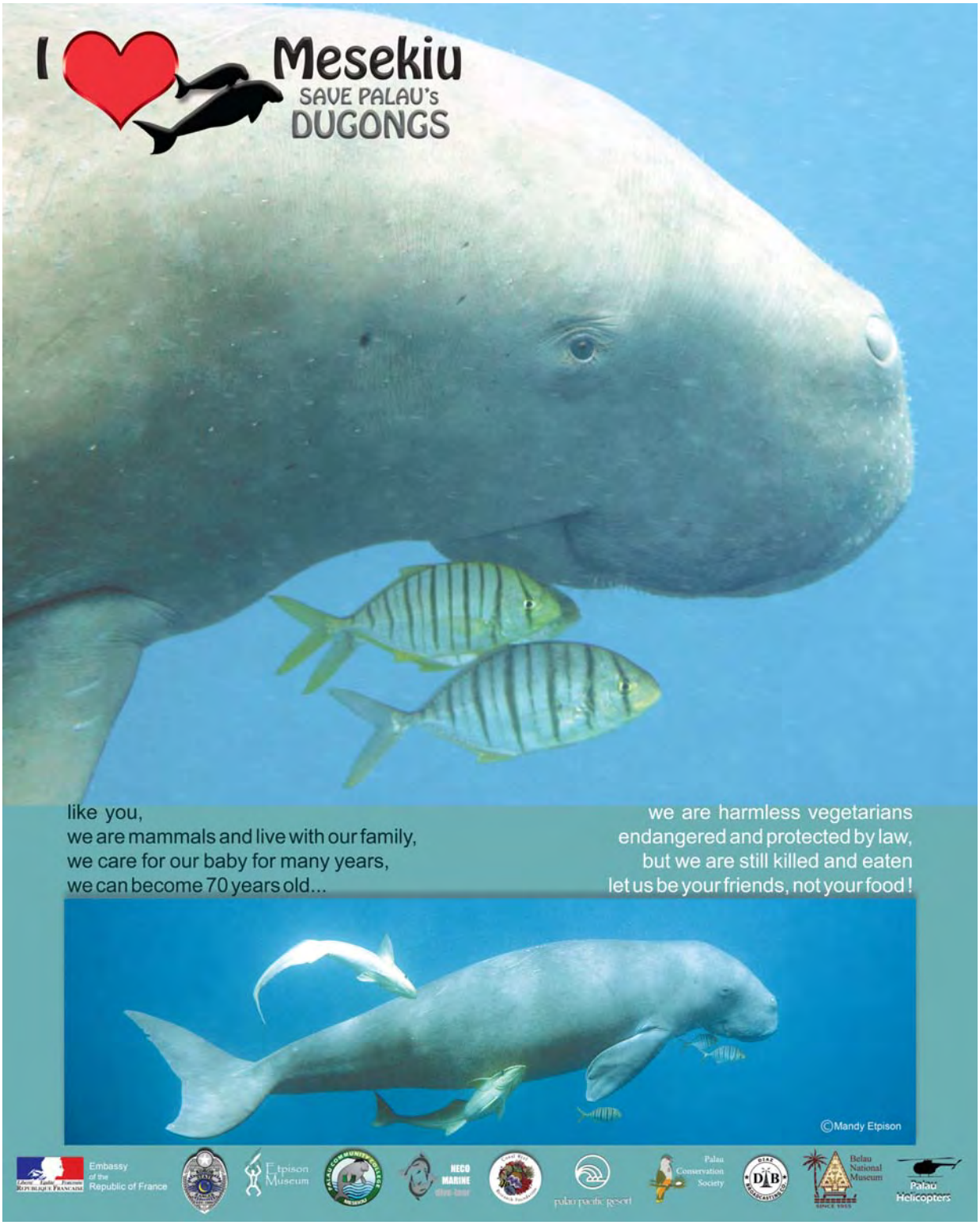
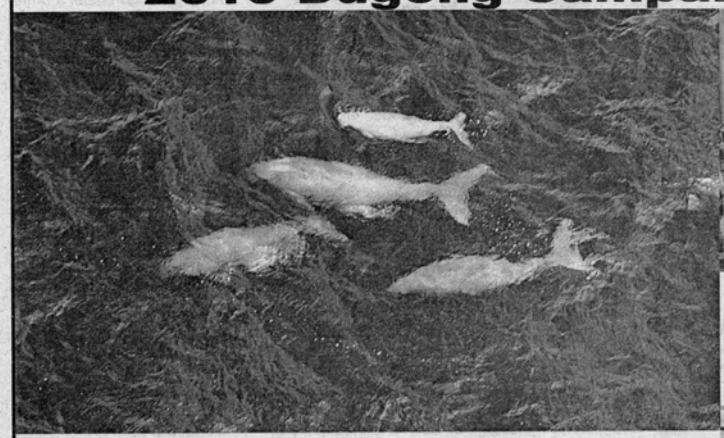
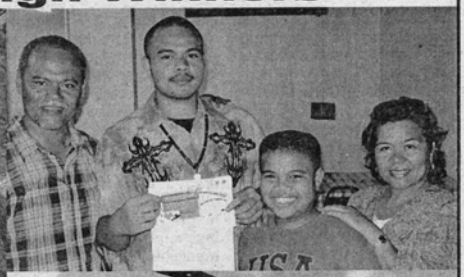


Appendix II. Newspaper Articles from the Dugong Awareness Campaign

2010 Dugong Campaign Winners





1st prize winner Gem Petrus (11)(bottom right) and Biusech Tabelual (18)(top right), of the 2010 Dugong Campaign drawing and essay contest, went up for their first helicopter ride on March 20 with pilot Matt, donated by Palau Helicopters, and were able to observe 12 different dugongs around the Koror harbor area, adults with several young calves (top). Proud parents and brother of Biusech (top right).

Photographs by Mandy Etpison

2010 Dugong Campaign Contest Winners

***Grand Prize winner Drawing Contest*: Gem Petrus**

***Grand Prize winner Essay*: Biusech Tabelual**

Prizes are a Helicopter Ride, T-Shirt and Palau Books

The Following Students are the runner-ups for the drawing contest, who will receive a Palau Books.

1. Jeradeen Subediang
2. Notwe-Ruth George
3. Hazel Metes
4. Ally Iyechad
5. Koteb Aulerio
6. Shaun Rengull
7. Jewel Baustor
8. Shan-Dy Tevid
9. Jermiah Rubario
10. Romalanie Turang Marino
11. Pethahiah Masters
12. Jay-C Tangelbad
13. Hulda Dilmei Terion
14. Emaraldil Renguul
15. Allison Allen
16. McClina Angelino
17. Cherry Steven
18. Kato Remeliik
19. Elab Towai
20. Maria L. Ichiro
21. Alex Bmaw
22. Leilua L. Gardner
23. Madrey Polloi
24. Bao Tellei
25. Waydel Tomei
26. Diluey Takawo
27. Misao Graidy
28. Ailan Flowers

This contest is part of the 2010 Dugong Campaign, sponsored by the Palau Pacific Resort, Palau Community College, Palau Conservation Society, NECO Marine Dive Tour, Coral Reef Research Foundation, Etpison Museum, Diaz Broadcasting, Belau National Museum, Palau Helicopters and the Embassy of France.

UAE to assist Palau in dugong protection

By BERNADETTE H. CARREON
Horizon News Staff

THE United Arab Emirates has expressed interest in assisting Palau in the protection of dugongs.

Mandy Etpison, proponent of the Dugong Awareness campaign in the country said that UAE will be giving a technical assistance grant to Palau for this effort.

Etpison said this resulted from the visit of Sheikh Abdullah bin Zayed Al Nahyan to Palau in February of this year.

Abu Dhabi has a large population of dugongs, unlike Palau, which has the smallest most isolated population in the world, she said. With this, Etpison Museum master carver Rico Soliman is working on a 12- foot high mahogany statue of a dugong with two calves.

Rico has been in Palau since 1982 and is a respected by other Palauan carvers for his work. Rico started out working for Roman Tmetuchl at the Airai View, then transferred to work for Ngiratkel Etpison at the Royal P Shell Museum in the 1990s, and for the last ten years he has been employed by the Etpison Museum.

Etpison Museum master carver Rico Soliman is working on a 12- foot high mahogany statue of a dugong with two calves. Contributed photo

The life-sized dugong carving will be displayed at the entrance hall of the Minister of State's office in Melekeok in August for the next two years, after which it will be displayed at the Palau Pacific Resort and the Etpison Museum.

The carving, Etpison said is part of the 2010 Dugong Awareness Campaign.

The aim of the campaign is to attract attention to Palau's most endangered marine mammal species. Although protected by law, local poaching remains a problem.

It was learned that local fishermen still hunt these creatures using spears, nets and dynamite, and admit Palau's traditional chiefs order dugong meat from them for special occasions.

The Campaign is locally sponsored by PPR, the Etpison Museum, Neco Marine, Diaz Broadcasting, and Palau Helicopters, and is a special project for the Palau Community College Marine Science class.

The Koror State Rangers, Belau National Museum, Bureau of Marine Resources, Coral Reef Research Foundation and Palau Conservation Society are also giving its hand to the cause.

A grant to support the project with helicopter and boat surveys and publication of a report/booklet on Palau dugongs has been approved through the French Embassy in Manila and is awaiting signature.

Appendix II. Newspaper Articles from the Dugong Awareness Campaign

EDITORIALS

April 23/2010

Stop the killing

Some unthinking idiots are blowing up our reefs with dynamite, and they need to be stopped. They also need to be prosecuted and thrown in jail.

We suspect the culprits are actually dynamiting schools of fish, not knowing there are Dugongs in the vicinity but the destruction is indiscriminate and destroys much more than just the fish.

Earlier this week, a fourth Dugong was found floating in Airai waters, the latest victim of this senseless practice that seems to be on the rise. Officials have pulled out at least four dead animals since January and medical evidence point to dynamiting as the cause of at least two of the cases.

This rare mammal is found only in Palau in all of Micronesia and is on the protected animals list. The French recently gave us money to help in its protection, and that's why Mandy is really ticked off that people are killing them.

Dynamite casings have been recovered and traced to a quarry company, but it seems to have stopped there. Evidently someone is getting their hands on the explosives and using them to kill fish, coral, Dugongs and all kinds of marine life. Unless it is stopped, this indiscriminate destruction of our marine resources will be our ruin.

The Ministry of Justice is offering a reward for any one who provides information on those responsible for the deaths of these highly endangered species but more needs to be done. The OEK needs to impose stricter penalties for any one found killing Dugongs and enforcement needs to be beefed up.

If someone knows that the dynamite was obtained from a quarry operation, the investigation should go further and determine who actually stole, sold or used it to "fish."

Fish markets also shouldn't buy suspected dynamite catch, and in fact can assist in the investigation by reporting fishermen they think use dynamite.

What prompts adults to throw bombs in the ocean is beyond us, but unless the government shows it is serious about putting an end to this practice, it will continue.

Thank You

Island Times

Fermin Meriang
Editor

Peter Erick L. Magbanua
Reporter

Dugongs found dead

Lifeless dugong found inside of Mekeald bay

This lifeless female dugong was discovered floating inside the bay of Mekeald on April 2nd, 2010. An autopsy was performed by Koror State Clinic Veterinarian Mihnea Mure Sanu, assistant Sherman Sato, Heather Ketebengang of the Palau Conservation Society and 1st Lt. Katrina Babelko who is a medical officer with the U.S. Army CAT Team.

A lifeless female dugong was discovered floating inside the bay of Mekeald on April 2nd, 2010 around 10:30am. With no clear signs of the cause of death, an autopsy was performed by Koror State Clinic Veterinarian Mihnea Mure Sanu, assistant Sherman Sato, Heather Ketebengang of the Palau Conservation Society and 1st Lt. Katrina Babelko who is a medical officer with the

see Lifeless p. 10

Lifeless...

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...area with no clear indication of whether these deaths are related to contact the Koror State Department of Conservation and Law Enforcement at 488-2150 if any dugong is found injured or dead. Appreciation goes out to all the agencies involved in the entire operation.

Another dugong found dead

On April 19, at 1.30 PM, Chief Ngiraked Robert Ngirebleluu called the Airai State Rangers to report a dead dugong floating at the Ngerkedelukl area. Airai State Rangers reported it to Fish and Wildlife, and brought the dugong to the dock area the next day.

Division of Fish and Wildlife officers from the National Government, Airai State Governor Vicky Kanai and her staff from the Airai State Department of Conservation and Marine and Coastal Management, Mrs. Mandy Etpison from the 2010 Dugong Awareness Campaign, and the Koror State vet Mihnea Muresanu all came out to check on the dugong on April 20 before it was taken from the water to be buried. The dugong was too decomposed to do a necropsy, but the cause of death was an obvious spear gun wound on its back. The dugong was a 310 cm long adult male and had been dead for probably 4-5 days.

Airai State Governor Vicky Kanai said she plans to bury the animal and will preserve the bones later for public awareness and educational displays. She also mentioned the need for a responsible agency to be in charge for people to report dead dugongs to, this would enable Palau to get a better idea and more accurate reports on how many dugongs are killed each year. There also seems to be confusion about which agency is well equipped and is in charge of disposing the dead animals, especially dead dugongs that are reported. According to reliable sources, often the animals are buried or taken away without any reports or efforts to determine the cause of death. This is the fourth dugong reported so far this year believed to be killed by illegal fishing/hunting. *(Airai State Press Release)*

Dead dugong floating at the Ngerkedelukl area. The dugong was too decomposed to do a necropsy, but the cause of death was an obvious spear gun wound on its back.

Appendix III

2010-2011 Dugong Awareness Campaign

488- 6730 Fax 488- 4718 etpison@palaunet.com

DUGONG SIGHTING FORM

PALAU HELICOPTERS

Date:_____

Time of observation: _____AM/PM Moon/ tide: _____

Total # Dugongs seen:_____ # Dugongs swimming together:_____

calves:_____ newborn _____ larger sized calves

O Idling **O** On the move

O Inside lagoon **O** Open ocean **O** Sandy bottom **O** Reef

O Harbor area inside **O** Outside Lighthouse Channel **O** Airai

O Other:_____

O Unusual behaviour or feeding: _____
_____