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Marine wildlife stranding and mortality database annual reports 2011

I. Dugong

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Cover photo

Bottom Photo: W228101 beach washed in very poor body condition, at Cooktown on 18 September 2011. StrandNet. (https://www.derm.qld.gov.au/strandnet/application [accessed: March 2012]). Photo courtesy of Ant from Australian Kite Safari.

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Foreword

The Department of Environment and Heritage Protection (EHP) monitors dugong mortality along the Queensland coast via StrandNet, the marine wildlife strandings and mortality database. StrandNet records injured, moribund and dead marine wildlife in Queensland from reports received by the Department of National Parks, Recreation, Sport and Racing (NPRSR), EHP, the Great Barrier Reef Marine Park Authority (GBRMPA) and the Department of Agriculture, Fisheries and Forestry (DAFF), in addition to those received directly from the public and rehabilitation facilities. This annual report has been published as part of EHP's Conservation Technical and Data Report series. Any request to access these data for research purposes should be made in writing to the StrandNet Coordinator, email: strand.data@ehp.qld.gov.au.

Contents

List of acronyms and abbreviations

COD	Cause of Death
Cwlth	Commonwealth
DEEDI	Department of Employment, Economic Development and Innovation
DERM	Department of Environment and Heritage Protection
DAFF	Department of Agriculture, Fisheries and Forestry
DPA	Dugong Protection Area
ECIFFF	East Coast Inshore Fin Fish Fishery
EHP	Department of Environment and Heritage Protection
GBRMPA	Great Barrier Reef Marine Park Authority
JCU	James Cook University
MPA	Marine Protected Areas
NPRSR	Department of National Parks, Recreation, Sport and Racing
SE	Standard Error
Qld	Queensland
SCP	Queensland Shark Control Program
SOCI	Species of Conservation Interest
UQ	University of Queensland
UQSVS	School of Veterinary Science, University of Queensland

Summary

A total of 199 records were received by the Queensland Strandings program during 2011, relating to 250 dugongs (including ten unconfirmed reports). Of the 240 confirmed cases of dugongs; two were released alive *in situ*, and a third was alive and left to natural processes.

Eighteen per cent of the dugongs (44 dugongs) were recorded in southern Queensland (Hervey Bay to Moreton Bay), which corresponds to 24 per cent excluding hunting. The Bowen to Cardwell region accounted for 40 per cent of all dugongs recorded in 2011, or 51 per cent excluding hunting.

Of the 237 records of dugong mortalities, 57 were attributed to indigenous hunting, 33 were attributed to natural causes, six were attributed to other human activities and the cause of death was unidentified in the remaining 141 dugongs. Of the three records of live dugongs, one was released alive after net entanglement, one was reported to have been entangled in plastic debris and was left to natural processes, and the third was released after stranding for an unknown reason.

Of the 33 dugongs which died of natural causes, twelve dugongs died after extended ill health and had poor body condition. Pneumonia was associated with the deaths of three dugongs, and a further 15 died of unidentified disease. Shark attack or unidentified natural causes were suspected to have caused the death of three dugongs.

The poor condition of many of the stranded dugongs, and the location of the stranded dugongs in areas impacted by the extreme weather events (tropical cyclone and floods) of summer 2010-11 suggested that seagrass loss was the main contributing factor to elevated dugong mortality in 2011.

Despite the large number of necropsies undertaken in 2011, the number of deaths attributable to anthropogenic activities (excluding hunting) was similar to previous years in the StrandNet program. Three dugongs were entangled in nets used in the Queensland shark control program. The number of reported fisheries-related interactions was less than 2010, with two suspected cases of mortality from net entanglement and a third which was released alive. The number of stranded dugongs with vessel-related injuries was less than that of previous years, and only one dugong was suspected to have been killed by an interaction with a vessel, in this case a large vessel.

The number of mortalities associated with indigenous hunting was elevated compared to previous years, this was likely to be because of increased reporting rather than an increase in hunting.

Introduction

Dugongs are conservation dependent because of a low reproductive potential, high investment in offspring, a dependence upon coastal seagrasses and other life-history traits (Marsh 1984; Marsh *et al.* 2011).

Under the *Nature Conservation Act 1992* (Qld) all native marine mammals in Queensland are protected and the dugong is listed as a vulnerable species by the Nature Conservation (Wildlife) Regulation 2006 (Qld). It is also protected nationally as a migratory species under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth).

Within State and Commonwealth waters, the *Marine Parks Act 2004* (Qld) and the *Great Barrier Reef Marine Park Act 1975* (Cwlth) also provide the capacity to protect marine wildlife. State marine parks include the Moreton Bay Marine Park, the Great Sandy Marine Park and the Great Barrier Reef Coast Marine Park. The Great Barrier Reef was rezoned in 2004 (Fernandes *et al.* 2005), greatly increasing the dugong habitat protected from gill netting (Dobbs *et al.* 2008).

The two-tiered Dugong Protection Area (DPA) system was declared under the *Fisheries Act 1994* (Qld) by the Fisheries Amendment Regulation (No. 11) 1997 (Qld). Zone A DPAs represent significant dugong habitat where foreshore set nets and offshore set and drift nets are prohibited (except in the Hervey Bay-Great Sandy Strait Protection Area, where specialised fish netting practises are allowed to continue with modifications). Mesh netting is permitted in Zone B DPAs, but with restrictions on the type, size and locations of nets, and requirements for net attendance. The Nature Conservation (Dugong) Plan 1999 (Qld) was implemented under the *Nature Conservation Act 1992* to reduce the mortality of dugongs in commercial gill net fisheries in Queensland waters. A series of management arrangements specific for the East Coast Inshore Fin Fish Fishery (ECIFFF) also provides protection for dugongs in Queensland.

Monitoring the incidence of dugongs that are sick, injured or dead provides a measure of the effectiveness of the above legislation for maintaining sustainable dugong populations. StrandNet is the database where these data are recorded in Queensland. This report presents a summary of the dugong strandings data recorded in 2011.

Methods

StrandNet is an Oracle database which summarises all records of sick, injured or dead marine wildlife reported to the Department of Environment and Heritage Protection (EHP). EHP has managed StrandNet since March 2012, when the Department of Environment and Resource Management (DERM) was divided into five new departments. The previous departmental names are used in the current report, because the data were collected prior to the restructure.

The term 'stranding' is here used to include sick, injured or dead dugongs that were washed ashore or encountered at sea; in addition to dugongs which were entangled in fishing nets/synthetic debris or rescued from a situation where they would have died had they not been rescued (Geraci and Loundsbury 1993).

In 2011, most dugong strandings were reported by staff from DERM or the Great Barrier Reef Marine Park Authority (GBRMPA). Other records were received directly from the public, including records reported via the state-wide stranding telephone hotline (1300 264 625). Records from the Queensland Shark Control Program (SCP) were received from the Department of Employment, Economic Development and Innovation (DEEDI, now the Department of Agriculture, Fisheries and Forestry). Officers from DERM, GBRMPA or DEEDI inspected carcasses that were accessible.

Records were lodged in StrandNet by registered users via a web-based interface and each stranding record was assigned a unique identification number, prefixed by 'W' for marine mammals, unless the animal had been assigned a pre-existing tag number. A report of a dugong where the species could not be confirmed, or where there was insufficient evidence to establish whether the stranding occurred at the time and location reported, was entered into StrandNet as an unconfirmed report (coded as '?'). Additional details that were recorded include the coordinates, location details and date of the report; the sex, life-history stage, size and condition of the animal, and the fate of the animal or carcass. Where available, photos were attached to the record.

Records were then verified by a regional Stranding Coordinator. This process was overseen by the state-wide Stranding Coordinator to ensure that records were accurate, complete and consistent. The cause of death was established by trained staff examining the carcass and/or photographic records, or by necropsy. Only carcasses that were readily accessible to DERM staff and that were not showing signs of advanced decomposition were necropsied, either by a regional veterinary surgeon, at the University of Queensland's School of Veterinary Science (UQSVS) or James Cook University (JCU). Necropsy reports were then uploaded to StrandNet. For those dugongs not adequately examined, the cause of death was recorded as unknown.

It is recognised that StrandNet represents only a proportion of sick, injured or dead dugongs occurring in Queensland. The number of carcasses or debilitated animals that reach the shoreline depends on factors such as currents, wind and carcass buoyancy, and losses to scavengers (Peltier *et al.* 2012). This also means that a carcass or debilitated dugong may drift substantial distances from the location before stranding.

Although StrandNet has systematically recorded dugong strandings from Cairns to the Queensland–New South Wales border since 1996, coverage is less comprehensive in sparsely populated areas of the Gulf of Carpentaria, Torres Strait and eastern Cape York Peninsula. It is acknowledged that most hunting of dugongs is not reported to StrandNet. There are very few records of hunting in the Torres Strait, for example, where a high level of hunting occurs (Marsh *et al.* 2004). Illegal hunting in Queensland is only generally reported when encountered by DERM or GBRMPA staff. 'Legal hunting' refers to hunting by Aboriginal or Torres Strait Islander people which is allowed under various State or Commonwealth laws, and is reported voluntarily.

It is also acknowledged that fisheries bycatch records in StrandNet may be incomplete. Dugongs can be unintentionally caught as bycatch in nets or other gear associated with fisheries activities. Since 2002, it has been a Commonwealth and State obligation for commercial fishers to report interactions with all protected species including dugongs in their Species of Conservation Interest (SOCI) logbook. Where available, bycatch records in the Fisheries Queensland annual fisheries updates (http://www.daff.qld.gov.au/28_10916.htm) were checked against records in StrandNet.

Results

Number and distribution of strandings

A total of 199 records were received by the Queensland Strandings program in 2011, representing 250 dugongs, because six records related to hunting incidents which each included more than one dugong. Ten of these records could not be confirmed by trained experts and are not analysed further, leaving 240 confirmed cases of dugongs.

In total, 237 mortalities were recorded. An additional two dugongs were released alive *in situ* and a third was alive and left to natural processes.

The six recorded incidents of indigenous hunting accounted for an estimated minimum of 57 dugongs. Legal indigenous hunting of 33 dugongs was reported in the Mapoon area on the western Cape York during April. Investigations of the five other reports of dugong hunting in 2011 were unable to ascertain whether these were legal or illegal hunting incidents. Similarly, except for the Mapoon report, it was not always possible to determine exactly how many dugongs were taken in each incident. The spatial and temporal distribution of strandings is therefore analysed with and without the indigenous hunting records.

Excluding records of hunting, 183 dugongs were recorded to have stranded in 2011 (Figure 2). This represents the largest annual total recorded in StrandNet since comprehensive recording commenced in 1996 (Figure 2). In terms of the geographic distribution of records during 2011, eighteen per cent of dugong strandings (44 of 240 dugongs) came from the Hervey Bay to Moreton Bay region, which corresponds to 24 per cent of dugongs if hunting is excluded (44 of 183 dugongs). The number of stranding records for Moreton Bay and Hervey Bay was the same (21 dugongs in each region, Table 1). The Bowen to Cardwell region accounted for 40 per cent of strandings (96 of 240), or 51 per cent of non-hunting records (94 of 183 dugongs) (Table 1).

In total, 41 dugong carcasses were examined in detail (Table 4). Histopathology samples were examined in 14 of these cases.

Strandings and mortality from natural causes

Mortalities:

- Suspected shark attack:
    - W2423. 14/01/201. Cardwell region. No necropsy undertaken. Biopsy samples taken for genetic analysis
    - W2474. 19/06/2011 in the Cairns region. Necropsy performed at JCU.
- Extended ill health. 12 cases: three adults, seven immature dugongs and two calves. These dugongs were all characterised by very poor body condition, as determined from external examination and/or by fat layers after dissection. No strong spatial-temporal clustering was evident - cases occurred between April and November, 2011 and spanned locations from 15°S to 20°S.
- Pneumonia: W11171. 7/09/11. Moreton Bay. Severe and extensive pneumonia. Poor condition. Extensive secondary infection of the skin, mild parasitic infection (trachea and vasculature). Necropsy and histopathology analysis at UQSVS. Rich mixed growth consisting of *Morganella morganii*, *Pasteurella multocida* and *Serratia marscesens* from the lung lesions (Dr Helen Owens, UQSVS).
- Suspected pneumonia:
    - W2504. 6/07/11. Dicksons Inlet, Port Douglas. Necropsy by Dr Rod Gilbert, Marlin Coast Veterinary Clinic. Histopathology samples analysed by IDEXX Laboratories.
    - W2481.10/06/2011. Rodds Bay area. DERM experts suspected net entanglement based on superficial damage to head and fin. Samples and photos were sent to UQSVS. Tissue examination did not indicate clear inflammatory reactions or haemorrhaging around the skin lesions therefore they may have occurred post mortem. The suspected cause of death was locally extensive heterophilic pneumonia, and serous atrophy suggested protracted poor health/ suboptimal nutrition (Dr Helen Owens, UQSVS).
- Suspected traumatic injury to gastrointestinal system: W11182. 18/09/11. Hervey Bay. Necropsy by Dr Randall McKellan. Ruptured intestine but not sign of the cause. Samples were too decomposed for histopathology.
- Unidentified disease: 14 cases. June to September, 2011, and between 18°S and 27°S.

- Unidentified natural causes. W2470. 29/05/11. Trinity Beach, Cairns. Necropsy by Dr Mark Flint (UQSVS).

Strandings / dugongs in poor health (and were subsequently released/escaped alive):

- W228109. 23/09/2011. Bowen Region (mouth of Doherty Creek). External injuries attributed to social interactions with other dugongs. Released *in situ*.

Indigenous hunting

Six reports of indigenous hunting were received in 2011. As discussed in the Methods section, it is acknowledged this is an underestimate of the actual number of hunting incidents.

- W11112. 15/03/11. Mapoon. 33 dugongs legally hunted at Mapoon between February and March 2011.
- W2491. 23/06/11. Western Beach on Rocky Island, Mackay region (Stewart Peninsula - Newry Island - Ball Bay DPA Zone A). The remains of one dugong were reported. DERM investigated whether it was legal or illegal but the case remains unsolved due to lack of evidence.
- W11157. 22/08/11. Mackay region (Stewart Peninsula - Newry Island - Ball Bay DPA Zone A). The remains of one dugong were reported. DERM investigated whether it was legal or illegal. The case remains unsolved due to lack of evidence.
- W11161. 23/08/11. Starke River (north of Hopevale). Butchered remains of one dugong were found near the remains of two marine turtles. DERM investigated but the case remains unsolved.
- W228188. 15/09/11. Starke River. Report received from indigenous commercial crab fishermen that more than 20 dugongs had been hunted in the area over a period of three days. Large amounts of dugong viscera at the Starke River crossing were reported by another commercial fisherman. Investigation by compliance did not find sufficient evidence to determine whether illegal hunting occurred.
- W228170. 21/09/11. Butchered remains. Close to the mouth of the Starke River. Not thought to correspond to the earlier incident. Investigated but the case remains unsolved.

Other anthropogenic causes of strandings and mortality

Interactions with vessels

- W2480. 22/06/2011. Calliope River, Gladstone Region. Necropsy performed by Dr Scott McAuley from the Gladstone Veterinary Clinic. Toxicology and histopathology samples were sent to the UQSVS. Gross examination indicated significant haemorrhaging across back of neck and right side of spine, larynx damaged and blood in lungs. A large vessel strike was therefore noted as the suspected cause of death. The dugong was a large male in good condition at death (i.e. good fat layer) and there were no indications of an alternative cause of death from the histopathology, but autolysis may have masked subtle changes (Dr Helen Owen, UQSVS).

Fisheries-related activities

- W2447. 18/03/2011. Trinity Beach. Abdominal cavity opened. Ongoing compliance investigation.
- W2476. 18/06/2011. Princess Charlotte Bay. Commercial fisherman was suspected to have caught the dugong in a gill net in a Special Management Area of the Far North Management Area of the Great Barrier Reef Marine Park [*Great Barrier Reef Marine Park Zoning Plan 2003* (Cwlth)]. Ongoing compliance investigation.
- W2483. 20/06/2011. Calliope River, Gladstone Region (DPA B). Commercial bycatch in barramundi fishery. Animal released *in situ* and the incident was reported by the fisherman.
- At the time of writing, SOCI bycatch records were not yet available for Queensland fisheries for the reporting period (http://www.daff.qld.gov.au/28_10916.htm; accessed November 15, 2012). The exception to this was the River and Inshore Beam Trawl Fishery, for which no dugongs were reported between January and June 2011.

Queensland Shark Control Program

- W11143. 30/04/2011. Trinity Beach. Gill net entanglement.
- W2456. 11/04/2011. Noosa. Gill net entanglement. Good condition juvenile male. Necropsy and histopathology performed at UQVS. Marked autolysis.
- W2424. 8/01/2011. Mackay. Gill net entanglement.

Entanglement (synthetic material not related to fisheries activities)

- W2439. 20/02/2011. Turtle Bay, Cairns Region. Suspected entanglement in plastic debris. Reported by a member of the public. The dugong was swimming freely and was not stranded or captured for examination.

Rescued, natural escape and/or rehabilitated animals

Two dugongs were released alive and a third was alive and left natural processes. Full case histories are provided above (W2483, W228109 and W2439).

Marine Protected Areas (MPAs) and Dugong Protection Areas (DPAs)

Dugong strandings within DPAs and Marine Protected Areas (MPAs) are summarised in Table 5 (note that MPAs and DPAs may overlap). 122 stranding records were received for dugongs within MPAs in 2011. 77 mortalities and two live strandings occurred within DPAs. Four incidents were associated with human-related activities within DPAs in 2011:

- two hunting incidents (W2491, W11157) were investigated in the Stewart Peninsula - Newry Island - Ball Bay DPA A, but whether or not these were legal remain unsolved due to lack of evidence.
- one report was received in the Gladstone-Rodds Bay DPA B (W2483, 20/06/2011) of a dugong that was entangled in a commercial set-net in the barramundi fishery. This dugong was released alive *in situ.*
- one report was received for a dugong that was suspected to have been killed by a vessel strike in the Calliope River (22/06/2011, W2480),
- Full case histories of W2491, W11157, W2483 and W2480 are reported in the results above.

Sex and life-history stage of dugongs

Sex did not differ from random for either adult (binomial test, $p = 0.15$) or immature dugongs (binomial test, $p = 0.78$) (Table 6). Only 9 calves were sexed. Adults represented 56 per cent of strandings where the life history stage was recorded, immature dugongs represented 30 per cent of strandings and calves represented the remaining 14.

Discussion

Dugong strandings in relation to the extreme weather events 2010-11

Mortalities of dugongs in 2011 were the highest recorded in Queensland since comprehensive data have been collected (1996). Even if the single largest identifiable cause of mortality (hunting) is excluded, more than twice the number of records were received in 2011 than in 2010, and more than three times the number of records were received in 2011 than in 2009. The spatial-temporal distribution of mortalities and strandings, and historical experience (e.g. Preen and Marsh 1995; Gales *et al.* 2004; Marsh and Kwan 2008) suggest that the elevated number of strandings in 2011 is likely to be because of extreme weather events of summer 2011-11 and associated disturbance to seagrass pastures.

Dugongs are seagrass specialists (Heinsohn and Birch 1972; Marsh *et al.* 1982), and a number of studies have attributed local declines in dugong density, or elevated mortality rates to major seagrass loss (Heinsohn and Spain 1974; Preen and Marsh 1995; Gales *et al.* 2004; Marsh and Kwan 2008). Extreme weather events such as cyclones can impact directly on seagrass and dugongs (Marsh 1989). Floods and elevated river discharge increase the export of nutrients and suspended sediments into coastal waters, which impact on seagrasses by reducing the availability of photosynthetic light or modifying sediment characteristics (Campbell and McKenzie 2004). It is also possible that flooding increases the exposure and/or susceptibility of dugongs to disease.

In 1992, two floods and a cyclone resulted in the loss of around 1000 km^2 of seagrass in Hervey Bay (Preen *et al.* 1995). A total of 99 dugong carcasses were subsequently recovered (Preen and Marsh 1995). Prior to this event, it was estimated that 22 per cent of the population were calves and after this event, in 1993, it was estimated that only 2.2 per cent of the population were calves. Comparisons between aerial surveys before and after the event, and anecdotal reports suggested that dugongs also moved away from the most severely impacted areas.

It is expected that similar responses to damaged seagrass occurred during 2011. Compared to historical trends, reports of dugong strandings in 2011 were especially elevated in the tropics between 18°S and 20°S. Cyclone Yasi crossed the Queensland coast near Cardwell (18°15'S) in February 2011, and resulted in extensive seagrass loss in the Missionary Bay-Hinchinbrook area (near Cardwell) and in Cleveland Bay (off Townsville). Subsequently, the Bowen-Cardwell region (18°S to 20°S) accounted for 40 per cent of all stranded dugongs in 2011 (excluding hunting). Dugong strandings and mortality were also elevated in central to southern Queensland, compared to historical records. Seagrasses within Port Curtis, Moreton Bay and Hervey Bay were impacted upon by flooding and/or high levels of river discharge in the Burnett, Mary and Brisbane Rivers.

Spatial distribution of mortality and strandings records

The number of stranding reports was elevated across eastern Queensland. Compared to historical annual stranding rates (Table 1), notable 'hot spots' for dugong strandings occurred in the Townsville, Hervey Bay, Moreton Bay and Gladstone regions. Strandings in the Townsville region were close to threefold the 2010 rate and strandings in Hervey Bay and Gladstone regions were more than twice the 2010 rate.

The number of stranding reports for the Moreton Bay region was the highest since 1996, but not more than 20 per cent higher than in 2010, 2004, 2002 and 2000. Historical data indicate that Moreton Bay often has elevated dugong strandings and mortalities compared to other areas in Queensland. Whether this is because of higher stranding rates and/or higher reporting rates is not known.

Twelve strandings in the Gladstone region in 2011 (26/03/11 to 1/11/11) represented an elevated level compared to the previous five years, but this was comparable to 2005 when 10 dugongs were recorded (Table 1). Ten of the twelve reports in 2011 occurred in the Port of Gladstone-Rodds Bay DPA, including the dugong that was released alive in the Calliope River after net entanglement. The eleventh dugong was recorded further north near Yeppoon (W2449) and the twelfth was recorded east of Curtis Island (W2468).

Necropsies were undertaken in four of dugongs stranded in the Gladstone region, and of these, tissue samples were examined in detail for three cases (the fourth was too decomposed for histopathology). In two of these necropsies, the cause of death could not be confirmed. Of the remaining two, pneumonia was suspected to be the cause of death in one dugong (W2481, full details above) and an interaction with a large vessel was the suspected cause of death in the other (W2480, full details above). The dugong that was suspected to have died of pneumonia had poor condition and low fat reserves, suggesting protracted ill health/suboptimal nutrition (Dr Helen Owens, UQSVS).

Temporal distribution of mortality and strandings records

The overall seasonal pattern of dugong strandings in 2011 was similar to that of previous years, with a winter peak and an approximate normal (i.e. Gaussian) month-frequency distribution (Figure 6). In southern Queensland (south

of 24°S), the monthly rate of strandings in 2011 exceeded historical monthly averages from winter to early spring (June – September, Figure 7) and peaked in August. In northern Queensland (north of 24°S), strandings exceeded average monthly averages between March and October (Figure 7), peaking in July. Although comparatively few dugongs had condition recorded, there was again a clear peak in the number of stranded dugongs in poor or very poor condition in winter to early spring (July and September), with a secondary peak in April (Figure 7).

Long-term data also indicate seasonality in dugong stranding rates, and that this seasonality is generally more pronounced in southern Queensland with a clear peak in late winter-early spring (Figure 7). Possible reasons for this include winter temperatures and/or seasonal changes in seagrass production (Marsh *et al.* 2011). How water temperatures affect mortality rates of dugong populations that were already stressed by reduced food resources is worth investigating, especially towards the southern limit of the species range in southern Queensland. Even so, these results highlight how temporal patterns of mortality after an extreme weather event should to be interpreted with caution. It is also possible that floods impact directly on dugong health by increasing exposure to pathogens or contaminants, or by increasing disease susceptibility. Unfavourable environmental conditions or malnutrition can increase susceptibility to diseases in marine mammals by affecting immunocompetence (Bossart 2007; Halvorsen and Keith 2008).

Anthropogenic causes of mortality

Despite undertaking a record number of necropsies in 2011, the number of deaths attributable to anthropogenic activities (excluding hunting) were similar to that recorded in previous years in the StrandNet program.

Net entanglement and vessel strikes are considered to be the major direct anthropogenic threats to dugongs in urbanised and near-urban sections of the Queensland coastline (Grech and Marsh 2008). Data presented in this report indicate that these threats were unlikely to have caused significant mortality in 2011.

The number of reported fisheries-related interactions was less than in 2009 or 2010, with two suspected cases of mortality from net entanglement and one that was released alive after net entanglement. This latter case occurred within a DPA Zone B – underscoring the importance of continued monitoring of DPAs and education of the public of the regulations. At the time of writing, the Fisheries Queensland annual status report for the East Coast Inshore Fin Fish Fishery was not available for 2011, but no dugong bycatch was reported in 2011 for the Gulf of Carpentaria Inshore Fin Fish Fisheries. Three dugongs were entangled in mesh used in the SCP; at Noosa, MacKay and Trinity Beach.

The number of stranded dugongs reported with vessel-related injuries was less that of previous years, with one case of a dugong suspected to have been killed by an interaction with a large vessel. This dugong was suspected to have been killed by a vessel strike in the Gladstone region (a large vessel in the Calliope River) in June 2011.

Indigenous hunting is considered to be the major anthropogenic mortality source to dugongs in remote regions (Heinsohn *et al.* 2004; Marsh *et al.* 2004; Grech and Marsh 2008). Hunting was the largest single anthropogenic source of dugong mortality recorded in 2011. The six hunting reports in 2011 were for incidents which occurred in three general areas, the Mackay region in central Queensland, the Starke River area in northern Queensland and Mapoon area of the western Cape York. No reports were received for areas south of Mackay. Of the records received for 2011, the records from the Starke River region are of the greatest concern because they were suspected to be from illegal hunting and were estimated to have included at least 23 dugongs. The cases were investigated by DERM staff but remain unsolved.

Although the reporting rate of hunting incidents has improved in 2011 compared to previous years, it is cautioned that that not all hunting mortality is reported, nor is the reporting rate likely to be constant across all areas. Further, with the exception of records provided by indigenous rangers such as in Mapoon, it can be difficult to determine whether a hunting incident is legal or illegal. Indigenous hunting therefore remains the largest source of uncertainty in estimating levels of anthropogenic mortalities to dugongs in Queensland

Perspectives on monitoring dugong mortalities

Dugongs undergo large-scale movements (Holley *et al.* 2006; Sheppard *et al.* 2006; Whiting 2008) and are often difficult to detect in surveys, leading to large variability in population estimates. Management actions have therefore often depended on detecting anthropogenic mortalities rather than population declines (Lanyon 2003; Marsh *et al.* 2004).

This approach highlights the need for accurate and complete records of anthropogenic mortalities, particularly given the fact that (a) some carcasses are too decomposed to identify the cause of death, (b) not all carcasses can be recovered if they occur in remote locations, and (c) human-related mortalities such as net entanglements are difficult to identify without detailed necropsies and histopathology.

Of the 180 reported non-hunting mortalities in 2011, a cause of death was identifiable in 42 cases - representing 23 per cent of cases. While this is proportionally lower than recent years in the Queensland Marine Wildlife and

Strandings Program (2010: 47%; 2009: 39%; 2008: 40%), it represented the most identified in a given year and the result of substantial effort by DERM and its partners.

Conclusion

In summary, the high number of dugong mortalities recorded in 2011 was likely to have been because of (a) an increase in the reporting rate of indigenous hunting and (b) seagrass loss associated with the extreme weather events of 2010-11. Ongoing research at EHP, JCU and UQ will improve understanding the link between extreme weather and the health and population dynamics of dugong populations.

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Table 1. Geographical distribution of dugong strandings in Queensland, 1996 to 2011(refer to Figure 1 for latitudinal block locations). Subscripts denote stranded dugongs that were released or left to natural processes. ^{h}, hunting (legal or illegal); GC, Gulf of Carpentaria; ?, unconfirmed report.

Year	GC	Qld (east coast in 1° latitude blocks)																				Total
		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
1996*											9_1	1	2	4	1	1	2	9	3	4		36_1
1997*										1	2	8	3		4	1	2	4		10_1		35_1
1998*									1		2_1	4+1?	3	1	1	1	1	11_1+1?		6+1?		31_2+3?
1999*	1							1+1?	12		9	16_1	4	3		1+1?	3	17_1	2	1		70_2+2?
2000*								1	6_1	2	12_3	18_1	2	2	1	2	5	11_1	4	17_2		83_8
2001*	2						1		1	1?	11_1+1?	8		1	1	2_1	6	9+2?	1	6+1?	1?	49_2+6?
2002*								1			1	3	3		1+1?	3	3	6_1+1?	1	19+1?		41_1+3?
2003*	1			1					1_1+1?		2+2?	1+3?	2	4	1+1?	4	1	9		11		38_1+7?
2004*							2	1	1+1?		2	2+1?		1	2	4		4	1	18_1+1?		38_1+3?
2005*							1	1	4		2+1?	4	1			9_1+1?	2	4		8+2?		36_1+4?
2006*	1								3	1	1	3	1	2+1?	3	3		4		14+1?		36+2?
2007*		3						1	4+1?		2	8+2?	1+1?	3	2	2	1	2+1?	1	10+2?		40+7?
2008*	1								1	1	2	5+1?		3	3	4+1?		7	3	11		41+2?
2009*	2								12_1+1?	1	7	12_1+3?		1	3_1	1	2+1?	13+1?		9		63_3+6?
2010*	1	2_1							17_1	6	5	18+3?	2+1?	2+1?		3_2	2	9	1	17		85_4+5?
2011	33^{h}						23^{h}	2	12_1	2	22	53+8?	18_{1+} 2^{h}+1?	4	8	11_1	2	21	2	21+1?		237_3+10?

Table 2. Dugong strandings by month and identified sources of mortality for Queensland. For each mortality source, the first column denotes cases where the cause of death was confirmed and the second column (italised) where a cause of death was suspected. Numbers in parentheses were subsequently released or escaped unaided. SCP: Queensland Shark Control Program.

Month	Total	Natural causes			Anthropogenic causes						Undetermined
		Disease or ill health	Predation	Other/un-determined	Boat strike/ fractures	Nets	Hunting	SCP	Entangle in rope/ chains	Other/ undetermined	
January	3		1					1			1
February	3(1)									*(1)*	3
March	42					*1*	33				8
April	11	1						2			8
May	10			*1*							9
June	16(1)	1 *1*	1		*1*	(1) *1*	*1*				10
July	43	2 *5*									36
August	38	1 *9*					*2*				26
September	48(1)	4 *4*					*21*				19(1)
October	11	*1*									10
November	8	*1*									7
December	4										4
Total	237(3)	9 *21?*	*2?*	*1?*	*1?*	(1) *2?*	33 *24*	3		*(1)?*	141(1)

Table 3. Summary of dugong strandings by year and identified sources of mortality for Queensland, 1996–2011. ?, unconfirmed report; [A] death during capture of a sick dugong; *data taken from Biddle *et al.* (2011). Numbers in parentheses were released or left to natural processes

Cause of stranding and mortality	Year															
	1996*	1997*	1998*	1999*	2000*	2001*	2002*	2003*	2004*	2005*	2006*	2007*	2008*	2009*	2010*	2011
Natural causes																
Disease and ill health	2	3	1+2?	4	14	7	2	4	1	2		2	2	7	16	30
Predation/predator attack	1?	1					1	1								2
Stingray barb					1											
Cause undetermined		2	1	2	2	2	1	1								1
Human related																
Boat strike/fractures	3	4	2		3	4	7	3	3+2?	1(1)+2?	2	2	2	3	4	1
Entanglement in floatlines and ropes					1		1	(1)	1		2		1			
Netting	4	5	1+1?	9	3(1)	2			2	3(1)	1	2	2	7	9(3)+3?	2(1)
Entanglement (other)																
SCP	3			2	2				2	1		2(1)	2	1	1	3
Ingestion of fishing line/hooks								2								
Research			1[A]													
Hunting	3	4	1	4		1	2	1	4			1			1	57
Disease: *Toxoplasmosis*								1								
Undetermined		1	1?	5	3		1	5	2	1	2	5+1?	5	4+1?	5	(1)
Undetermined causes	19(1)	18(1)	18(2)	40(4)+2?	47(6)+1?	31(2)+6?	24(1)+3?	19+7?	21(1)+2?	25(1)+2?	29+2?	23+2[R]+6?	23(2)+3?	38(3)+5?	45(1)+2?	141(1)
Total	35+1?	35+4?	27+4?	70+2?	83+1?	49+6?	40+3?	38+7?	37+4?	36+4?	36+2?	40+7?	39+3?	63+5?	85+5?	240+10?

Table 4. Examinations and necropsies of stranded dugongs in 2011 by carcass condition (excluding hunting records). Also shown is the number of carcasses with an identifiable cause of death (COD). The number examined refers to the carcasses inspected by DERM, DEEDI and/or GBRMPA. *, includes cases with either a confirmed and suspected cause of death.

Carcass condition	Description	Number recorded	Number examined	Number to necropsy	COD identified*
D1	Alive but subsequently died	3	0	2	2
D2	Dead, carcass fresh – suitable for pathology or resembling a carcass fresh enough for eating	33	0	16	20
D3	Dead, carcass fair – decomposing but internal organs intact	57	1	15	12
D4	Dead, carcass poor – advanced decomposition with internal organs falling apart	60	0	3	5
D5	Dead, mummified carcass with skin holding bones together	14	0	2	0
D6	Dead, disarticulated bones – no soft tissue remaining	6	0	1	0
D	Dead, not freshly dead, carcass condition not assessed	7	0	1	0
DL	Stranded dugong that escaped without assistance	1	0	0	1
DZ	Moribund but rescued/escaped	2	0	0	2
	Total	**183**	**1**	**40**	**42**

Table 5. Dugong strandings and mortality in (a) Dugong Protection Areas (DPA) and (b) Marine Parks. Numbers in parenthesis are dugongs that were released/escaped. ?, non-validated dugong report (note that Dugong Protection Areas and Marine Parks may overlap).

(a) Dugong Protection Areas (DPA)

Protected area		
Dugong Protection Area	**DPA A**	**DPA B**
Hinchinbrook Region	9	
Cleveland Bay–Magnetic Island – Bowling Green Bay Region	21+2?	5
Upstart Bay	5	
Edgecumbe Bay		4(1)
Repulse Bay Region		
Stewart Peninsula - Newry Island – Ball Bay Region	3	
Llewellyn Bay Ince Bay Region		
Clairview Bluff- Carmilla Creek		1
Shoalwater Bay	5	
Port of Gladstone - Rodds Bay		9(1)
Hervey Bay–Great Sandy Region		7
Total	8	
	51+2?	**26(2)**

(b) Marine Parks

Protected areas	**Total within Marine Park area**
Great Barrier Reef Marine Park*	93
Great Sandy Marine Park	23
Moreton Bay Marine Park	6
Total	**122**

* Includes both the Great Barrier Reef Coastal Marine Park and the Great Barrier Reef Marine Park.

Table 6. Dugong mortalities and strandings by life-history class and sex, 2011. An additional 57 dugongs recorded as hunted did not have any information on the sex or age class. The definitions of age class sizes used below follow those used in previous reports for consistency. However, more recently, Marsh *et al.* (2011) has described calves (neonates) as less than 1.3 m in length, immature females as between 1.3 and 2.27 m, immature males as between 1.3 and 1.9, and adults as larger than 2.5 m in length.

Sex	**Age class**				**Total**
	Calf (<1.8 m length)	Immature (1.8-2.2 m length)	Adult sized (>2.2 m length)	Not recorded	
Male	5	19	23	0	47
Female	4	11	27	2	44
Undetermined	6	25	53	8	92
Total	**15**	**55**	**103**	**10**	**183**

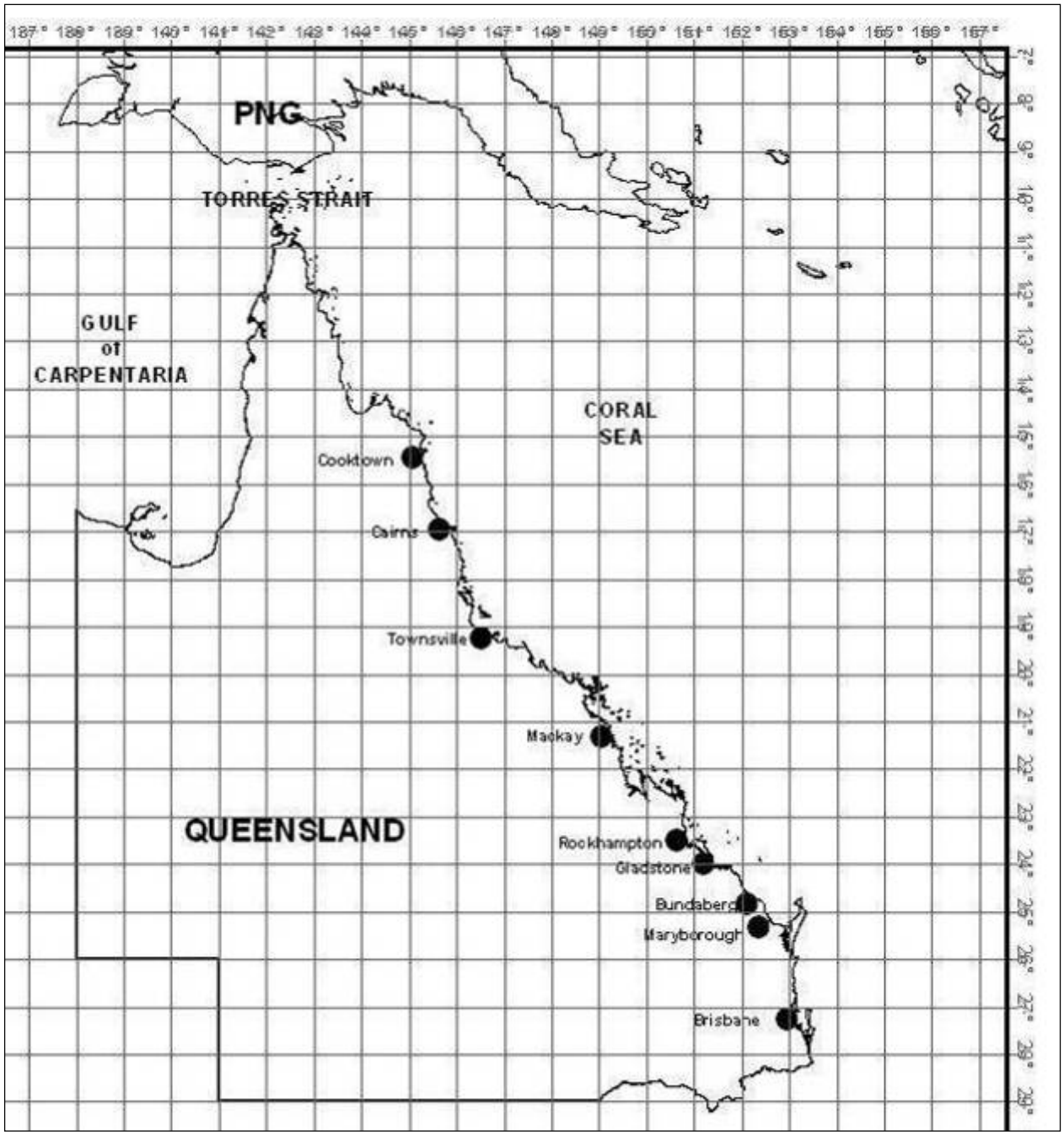


Figure 1. Queensland map showing latitudinal and longitudinal grids.

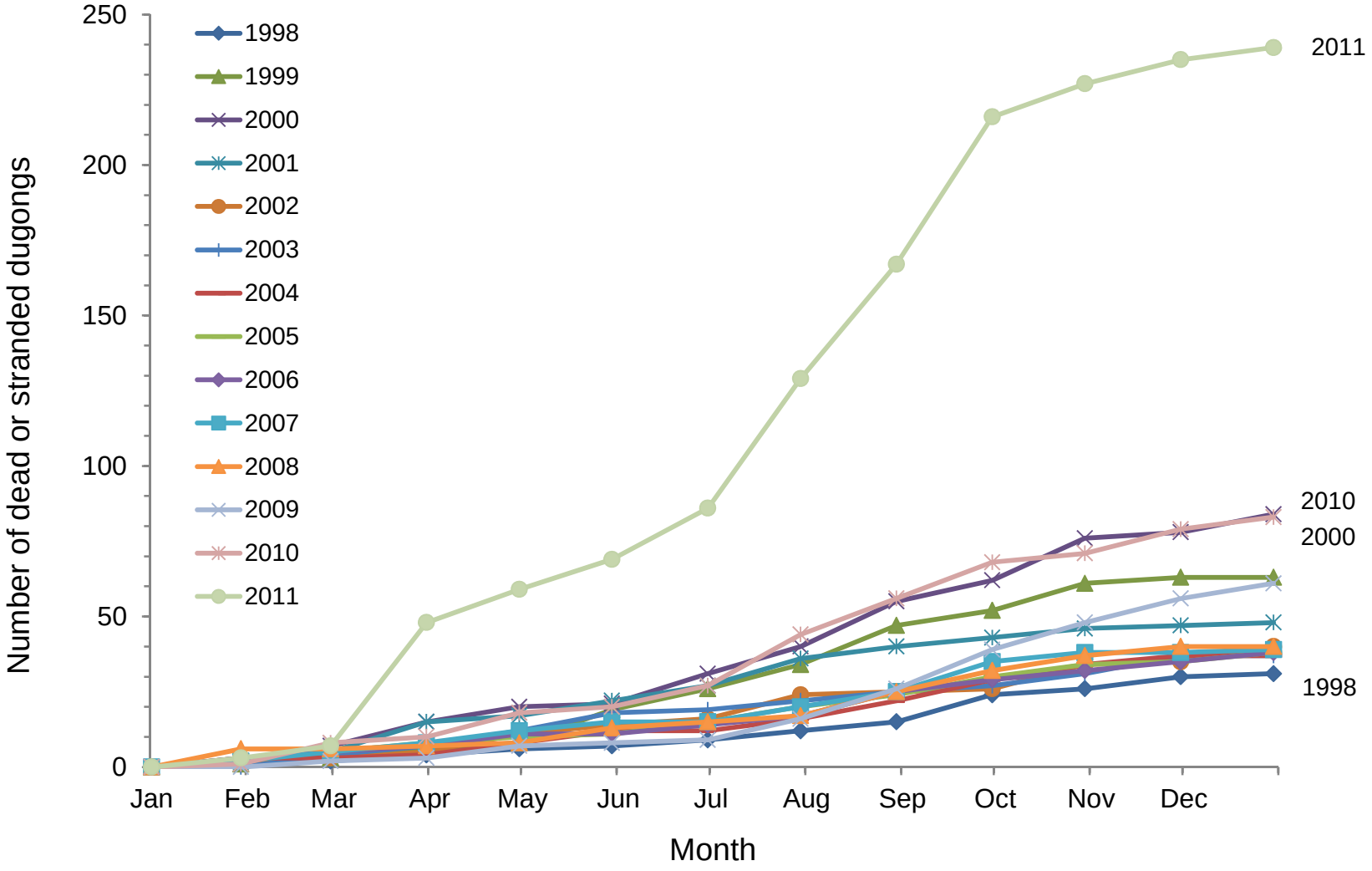


Figure 2. Monthly cumulative dugong strandings by year for Queensland (1998-2011). Only confirmed cases are included.

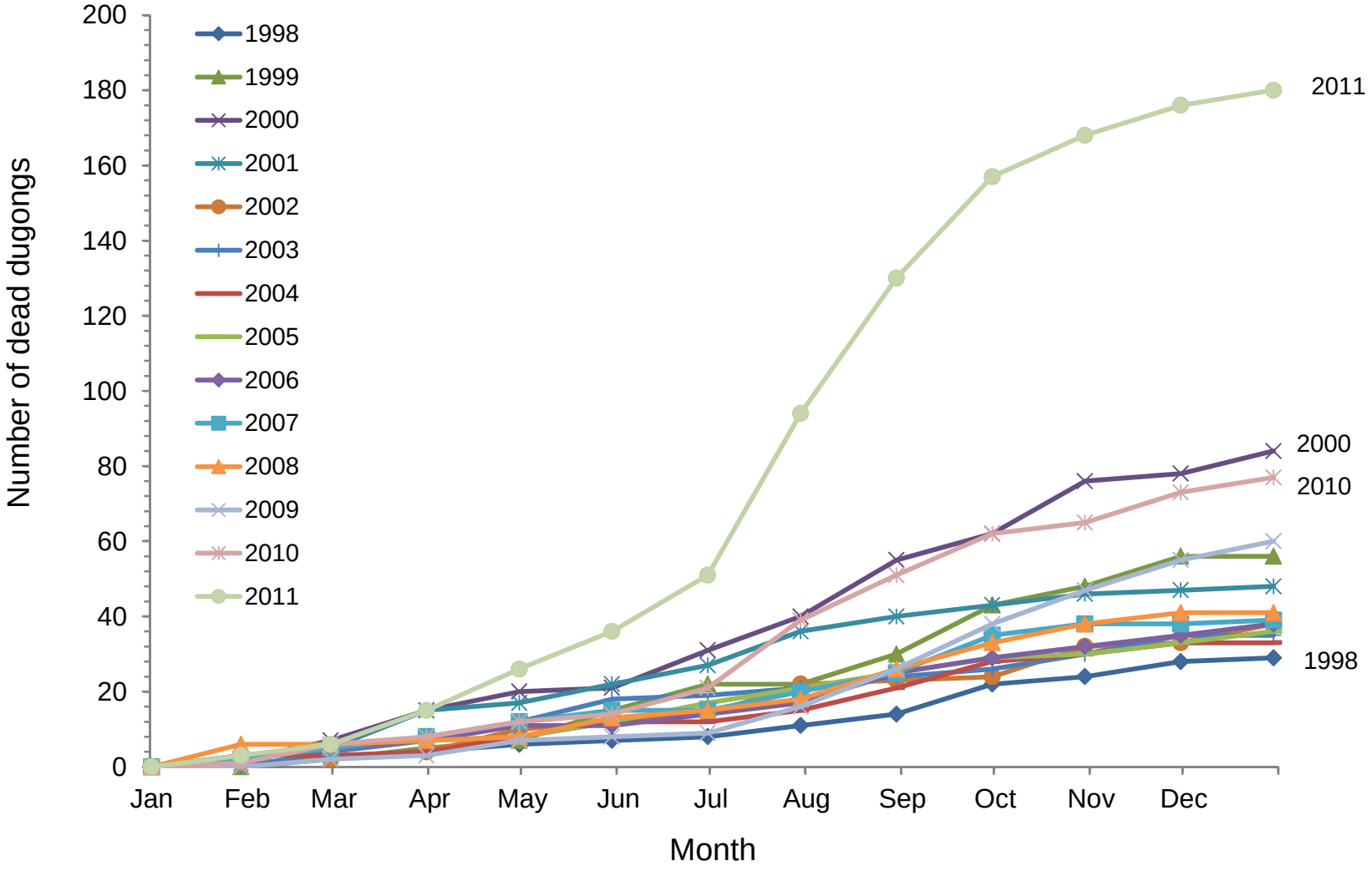


Figure 3. Monthly cumulative dugong mortality (excluding hunting reports) in Queensland by year between 1998 and 2011

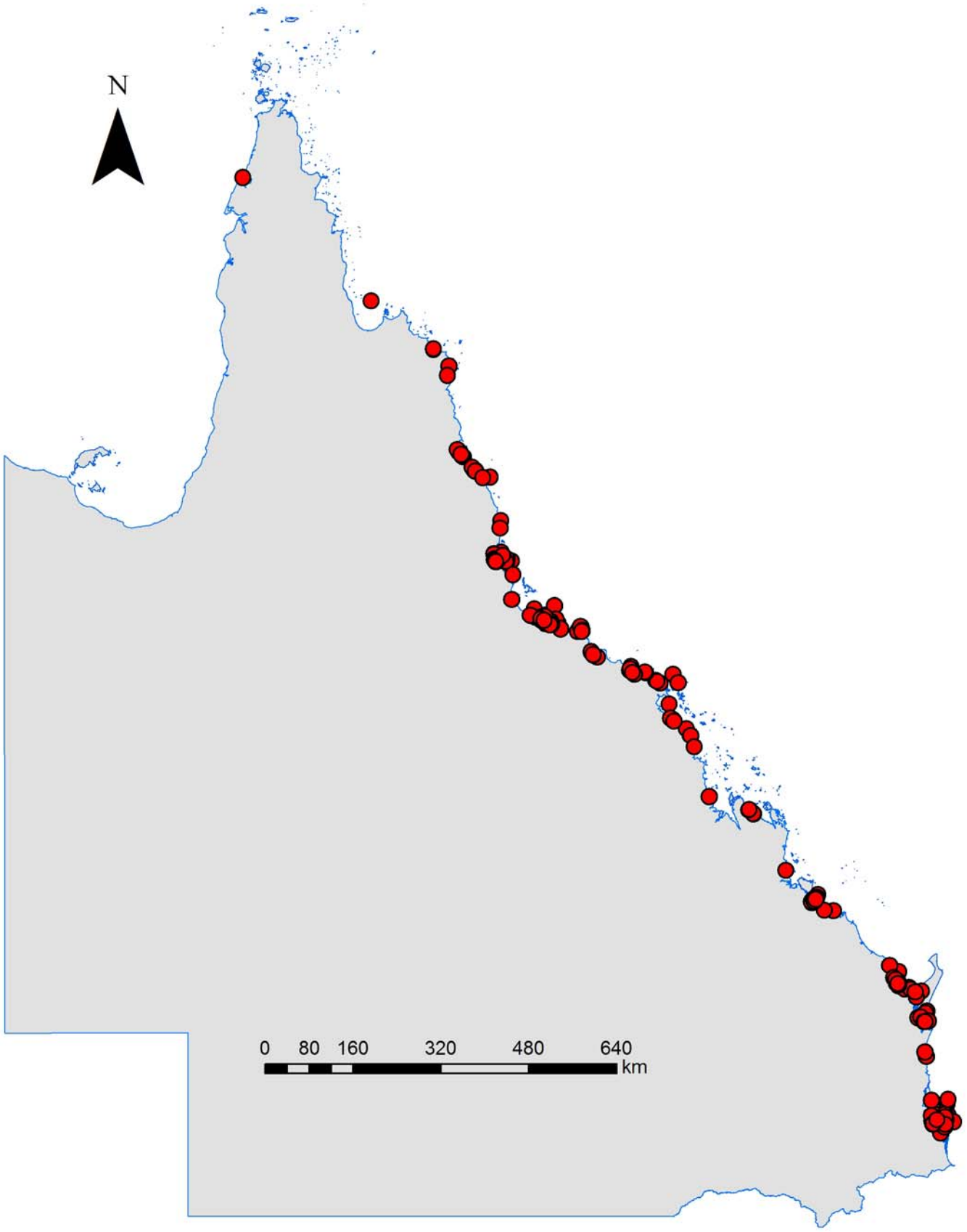


Figure 3. Distribution of dugong strandings in 2011. Only confirmed records are included.

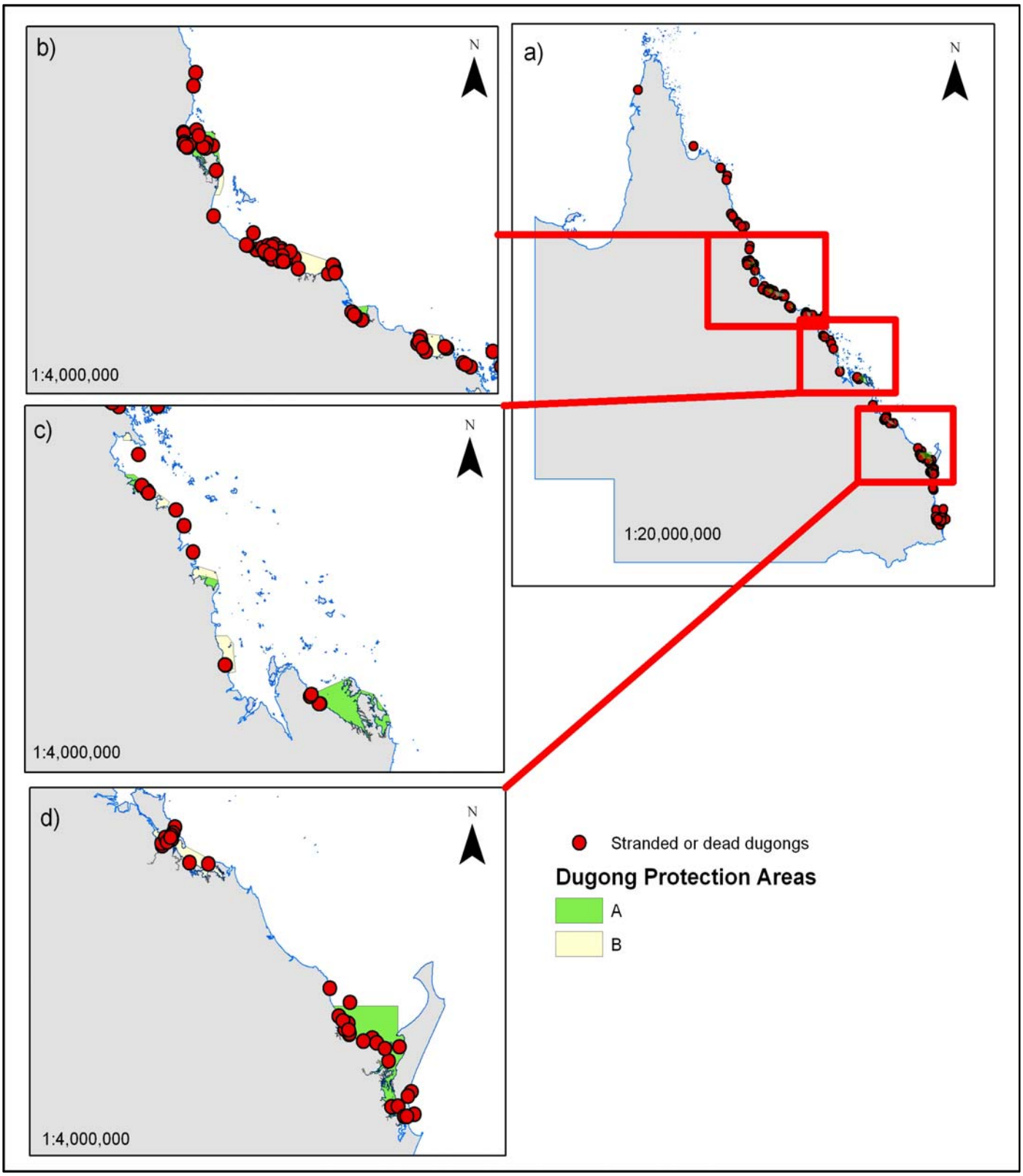


Figure 4. Dugong strandings within Dugong Protection Areas.

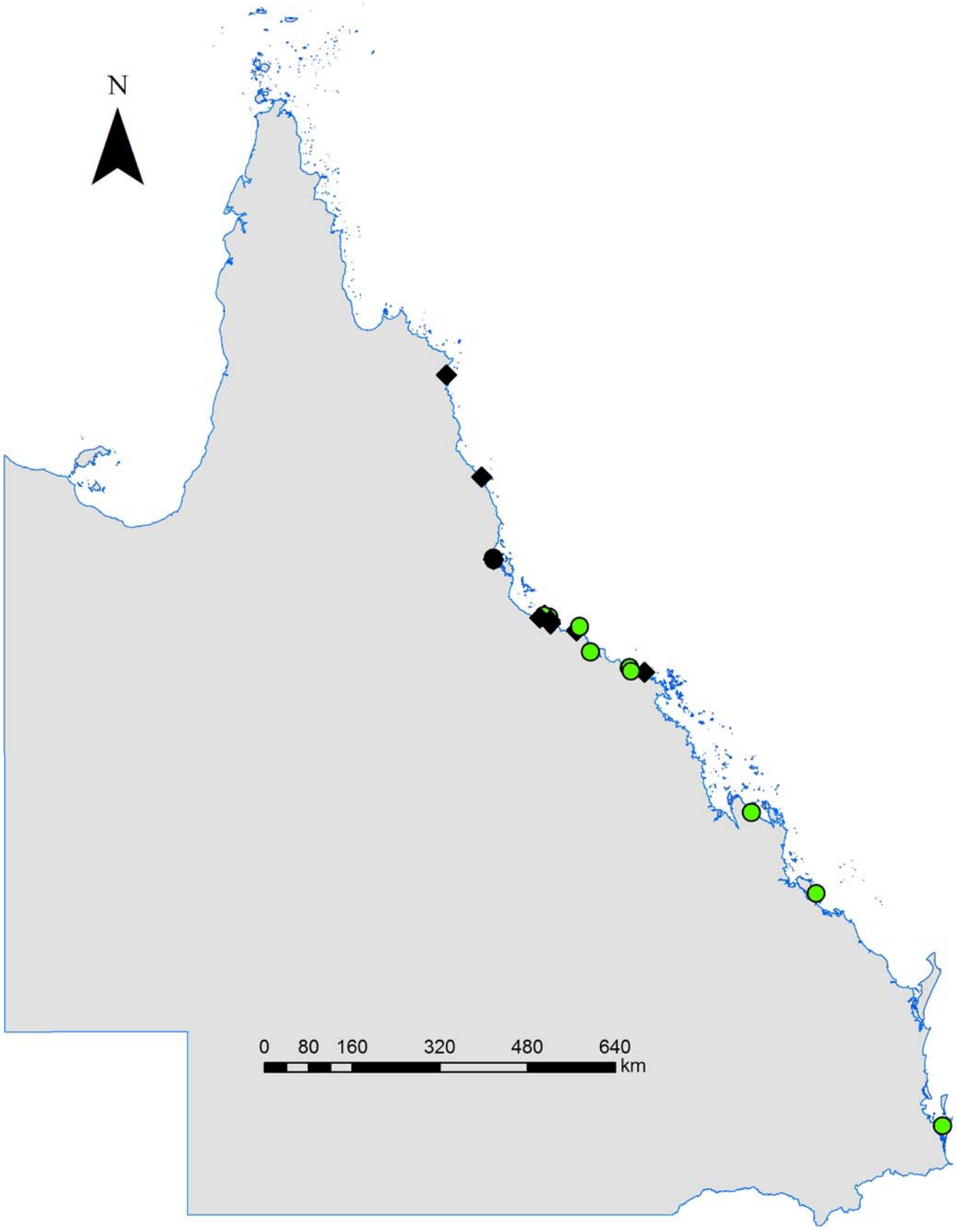
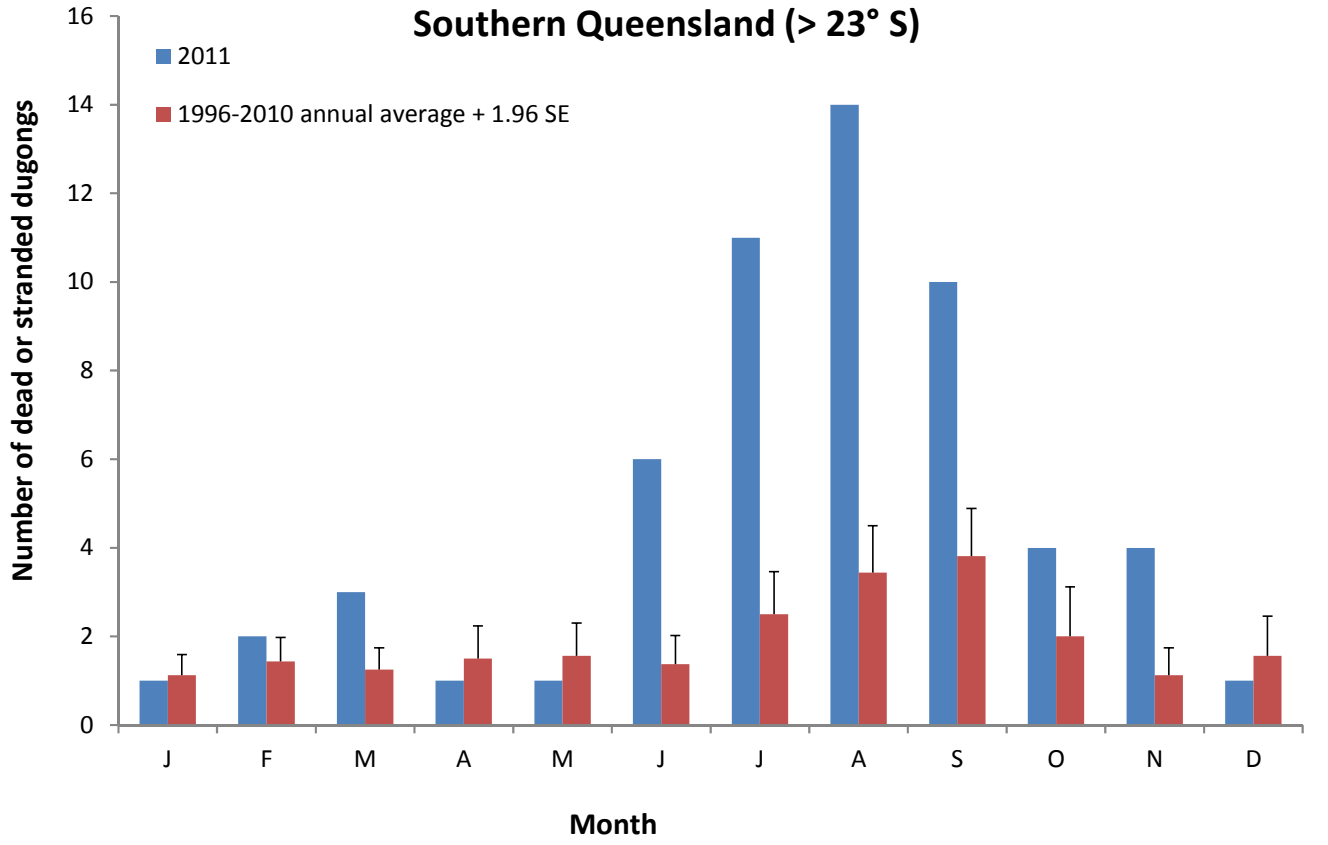


Figure 5. Condition of stranded dugongs in 2011. Black diamonds, very poor condition; green circles, poor condition. Only animals in poor or very poor condition are included because StrandNet does not distinguish between records where animals are in good condition and records where condition is not recorded.



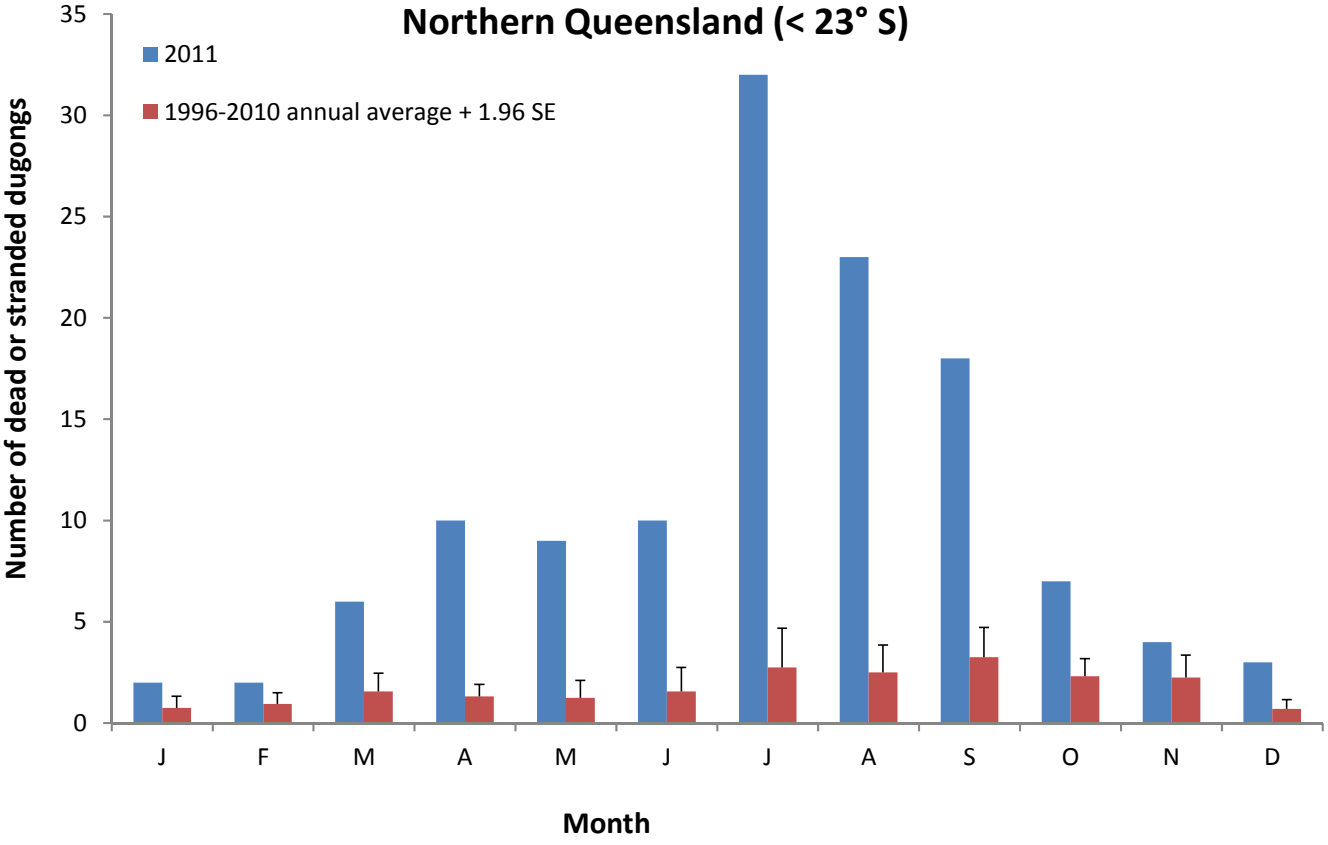


Figure 6. Seasonal trends in dugong strandings during 2011, compared to the long-term average (1995-2010). Hunting records and unconfirmed reports are not included.

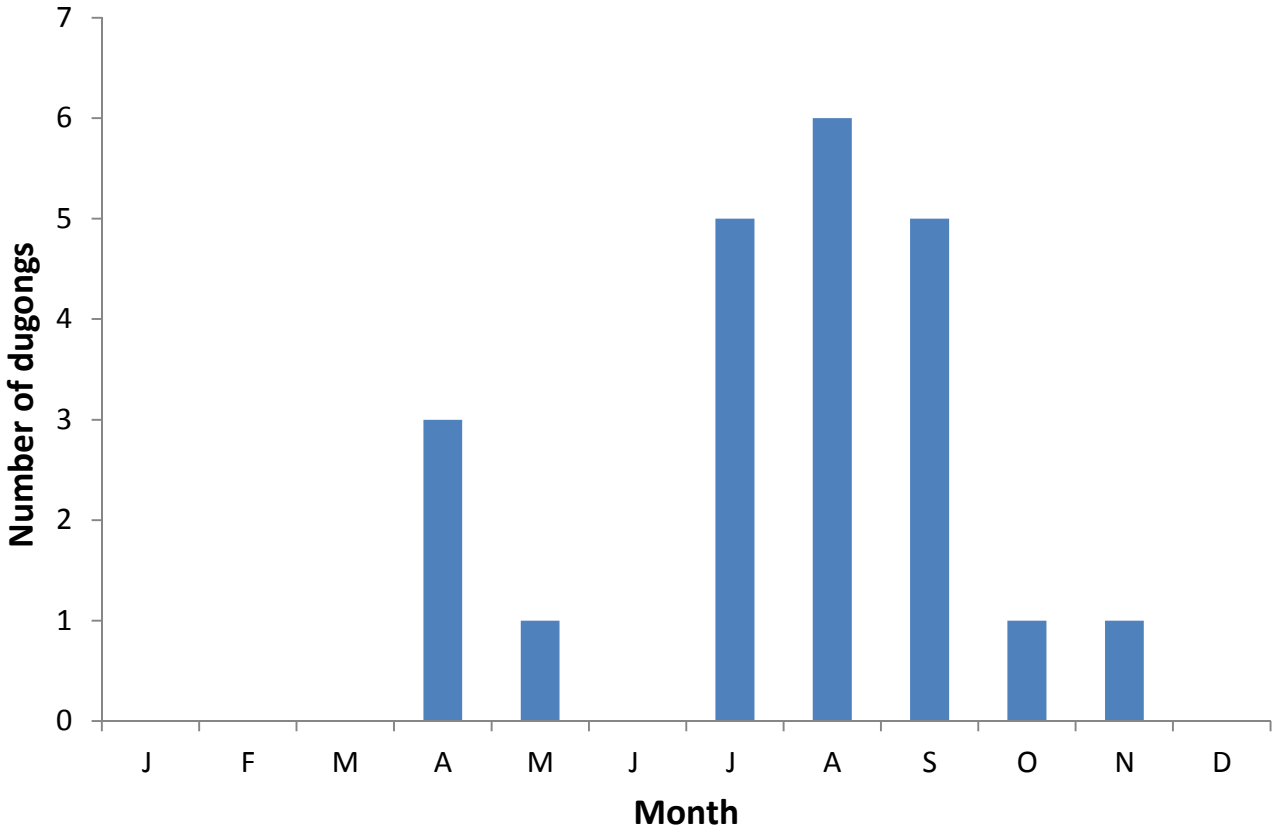


Figure 7. Number of reports of dugongs in poor to very poor body condition in 2011, by month.

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