

**An Assessment of
Dugong (*Dugong dugon*) Resources
in the
Autonomous Region of Bougainville,
Papua New Guinea**

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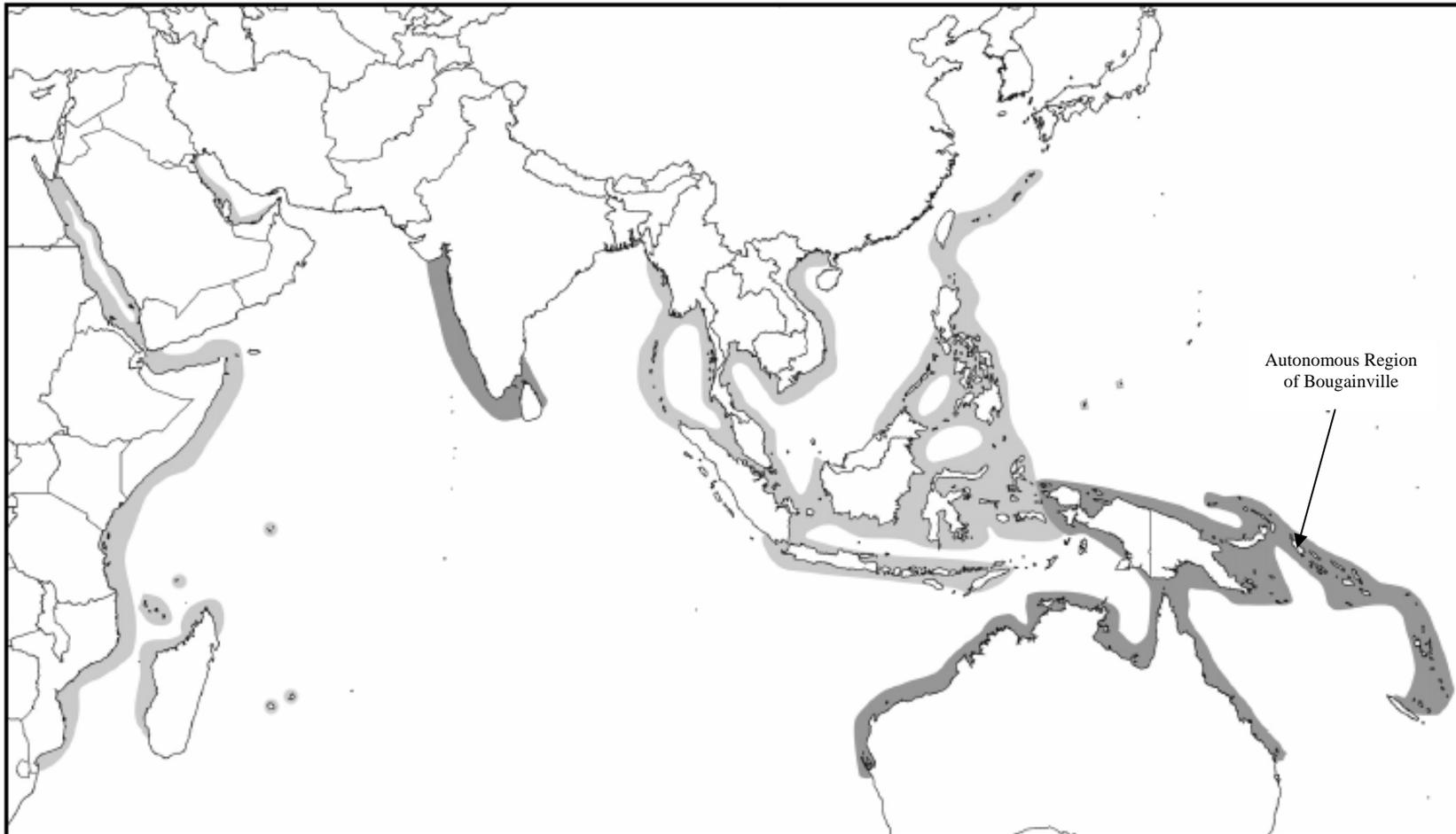
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Frontispiece Map: Known range of dugongs (Map source: Marsh *et al.*, 2002).
Note: Dark shading represents known remaining populations.

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Acronyms

ARB	Autonomous Region of Bougainville
CI	Conservation International
CMS	Conservation of Migratory Species of Wild Animals
DEC	Department of Environment and Conservation
IUCN	International Union's Conservation Network
MoU	Memorandum of Understanding
NGO	Non-government Organisation
PNG	Papua New Guinea
SPREP	Secretariat of the Pacific Regional Environment Program
WMA	Wildlife Management Area

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Executive Summary

Interviews were conducted in 25 locations (five in Survey Area 1, eight in Survey Area 2, and 12 in Survey Area 3) in the Autonomous Region of Bougainville (ARB) with the majority of the interviews conducted in a focus group setting (80 %). A total of 20 adults and 10 calves were reported during this assessment for the first two months of 2008, with a total of 37 adults and 17 calves reported overall for 2007 and 2008.

A total of 54.2 % respondent groups across all survey areas believed that dugong numbers had in fact increased in recent years, whilst 8.3 % thought that they had declined, 29.2 % felt that they were the same whilst 8.3 % were unsure. Reasons given for the increase in dugong populations in Survey Areas 1 and 2 was reported to be linked to the cessation of hunting; whilst respondents in Survey Area 3 thought it was due to the cessation of the mine, and subsequently less waste, sedimentation and boat traffic (both commercial and recreational).

Currently there are no active pursuit of dugong resources, with all animal that were reported consumed being the result of incidental catch in fishing nets. Only one incident of focused hunting was reported at Kiviri Village on the coast near Wakunai Village (Survey Area 3), whereby one dugong was speared in the Christmas period of 2004 for a reconciliation feast.

There were no strandings reported by an informant groups, though they do happen as a passing conversation with the President for Kunua District (Survey Area 2) whilst waiting for a dinghy, revealed that three dugongs had stranded near there in 2003.

In the surveyed areas, previous awareness had been conducted by Department of Primary Industries' Fisheries Division during the 1970s and 1980s. Subsequently a high proportion of interview respondents (64 %) had some knowledge of laws pertaining to the protection of dugongs. Overall, 96 % thought that dugongs did indeed require protection (or further protection) and that they would support the establishment of protected areas to achieve this. Presently, Matsungan, Pororan and Torvar Island communities (Survey Areas 1 and 2) have banned the taking of dugong resources, which in some cases is formalised in their 'Village Constitutions'. Along the east central coast around Arawa (Survey Area 3), resource owners formulated the Pirung Wildlife Management Area (WMA), which is the only protected area in the ARB and encompasses an area of some 43,200 ha.

The optimum management strategy is to identify areas that consistently support large numbers of dugongs and to set these aside as dugong sanctuaries in which dugong mortality is minimised and their seagrass habitats are protected. At the local level, it is the author's opinion that support should be given to the Pirung WMA to enable it to function adequately to allow it to become a vehicle for dugong conservation and management. It is also recommended that the WMA boundary be extended to cover the Wakanai and Asatavi areas. To compliment this, would be the delivery of a large-scale education and awareness campaign that highlighted the importance of dugongs (not only as a biodiversity 'flagship') but also its reproductive ecology and the inter-relationship dugongs have with healthy seagrass eco-systems.

Given the difficulty of identifying stock boundaries and the capacity of dugongs to move across jurisdictional boundaries, it will also be important to co-ordinate management initiatives across jurisdictions, and something instrument like the leatherback turtle Tri-Nation's Memorandum of Understanding should be pursued by the Department of Environment and Conservation and Non-government Organisations for the conservation and management of dugong resources in PNG, the Solomon Islands, Australia and West Papua (Indonesia).

Background and Aims of the Assessment

Conservation International (CI) has taken the lead in for assessing dugong resources in Melanesia through its Melanesian Centre for Biodiversity Conservation. The impetus for this dugong assessment stems in part from the optimum conservation strategies for dugongs recommended by United Nations Environment Program in the 2002 Dugong Status Report and Action Plan and the Secretariat of the Pacific Regional Environment Program's (SPREP) 2003-2007 Dugong Action Plan.

Scientific information on dugong distribution and abundance for Melanesia is currently either out-dated or non-existent (Marsh *et al*, 2002). Subsequently, CI aims to address this shortfall in information by obtaining sufficient qualitative information on dugong occurrence and distribution from local fishers through the use of interview surveys, and gauging the level of interest and support from the local coastal communities of these high occurrence areas for the conservation of seagrass beds as designated dugong protected areas. Information obtained from this assessment will feed into CI's Melanesian regional database and help delineate further Key Biodiversity Areas, which will in turn be used in planning for marine conservation interventions throughout Melanesia.

This report covers assessment activities and results for the Autonomous Region of Bougainville (ARB).

Methodology

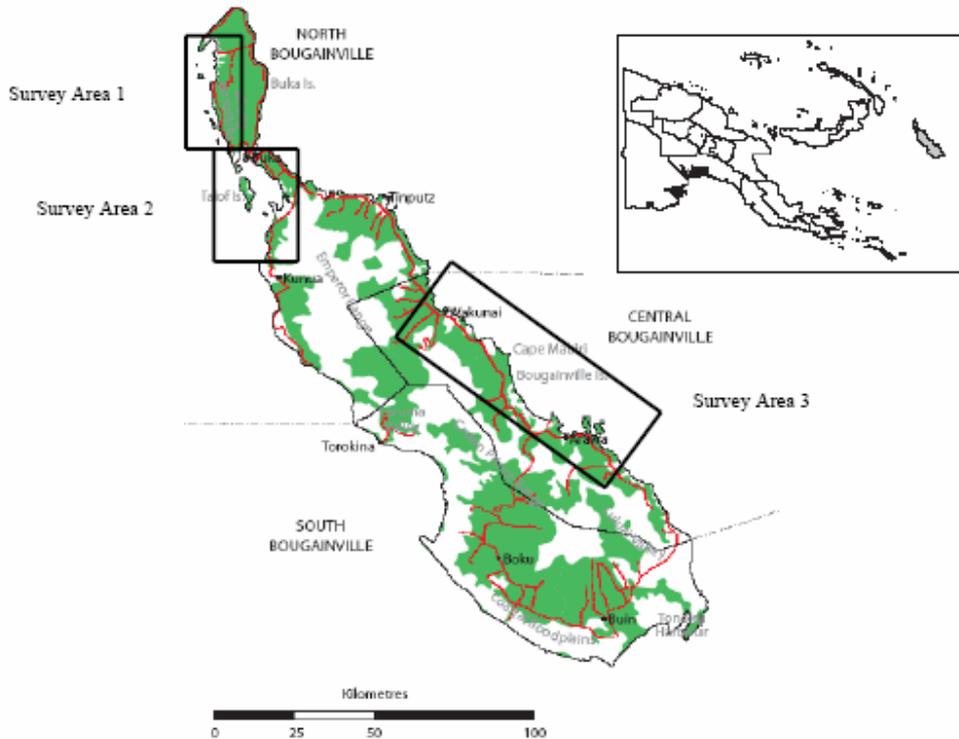
The assessment involved three activities, the first being education and awareness radio announcements (Appendix A), which were assisted by Stalin Sawa¹, a reporter at the National Broadcasting Corporation in Buka, the capital of the ARB. Consultation and awareness was also conducted with Jinro Boisen², the Fisheries Advisor with the Department of Primary Industries, also in Buka.

The second and third activities were combined as this involved conducting interviews with coastal and island communities (Appendix B and C), and conducting education and awareness activities including the distribution of awareness pamphlettes (Appendix D). As suggested by Marsh and Lefebvre (1994) and detailed in Aragones *et al*, (1998), interviews are an economical survey technique that can be used initially in areas where there is little or no information available to establish population status before more intensive assessments are conducted. By interviewing local people who reside in island and coastal areas, qualitative information can be obtained about dugong occurrences and thus an inclination of distribution patterns, mortality rates, threats and potential management strategies. The survey questionnaire used for this assessment was adapted from Yen (2006) who had adapted a similar format from Muir *et al*, (2003).

Identification of survey areas were based on a literature review and information obtained once the author was in Buka. In all, three areas were surveyed, the first being the island chain that spreads up the western back of Buka Island (Survey Area 1), the second area surveyed being the island and coastal communities on the west coast of the northern end of the ARB mainland (Survey Area 2), and lastly, the coastal and island communities stretching along the east central coast (an area around Arawa and Kieta) of the ARB mainland stretching from Wakunai Village in the north to Torobai Village in the south (Survey Area 3) (Map 1, see Appendices E-G for detailed locations).

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² Jinro Boisen, Fisheries Advisor, Department of Primary Industries – Fisheries, Buka, Autonomous Region of Bougainville, Tel: 973 9397, Mob: 659 7133, Eml: ngpfish@datec.net.pg



Map 1: Location of survey area (Map source: Hanson *et al*, 2001)

Interviews were conducted in 25 locations (five in Survey Area 1, eight in Survey Area 2, and 12 in Survey Area 3) with the majority of the interviews conducted in a focus group setting (80 %) (Plates 1 and 2, Table 1 for Activities). The use of focus groups was actually very beneficial (and unavoidable as people were interested in what was going on) because it allowed for consensus on sightings (and thus removing duplicated sightings) and provided a ready audience for education and awareness activities.



Plate 1: Focus group interview at Pororan Island



Plate 2: Focus group interview at Tubiano Market

In conducting the surveys, the author focused on sightings within the last month and within the last year, as from previous experience (see Kinch *et al*, 2005, 2006, 2007), informants have difficulties in remembering past events, and in this particular case, dugong sightings. By adopting this method, it was easier for informants to recount specific details and avoid the problems encountered by Yen (2006) in a similar assessment in the Milne Bay Province whereby

he reports that almost all the interview respondents could not provide the exact time when the sighting was made (see Bernard, 2006; Axinn and Pearce, 2006 for details on conducting qualitative surveys and eliminating informant bias).

Table 1: Assessment activities

Date		Activity
Saturday	23/02/08	Travel from Alotau to Buka via Port Moresby
Sunday	24/02/08	Logistical organisation
Monday	25/02/08	Visit NBC and briefing with DPI-Fisheries, conduct interviews at Matsungan, Pororan and Petats Islands
Tuesday	26/02/08	Conduct interviews at Taiof, Jupuno, Keravat, Fatsingan, Hon, Tsorotsian and Torvar Islands; and Tsirote Village
Wednesday	27/02/08	Travel to Arawa
Thursday	28/02/08	Conduct interviews at Kiviri, Rorivana, Arieve, Arawa, Pitia, Torobai and Taveomau Villages; Tubiano Market; and Pokpok and Tausina Islands
Friday	28/02/08	Travel to Buka, de-briefing with DPI-Fisheries
Saturday	29/02/08	Travel to Alotau via Port Moresby

1. Introduction

The dugong is the only extant species in the Family Dugongidae³ in the Order of Sirenia⁴; it is also the only marine herbivorous mammal, as the three manatee species of the Family Trichechidae⁵ all use fresh water to varying degrees (Reynolds and Odell, 1991). Dugongs are long-lived animals with a low reproductive rate, long generation time, and a high investment in each offspring (Marsh *et al*, 1999; Kwan, 2002).

Dugongs are of great subsistence and cultural importance to the coastal and island people of Papua New Guinea (PNG), including the Autonomous Region of Bougainville (ARB), whose marine eco-systems support an array of fringing reefs, and lagoons and bays that are home to seagrass meadows, areas which are ideal for dugongs (*Dugong dugon*) habitation.

2. Dugong Biology and Ecology

Distribution and Seagrass Inter-relationships

Dugongs are found in the warm tropical waters of the Indo-Pacific region (Bertram and Bertram, 1973) and historically from east Africa to Vanuatu, between about 26° and 27° north and south of the equator (see Frontispiece Map) (Nishiwaki and Marsh, 1985; Marsh *et al*, 1999; Kwan, 2002). It is generally believed that dugong populations outside of northern Australia and Melanesia are represented by relict populations separated by large areas where dugongs have been extirpated or are close to extirpation (Marsh and Lefebvre, 1994; Marsh *et al*, 1999, 2002, 2003).

Being seagrass specialists, dugongs are usually found to inhabit wide shallow protected bays, wide shallow mangrove channels and the lee-side of large inshore islands⁶, areas that support phanerogamous seagrass communities of the families Potamogetonaceae and Hydrocharitaceae (Husar, 1978), especially the lower seral or pioneer species, such as the genera *Halophila* and *Halodule*⁷ (Preen, 1995; Preen and Marsh, 1995; Kendrick *et al*, 1999), which have high variability, both spatially and temporally. Dugongs can consume between 28-40 kg of seagrass/day (Saalfeld and Marsh, 2004) by uprooting whole plants when accessible, but also feeding on leaves or rhizomes when the whole plant cannot be uprooted (Anderson 1982; Marsh *et al*, 1982). The main seagrasses identified by informants in the ARB Survey Areas included *Thalassia hemprichii*, *Cymodocea serrulata* and *Halophila decipiens*.

Aragones and Marsh (2000) suggest that grazing activities by dugongs alter the species composition of seagrass communities at a local scale, and there is actually some concern that the depletion of dugong populations may lead to major shifts in seagrass community structure (Preen, 1995). These concerns stem from evidence from the fossil record that extinction within the once diverse syrenid fauna were followed by extinctions of several seagrass species (Domning, 2000). It has also been suggested recently that the decline in mega-grazers, such as dugongs, may be causing an increase in organic matter deposition in seagrass sediments, resulting in large-scale decline of seagrasses eco-systems (Jackson *et al*, 2001; Duarte, 2002).

³ The only other recent dugongidid, the Steller's sea cow (*Hydrodamalis gigas*) was hunted to extinction within 27 years of its discovery in 1741 (Stejneger, 1887).

⁴ The Sirenia are members of the Tethytheria, which apparently evolved in the Tethys Seaway in Eurasia during the early Eocene some 55 million years ago (Domning, 1999; Reynolds and Odell, 1991).

⁵ This family includes the Amazonian manatee (*Trichechus inunguis*), the West African manatee (*T. senegalensis*) and the West Indian manatee which includes two sub-species, the Antillean manatee (*T. manatus manatus*) and the Florida manatee (*T. manatus latirostris*).

⁶ Dugongs are also regularly observed in deeper water further offshore in areas where the continental shelf is wide, shallow and protected.

⁷ Diet selection is correlated with the chemical and structural composition of the seagrasses, which makes them highly digestible. *Halophila* spp. and *Halodule* spp. are both low in fibre and high in available nitrogen, meaning that dugongs can maximize their intake of nutrients without consuming excessive bulk (Lanyon, 1991; Aragones, 1996).

Dugongs are generally more abundant and accessible in shallow waters, particularly in inter-tidal seagrass habitats during spring high tides, moving into inshore areas and the higher windward side of reef tops while at low tide they move offshore to deeper water on the leeward side of reefs (this survey, also see Johannes and MacFarlane, 1991; Kwan, 2002; Yen, 2006).

Migration

There is increasing evidence that some individual dugongs commonly move considerable distances making trips of up to 600 km within days (Marsh and Rathbun, 1990; Marsh *et al*, 1999; Preen 2001). The reasons for such large-scale movements are not generally known, though it is increasingly thought that these movements result from the reduction of high quality seagrass biomass due to either over-grazing or other environmental factors, which disturb seagrass habitats or cause die-back.

In some instances, large-scale dugong movements are associated with large-scale episodic disturbance to habitat caused by cyclones and floods. These extreme weather events cause extensive damage to tropical seagrass communities through severe wave action, shifting sand, adverse changes in salinity and light reduction⁸ (Heinsohn and Spain, 1974; Preen and Marsh, 1995; Preen *et al*, 1995; Poiner and Peterkin, 1996). Recovery and re-colonisation of seagrass communities after such losses may take up to a decade or more (Poiner and Peterken, 1996).

Reproduction and Life History

As a general rule, female dugong begin bearing calves between the ages of 10-17 years (Marsh *et al*, 1999) though dugongs in the Torres Strait have been reported to reach sexual maturity between 6-14 years, with body lengths between 2-2.5 m in length, with male dugongs reaching sexual maturity between 4-13 years, with body lengths between 1.9-2.6 m in length (Kwan, 2002).

Gestation periods tend to be as long as 13 months, with the female dugong usually bearing only one calf at a time, which she will then suckle for approximately 18 months. The period between successive calving is very variable; with estimates ranging from 3-7 year intervals (Marsh *et al*, 1999). Dugongs start eating seagrasses soon after birth, and grow rapidly during the suckling period when they also receive milk from their mothers.

Variability in life history parameters such as age at sexual maturity and first reproduction, pregnancy rates and calving intervals in dugongs is reported to be linked to the spatial and temporal variation in seagrass community composition and biomass (Kwan, 2002). Thus, food quality and availability influence dugong population dynamics. When their seagrass food disappears as a result of episodic disturbance, some dugongs suspend breeding (Marsh *et al*, 1999; Kwan, 2002). It is likely that the effects of food supply on life history parameters and hence fecundity in dugongs includes both density dependent and density independent components.

The oldest dugong reported to date was estimated to be 73 years old when she died (Marsh *et al*, 1999).

⁸ *Halophila ovalis*, one of the preferred food species of dugongs, appears to be particularly sensitive to light reduction, with the duration and frequency of light-deprivation events being the primary factors affecting its survival (Longstaff *et al*, 1999). Members of the genus *Halophila* occur at greater depths than other species of tropical seagrasses and this sensitivity to light reduction is a plausible contributor to the causes of the large-scale loss of deep-water seagrasses. The recovery and regeneration of *Halophila* spp. and *Halodule* spp. may be rapid enough to sustain large numbers of dugong, with recovery rates ranging from a couple of months to up to a year depending on local conditions (Preen and Marsh, 1995; Preen *et al*, 1995; Aragones and Marsh, 2000).

3. Threats

As the only surviving member of the family Dugongidae, the dugong is of 'high' biodiversity value and is listed as 'vulnerable to extinction'⁹, at a global scale by the International Union's Conservation Network's (IUCN) Red List.

As noted above dugongs populations are susceptible to environmental perturbations because of their life history and their dependence on seagrasses that are restricted to coastal habitats. They are also highly sensitive to anthropogenic impacts which impact on themselves, such as consumptive use and incidental drowning in nets¹⁰; or on their seagrass habitats (Fonseca 1987; Shepherd *et al*, 1989; Poiner and Peterkin, 1996; Duarte, 2002).

Seagrass beds may be destroyed directly by activities that cause increases in sedimentation (e.g. land clearing for agriculture and coastal developments, and mining), and turbidity (e.g. trawling and dredging), thus reducing light intensity or smothering of seagrasses; or eutrophication causing increased epiphytic growth¹¹ (e.g. sewage out-falls, herbicide run-off, aquaculture) (Heinsohn *et al*, 1977; Marsh *et al*, 1999). Other threats include herbicide runoff, detergents, heavy metals, hypersaline water from desalination plants and other waste products. Dugongs are also susceptible to a wide range of diseases, some of them infectious or parasitic (Blair, 1980; Blair and Hudson, 1992; Kwan, 2002).

All these factors can cause a chronic decline in a dugong population. Population simulations have indicated 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 by more than 5 %/year (Marsh, 1999; Marsh *et al*, 1999). Subsequently, a sustained reduction in their reproductive rates will affect the population's persistence and resilience to anthropogenic impacts. Estimates of sustainable harvests rates are thought to be in the order of 2 % of the female population/year (Marsh *et al*, 1999). The sustainable harvest rate will be reduced further in areas where the pre-reproductive period and/or calving interval are lengthened by food shortages (Marsh, 1999).

Dugongs are very slow-reproducing animals and as such, can only withstand very limited human-induced mortality within a given area or time. As they are relatively easy to kill, live close to the coast, have very palatable meat¹² and can be easily over-hunted due to their low recruitment rate, dugong resources are highly vulnerable to over-exploitation and thus need careful management. Studies suggest that if dugongs disappear from an area, it is unlikely to be re-colonised quickly despite the dugong's capacity for long-distance movements (Tikel, 1998). These results indicate the importance of maintaining numbers throughout the dugong's range including sections of coastlines where densities are low.

⁹ This category is based on an inferred significant population reduction.

¹⁰ Seagrass meadows are largely inter-tidal. In such circumstances, dugongs and netters are all forced to use inter-tidal areas on the high tide, increasing the chances that dugongs will be caught.

¹¹ Temporal distribution of dugongs has been observed in the Torres Strait of Australia which is consistent with periods of high seagrass productivity that occur when there is high water clarity (Walker *et al*, 1999; Kwan, 2002).

¹² A dugong yields about 35 % (approximately 115 kg) of its body weight in useable meat and fat (Nietschmann, 1984) and on average approximately 18 lt of oil (Smith, 1987).

4. National and International Management

With the institutionalisation of environmental concerns, dugongs have been increasingly employed as ‘flagship’ species for conservation by the environmental lobby, and the dugong is now well established as an iconic symbol to promote the ethos of conservation envisaged by conservation Non-government Organisations (NGOs)¹³ and other agencies, and to raise complex management and policy issues (Entwistle and Dunstone, 2000; Bowen-Jones and Entwistle, 2002). Other labels such as the IUCN’s threatened species Red List’s ‘vulnerable to extinction’ are also used in mobilising public opinion and more importantly fund raising, and the dugong is now of particular conservation significance globally, nationally and regionally.

In PNG, the dugong was made a ‘protected animal’ in May 1976, under the 1966 Flora and Fauna Protection and Control Act, which stipulates that dugongs can only be harvested by traditional means and used for traditional purposes, with all commercial exploitation is banned (Kula and George, 1996).

PNG also has several international obligations for dugong conservation because of several international conventions that it has ascribed to, including the Torres Strait Treaty, the Biodiversity Convention, the Convention on the Conservation of Migratory Species of Wild Animals (CMS), and the Convention on International Trade of Endangered Species of Wild Animals. Currently, the Department of Environment and Conservation (DEC) activities in regards to the conservation and management of dugong resources is directed more towards efforts to enhance co-operation and capacity building at the national, regional (i.e. Australia) and international levels (i.e. recent CMS Memorandum of Understanding [MoU] and the previous Dugong Action Plan 2003-2007 of the SPREP).

In 2002, the World Summit on Sustainable Development called for governments, regional agencies (thus the impetus for the SPREP Dugong Action Plan) and NGOs to develop partnerships to implement on-the-ground conservation and sustainable development actions for species and ecosystems in danger of extinction. Currently, the World Wide Fund for Nature’s Bismarck Solomon Seas Eco-region has developed a non-legal binding tri-national partnership MoU with government representatives from Indonesia, PNG and the Solomon Islands, and partners for the recovery of leatherback turtles (Kinch, 2006). This MoU has been devised to explore ways that governments, institutions and communities can effectively manage and conserve nesting sites, feeding areas and migratory routes in and across these three countries. The MoU also attempts to address issues such as take, technical capacity, and developing sustainable livelihood options through a network of communities and partnering of conservation NGOs, science and fisheries institutions (Wilson *et al*, 2006). A similar type of agreement should also be developed for dugongs with the three countries already mentioned, but also including Australia given the high numbers of dugongs in the Torres Strait and Western Province region¹⁴.

¹³ The Nature Conservancy launched a dugong awareness campaign in 2005 within Melanesia.

¹⁴ The Australian Department of Environment has recently called for tenders for the following program: ‘The engagement of Papua New Guinea in the sustainable management of marine resources (turtles and dugongs) in Torres Strait and adjacent land and sea within Papua New Guinea’.

5. Assessment Results

Population Numbers

Dugong surveys were conducted by post in 1973 and 1974, resulting in the first large-scale dugong survey in PNG. Although this method was successful in producing data, it had inherent biases. As Ligon and Hudson (1976, 1977) state, the results of a later aerial survey¹⁵ were much lower than the results achieved by the 1973-1974 postal survey, most probably because informants provided over-estimations of population numbers during the postal survey. Results of this postal survey showed that dugong populations in Survey Areas 1 and 2 were between in groups of 20-50, and in Survey Area 3 in groups of 5-20 in survey area 3 (Ligon and Hudson, 1976, 1977). From my observations, the author suggests that the results of the postal survey are unreliable.

During this assessment, dugong sightings were reported by all communities visited, with dugongs regularly visiting certain areas at certain times of the day. Dugongs were commonly reported to be seen (or heard) during the full moon and during high tides (see above).

A total of 20 adults and 10 calves were reported during this assessment for the first two months of 2008, with a total of 37 adults and 17 calves reported overall for 2007 and 2008. The actual number of dugongs resident will be lower than this number because dugongs do move, sightings at one coastal or island community maybe the same animal as one sighted at another coastal or island community. What can be said though, is that dugongs are alive (and assumed well) in the ARB (see Appendix for full details).

This is supported by the response to the question of 'are dugong populations increasing or decreasing'. A total of 54.2 % respondent groups across all survey areas believed that dugong numbers had in fact increased in recent years, whilst 8.3 % thought that they had declined, 29.2 % felt that they were the same whilst 8.3 % were unsure. Reasons given for the increase in dugong populations in Survey Areas 1 and 2 was reported to be linked to the cessation of hunting; whilst respondents in Survey Area 3 thought it was due to the cessation of the mine, and subsequently less waste, sedimentation and boat traffic (both commercial and recreational¹⁶). It was stated that one reason for high dugong concentrations in the Wakunai area was due to the fact that there was limited out-board dinghies in the area and thus minimal disturbance.

Mortalities in the Autonomous Region of Bougainville

The coastal and island people of the ARB are bounded to the sea by their customs, lifestyle and traditions. A part of this, was the exploitation of dugong resources, whereby historically, coastal and island communities used nets for capturing dugong resources setting their nets in the daily feeding migration paths of the dugongs¹⁷, though it should also be noted that fishing for dugongs was regarded only an occasional activity, and was done mostly for ceremonial feasting (Lokani, 1995).

Currently there are no active pursuit of dugong resources, with all animal that were reported consumed being the result of incidental catch in fishing nets, though it was also reported that if the dugong entangled is still alive, it would be released. One such incident was reported in 2006

¹⁵ These aerial surveys were conducted in 1975 (Ligon and Hudson, 1976, 1977) in the Daru and Warrior Reef Complex in Western Province, the south-east Papuan coast, the area around Lae in the Morobe Province, the northwest coast of West New Britain Province and the north-west New Guinea coast, but excluded the Bougainville area.

¹⁶ Previously, local people thought that the other Papua New Guineans and expatriates working at Bougainville Copper Ltd and living in Arawa and Kieta were threats to their marine resource base.

¹⁷ Nets were/are regularly used by communities in the Milne Bay Province (Jack, 1984) to harvest dugong resources, along with harpoons (Kinch, J. pers. obs.).

whereby one dugong was caught in a net at Pilvala Village on the north east coast of Petats Island (Survey Area 1) and later released unharmed. Other causes of mortality reported during the assessment included the previous use of dynamite¹⁸ in the 1980s, and the accidental spearing when targeting green turtles (*Chelonia mydas*) (Table 2). Only one incident of focused hunting was reported at Kiviri Village on the coast near Wakunai Village (Survey Area 3), whereby one dugong was speared in the Christmas period of 2004 for a reconciliation feast.

Table 2: Dugong mortalities

Place	Mortality
Palisal Village on the south east coast on Matsungan Island	In January 2008, one juvenile was caught in a net and drowned, was eaten.
Yaparu Village on the south east coast on Poraran Island	During the 1990s (crisis period), three dugongs were caught in nets.
Tsirote Village on the west coast of north Bougainville	In 2003, one adult caught accidentally in a net.
Tausina Island to the north of Pokpok Island	In the 1980s, people from Rabaul killed one dugong whilst fishing with dynamite, also 1 was speared.
Tausina Island to the north of Pokpok Island	One dugong was speared accidentally whilst hunting for green turtles.
Pitia Village on the coast below Arawa	In 2006, one dugong was caught in a net and drowned, was eaten.
Taveromau Village on the south coast below Kieta	In 1994, one dugong was caught in a net and drowned, was eaten.
Tubiano Market on the south coast below Kieta opposite Pokpok Island	In 2007, one dugong was caught in a net and drowned, was sold at the market.
Kiviri Village on the coast near Wakunai Village	In 2004, one dugong was speared for reconciliation feast at Christmas time.

There were no strandings reported by an informant groups, though they do happen, as a passing conversation with the President for Kunua District (Survey Area 2) whilst waiting for a dinghy, revealed that three dugongs had stranded near there in 2003. When informant groups were asked if they would help dugongs stranded return to the sea, several of them stated that they would keep them and eat them rather than returning them to the sea.

Custom Uses

The dugong is well known and respected by the people in the three survey areas, and they have built up some level of local knowledge about their habitats and habits. In all the survey areas, dugongs are names in the local vernacular, in Survey Area 1, they are called '*lium*' (Petats language group), in Survey Area 2 they are referred to as '*vonon*' (Saposa language group) and in Survey Area 3, they are called '*to*' (Nasioi language group).

Dugongs have been recorded in the mythology of many coastal and island people of PNG (Carrier and Carrier, 1980; Hudson, 1982; Olewale and Sedu, 1982; Ely, 1988; Stasch, 1996). A common 'custom' story (though with some variation) that was recounted in all areas surveyed told of a man (sometimes a woman) who was building a house (sometimes a sleeping area) only to have the section that he had completed collapse by the time that he had finished the other half, he had subsequently had enough of this and went to drink water from a 'traditional' water container made out of a coconut shell, only to have it fall on his head and break when he raised it to drink, he then fell into the sea and morphed into a dugong. It was regularly recounted also, that dugongs were people ('our relatives') because the females had breasts like a women and the male dugongs has whiskers ('*maus gras*') like a man. Dugongs are the totem animal for the Poini and

¹⁸ Dynamiting was done for capture of rabbitfish (*Sejanus* spp.), Indian mackerel (*Astrologer angora*), yellowtail scads (*Tule mate*) and mullets (Melinda) (Lokani, 1995). Dynamiting was a rare event by the 1990s and is no longer practiced.

Bokoringko Clans in Survey Area 3, and thus people from this clan are prohibited from consuming them.

During this assessment it was also reported that communities around the Wakanai area in Survey Area 3 on the east central coast utilised dugong teeth (along with green turtle [*Chelonia mydas*] shell) for bride price, with the last time these were used was in a marriage ceremony that occurred after the ‘crisis’ had ended. These are no longer used.

Local Management

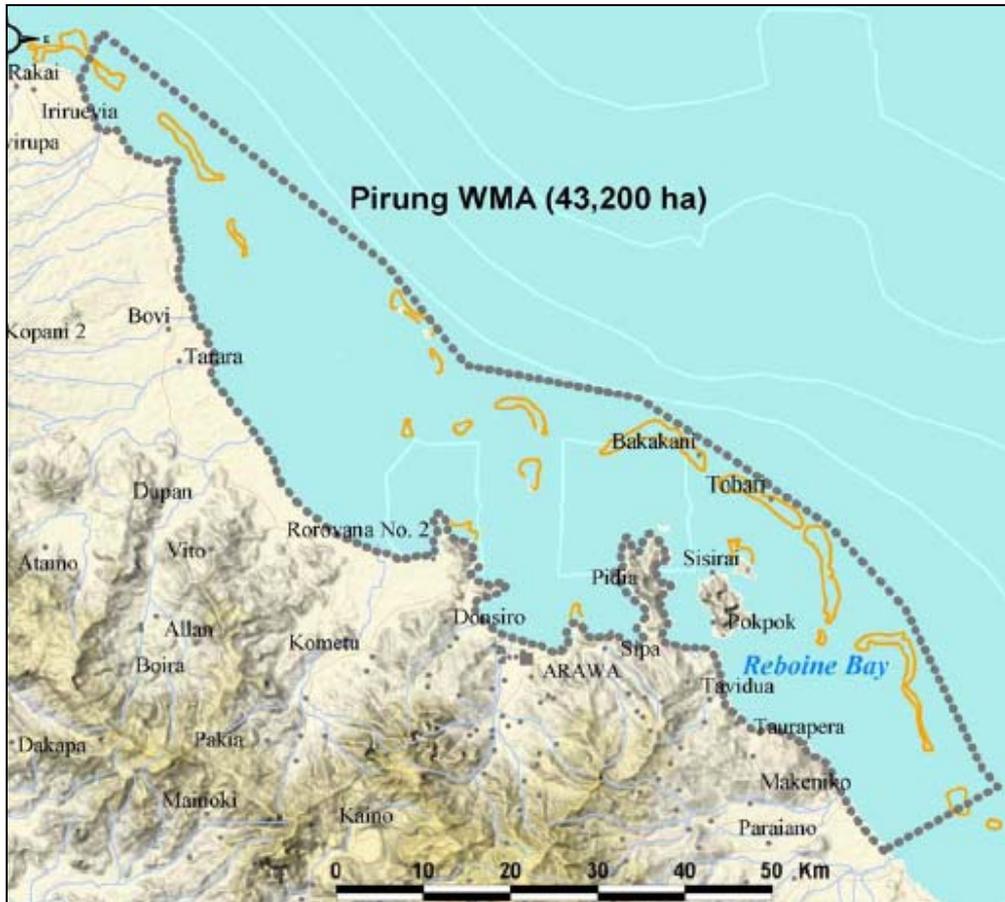
In the surveyed areas, previous awareness had been conducted by Department of Primary Industries’ Fisheries Division during the 1970s and 1980s. Subsequently a high proportion of interview respondents (64 %) had some knowledge of laws pertaining to the protection of dugongs. Overall, 96 % thought that dugongs did indeed require protection (or further protection) and that they would support the establishment of protected areas to achieve this. Concerns were however raised by one focus group, stating that with the recent ‘crisis’ there were still problems with disaffected youth, and also the inability of controlling people coming down from the interior and taking dugong resources.

Presently, Matsungan, Pororan and Torvar Island communities (Survey Areas 1 and 2) have banned the taking of dugong resources, which in some cases is formalised in their ‘Village Constitutions’. Along the east central coast around Arawa (Survey Area 3), resource owners formulated the Pirung Wildlife Management Area¹⁹ (WMA, declared on the 9th May 1989), which is the only protected area, in the ARB and encompasses an area of some 43,200 ha (Map 3). The Pirung WMA was established to control resource access by non-customary people and to protect subsistence resources. While dugong populations were reported by all informants in this area, the area is too large to monitor effectively and manage without appropriate resources, though its management committee is still in place (Table 3).

Table 3: Pirung WMA Committee members

Name	Position
Cyril Tivai	Chairman
Ambrose Omariko	Vice-chairman
Sebastian Kakau	Committee Member
Peter Karuai	Committee Member
Paul Taupa	BCC Chairman
John Dona	COE Chairman – North Nasioi
Frank Nigu	Electoral representative
Benjamin Kina	Osi Tanata Local NGO Group Representative

¹⁹ Before the ‘crisis’ and during the Pirung Community Government days an extensive awareness and clan consultative meetings was regularly held for a period of two years.



Map 2: Pirung WMA (Map source: WWF-PNG)

6. Conclusion

The optimum management strategy is to identify areas that consistently support large numbers of dugongs and to set these aside as dugong sanctuaries in which dugong mortality is minimised and their seagrass habitats are protected. Preen (1998) recommends that factors to be considered in the establishment of dugong sanctuaries include adequate size (to incorporate the home ranges of dugongs), quality of habitat, control of netting, local support and appropriate enforcement. Additional factors to be considered include the long-distance movement of dugongs and the need to protect movement corridors.

At the local level, it is the author's opinion that support should be given to the Pirung WMA to enable it to function adequately to allow it to become a vehicle for dugong conservation and management. It is also recommended that the WMA boundary be extended to cover the Wakanai and Asatavi areas. To compliment this, would be the delivery of a large-scale education and awareness campaign that highlighted the importance of dugongs (not only as a biodiversity 'flagship') but also in reproductive ecology and the inter-relationship dugongs have with healthy seagrass eco-systems.

Further collaboration with relevant partners and interested communities is also required to ensure the development of integrated dugong conservation strategies involving all stakeholders in other areas of the ARB, particularly in those communities who have developed 'Village Constitutions'.

Management of natural resources, such as dugongs presents an opportunity for them to work with government, scientists and NGOs towards a co-operative framework of shared expertise and decision-making. A community-based management approach for dugongs that give local coastal and island peoples authority and responsibility, and hence a sense of ownership, is more likely to result in greater commitment and compliance than management initiatives imposed by government agencies alone.

Given the difficulty of identifying stock boundaries and the capacity of dugongs to move across jurisdictional boundaries, it will also be important to co-ordinate management initiatives across jurisdictions, and something instrument like the leatherback turtle Tri-Nation MoU should be pursued by the DEC and NGOs for the conservation and management of dugong resources in PNG, the Solomon Islands, Australia and West Papua (Indonesia).

A final note, overall, the conservation and management of dugong resources will be a complex challenge in PNG for CI and its partners, such as the DEC, particularly because knowledge of the factors that determine sustainable harvest rates (where the taking of dugong resources occurs) is limited. Though the taking of dugong resources does not appear to be a problem in the ARB, it is certainly an issue for other areas of PNG, particularly in the Western Province, where there are limited income and protein opportunities. The development of a management plan or engagement with communities there is not going to result in a reduction in the take of dugong resources unless there is an improvement in the local economy, given the cultural value of both the meat from these animals and the ability to capture them²⁰ (which of course adds to their already significant economic value in dietary terms).

²⁰ Another factor for the conservation and management of dugong resources in the Western Province is that in terms of animals captured per head of population, Torres Strait Islanders from Australia harvest significantly more dugongs (see Heinsohn *et al.*, 2004; Marsh *et al.*, 1997, 2004; Kwan *et al.*, 2006) than the coastal people of Western Province (who have strong ties with Torres Strait Islanders), and are fiercely defensive of their right to continue to hunt under Australian Native Title legislation.

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Appendix A: Bougainville Radio Awareness Program

Dugong Conservation in PNG – Bougainville Dugong Radio Program

Humans and Dugongs

The slow-moving marine mammals called dugongs eat certain types of seagrass, so they're sometimes known as "sea cows." Hi, I'm Philip Lahui, and this is the Dugong Spot.

Dugongs may look fit, but they face some challenges to survive. Certain coastal communities value dugongs for their meat. They use dugong oil as a medicine. And hunting is not the only problem. Many dugongs drown in fishing nets. Meanwhile, coastal development and poor farming techniques cause sediment runoff that destroys dugong habitat – which are the seagrass beds.

Dr. Helene Marsh, a professor at the James Cook University in Australia says keeping dugong populations alive will take cooperation. Not only will hunters and fishermen need to kill fewer dugongs, but developers and farmers will need to reduce *their* impacts on dugong habitat. By working together, these very different groups can make a difference and keep dwindling dugong populations intact.

Call us with your dugong question: 323 1532. If we use it on the air, you'll receive a dugong Poster or Sticker. The Dugong Spot is a project of the Disney Wildlife Conservation Fund and Conservation International.

Basic Facts about Dugong

Dugongs are Special!

- They are the only surviving member of the Family Dugongidae;
- They are the only plant eating marine mammal that gives birth to their young;
- They are listed as vulnerable to extinction by the International Union for the Conservation of Nature (IUCN); and
- They are considered as a species of high biodiversity value that indicates a healthy marine environment.

Description

- Dull brown in colour and has a big body;
- Grows to about 3 meters in length and weighs as much as 400 kilograms;
- Has a round face with the mouth and snout extending downward;
- Has no beak and no fin arising from the back; and
- Displays the bonding-character of the baby dugong swimming alongside it's mother;

Food and Home

- Dugongs are seagrass eaters, they either uproot whole plants when they can or just feed only on the leaves;
- Dugongs are found in coastal waters with large areas of seagrass beds, usually in wide and shallow protected bays, wide and shallow mangrove areas (they do not enter rivers), and in sheltered parts of large inshore islands; and
- Sand banks and estuaries are used for giving birth to avoid sharks.

Life of Dugongs

- They live for a very long time, as old as 73 years;
- Reproduction is very long because females do not bear their first young until they are at least 10 and up to 17 years old – meaning that they have Low Reproduction Rates; and
- Have a long period of carrying and developing their young in their womb during pregnancy which can take up to 13 months.

Seagrass Introduction

It looks like meadow grass rippling in a breeze. But it's seagrass - swaying in the currents of a sunlit coastline. This underwater pasture provides food and shelter for many ocean animals, from shrimp and fish to dugongs.

Seagrasses look much like the grasses you find on land. But they're not very closely related. Like land plants, however, seagrasses need sunlight, so you find them in clear, shallow water. Dr. Michelle Waycott studies seagrass at the Smithsonian Tropical Research Institute. She says the grass beds are important habitat.

One of the things we don't realize about seagrass beds is how many things live in them and on them. Sea turtles and lumbering marine mammals such as dugongs graze on the grass, while worms and crabs feast on decaying leaves. Crustaceans, snails, and young fish hide in the grass and graze on the alga that coats it. Seagrass beds also prevent erosion by stabilizing the sea floor with their roots.

It's a really beautiful system, but if they're to flourish, they do need protection.

If you have comments about the spot show, call us: 323 1532. The Dugong Spot is a project of the Disney Wildlife Conservation Fund and Conservation International.

Appendix B: Bougainville Dugong Survey Data Sheet

Name of interviewee: Date:

Occupation: Reporter:

Age: <20; 20-35; 35-50; 50+ Location of interview:

Gender: Male / Female Province:

1. Have you seen dugong in this area? **Yes No**
- a) When did you see a dugong? (*time of year or date*)
 - b) Where did you see it? (*location name, description or mark on map*)
 - c) What was it doing? (*i.e., feeding, swimming, mating*)
 - d) Was it alone or in a group? How many in the group?
 - e) Did you see calves?

Date/season	Location	Number	Calves	Activity

2. Have you seen or heard of dugong being stranded? When, where, how many, was it dead or alive, and if dead, do you know what it died of?

Date/season	Location	Number	Cause of death? Or alive?

3. What would you do/or did you do if you found a dugong stranded?
-
-
-

4. Where do dugongs feed mainly? (*Location name or clear description of location and habitat type, distance off shore etc*)
-
-

5. Have people ever hunted dugongs in this area? **Yes No**

a) If yes, do they still hunt them now? **Yes No**

b) How many dugongs are caught here each year?

.....

6. Do you eat dugong? **Yes No**

a) If yes, how often do you eat dugong?

.....

b) When did you last eat dugong?

.....

c) Was it for a special occasion?

.....

d) If no, are there any tabus about eating dugong in this area?

.....

7. Have you seen a change in dugong numbers over the years? Have numbers increased, decreased or stayed the same? When did you notice this change occur?

.....

.....

8. If numbers have increased/decreased, why have they changed?

.....

.....

9. Are you aware of any laws that protect dugong? **Yes No**

10. Do you think dugongs need to be protected? **Yes No**

11. Would you support protected areas for dugong where no hunting was allowed?

.....

.....

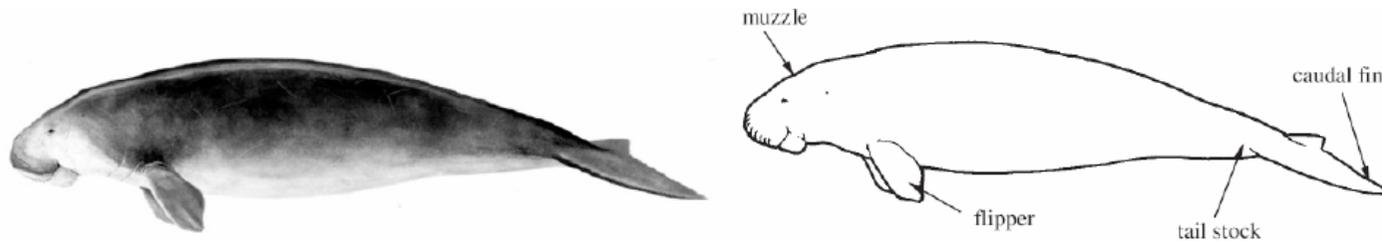
Appendix C: Dugong Identification Sheet



Dugong – Bulmakau long solwara



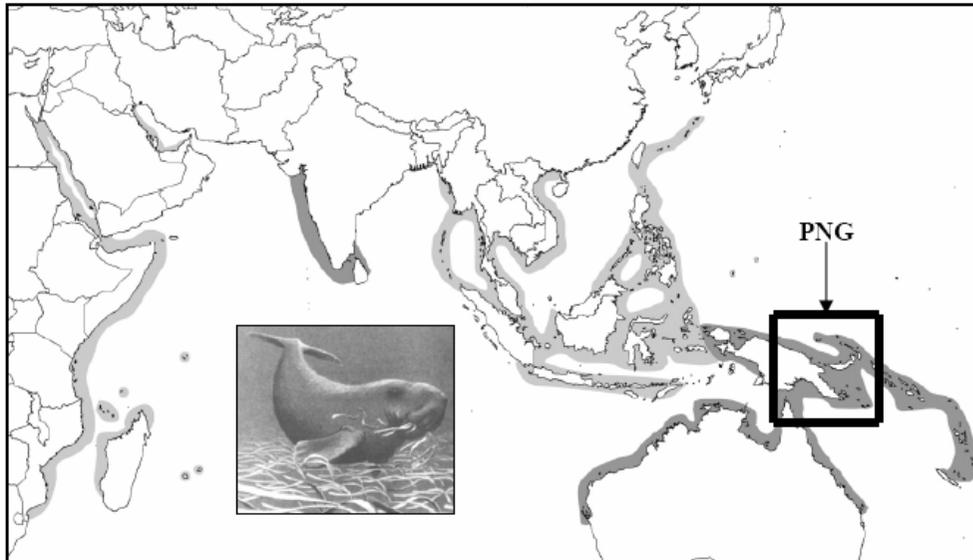
Appendix D: Dugong Awareness Pamphlette



Dugong (*Dugong dugon*) - Bulmakau long solwara

Colour: Medium grey, with lighter coloration on belly. Presence of bristles on snout and a few small hairs all over body.

Body length: Ranges from 1 m when new-born to 3.3 m as an adult.



Distribution range: (Dark shading represents known remaining populations)

Dugongs have a high biodiversity value and are vulnerable to extinction. Survey's suggests that dugong numbers have decreased throughout most of their range. PNG is one of the last places to still have some dugongs.

Government Protection: Under the PNG Flora and Fauna Act, dugongs are Protected animals. This means that you can be fined K 500 for: 1. Killing a dugong, and 2. Buying or selling dugong meat or teeth.

Life History: Dugongs can live to up to 70 years of age. They become sexually mature between the age of 10 to 17 years. Female dugongs give birth to 1 calf (child) every 2 to 7 years. For dugongs, pregnancy lasts for about 11 to 13 months before birth. The mother will breast feed its calf (like a baby) until it is 18 months old and will look after it until it reaches sexual maturity and it can then go off and start its own family..



Harvesting: Dugongs are easily hunted because they feed in areas that have seagrasses. Because of their life history, even if just one dugong dies, this death can cause a decline in the overall population.



Appendix F: Location of villages interviewed in Survey Area 2



Appendix G: Location of villages interviewed in Survey Area 3



Appendix H: Dugong sighting details

Date	Place	Main Informant	Focus Group	Sightings			
				Date	Adult	Calf	Activity
25/02/08	Palisal Village on the south east coast on Matsungan Island	Kevan	Yes	24/02/08		1	Feeding
25/02/08	Matigalgal Village on the north coast on Matsungan Island	Amos	Yes	15/02/08	2		Feeding
				??/11/08	2		Feeding
25/02/08	Yaparu Village on the south east coast on Poraran Island	Edward	Yes	??/10/07	2	2	Swimming and feeding
25/02/08	Poraran Village on the north coast of Pororan Island	Peter	Yes	23/02/08	1		Swimming
				11/02/08	1		Swimming (off Maliliu Island)
25/02/08	Pilvala Village on the north east coast of Petats Island	Tiko	Yes	??/06/07	1	1	Swimming
26/02/08	Jupuno Island on the west coast of Taiof Island	Gerard	Yes	22/02/08	1		Feeding
				??/01/08	1		Feeding
				??/12/07	2	1	Feeding
26/02/08	Keravat Island on the west coast of Taiof Island	Francis	Yes	??/4/07	1		Swimming
26/02/08	Kautsung Village on Fatsingan Island	Alfred	Yes	25/02/08	1		Swimming
26/02/08	Hon Island	Kevin	Yes	??/11/07	1		Swimming
26/02/08	Tsorotsian Island in the Saposia Group of Islands	Ronnie	Yes	15/02/08	1	1	Feeding
26/02/08	Torvar Island in the Saposia Group of Islands	Judy	Yes	??/12/07	1		Swimming
26/02/08	Tsuwanae Island	Smith	Yes	23/02/08	2		Swimming
26/02/08	Tsirote Village on the west coast of north Bougainville	Moses	Yes	20/02/08	1		Swimming and feeding
28/02/08	Sisriri Village on the south coast of Pokpok Island	Margaret	Yes	27/02/08	1		Feeding
28/02/08	Tausina Island to the north of Pokpok Island	Joe	No	??/??/01	2		Feeding
28/02/08	Tausina Island to the north of Pokpok Island	Judy	No	??/11/07	1	1	Swimming
28/02/08	Rorivana Village on the north coast above Arawa	Andrea	Yes	??/12/07	2	1	Swimming and feeding
28/02/08	Arieve Village on the coast next to Arawa	Naru	Yes	??/06/07		2	Swimming
28/02/08	Arawa Village on the coast next to Arawa	Raphael	No	??/11/07	1	1	Feeding
28/02/08	Pitia Village on the coast below Arawa	Mary	Yes	??/12/07	1		Swimming
28/02/08	Torobai Village on the south coast below Kieta	Sampin	No	??/06/06	1		Swimming
28/02/08	Taveromau Village on the south coast below Kieta	Justin	Yes	16/02/08	1		Feeding
28/02/08	Tubiano Market on the coast below Kieta opposite Pokpok Island	Elizabeth	Yes	27/02/08	1	1	Swimming
				??/01/08	1		Swimming
28/02/08	Kiviri Vilage on the coast near Wakunai Village	Simon	No	21/02/08	2	2	Feeding
28/01/00	Kiviri Vilage on the coast near Wakunai Village	Joel	Yes	23/02/08	3	3	Feeding
				Total	38	17	