Report

to

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THE STATUS OF DUGONGS, SEA TURTLES AND DOLPHINS IN THE TORRES STRAIT REGION.

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EXECUTIVE SUMMARY

In November-December 1991, dugongs, sea turtles and cetaceans were counted from the air at an overall sampling intensity of 5.8% over a total area of 30,560 km^2 in the Torres Strait region.

The population estimates for dugongs and sea turtles were corrected for perception bias (the proportion of animals visible in the transect which are missed by observers), and standardised for availability bias (the proportion of animals that are invisible due to water turbidity) with survey and species-specific correction factors. The estimates for cetaceans were corrected for perception bias only.

The minimum population estimate for dugongs for the survey area in Torres Strait in November-December 1991 (24,225 $\pm$ S.E. 3,276 dugongs), was significantly higher than the revised estimate for the same region in November 1987 using the same aerial survey technique (13,319 $\pm$ S.E. 2,136 dugongs). This difference between surveys is in marked contrast to repeats of similar large scale surveys in other areas, the results of which have been remarkably consistent. Our analyses suggest that this variation between surveys in Torres Strait is unlikely to be due to a difference in survey conditions which were slightly worse in 1991 than in 1987 or to the change in the availability correction factor.

The difference between the 1987 and 1991 population estimates represents a population increase of 82% if the 1991 availability correction factor is used for the 1991 data; 52% using the 1987 availability correction factors for both surveys. This change cannot be due to natural increase in the absence of immigration. We consider that the most likely explanation for the observed difference between surveys is that dugongs have migrated into the area.

Most of the turtles sighted during this survey were probably large green turtles. The population estimate for Torres Strait in November-December 1991 was 65244 $\pm$ S.E. 5338 at an overall density of 2.13 $\pm$ S.E.0.17 turtles per km^2 significantly higher than the revised estimate for the same region in November 1987 (43692 $\pm$ S.E. 4825 turtles at an overall density of 1.43 $\pm$ S.E. 0.16 per km^2). This difference between surveys cannot be explained by differences in sighting conditions, the change in the availability correction factor or the breeding migration of green turtles through Torres Strait. A major dieback of seagrass along the Irian Jayan coast would have adversely affected green turtles as well as dugongs and could have been a stimulus for the movement of both species. However, we have no evidence that such a dieback has occurred.

All the cetaceans sighted were dolphins. Most of the animals appeared to be bottlenose dolphins, *Tursiops truncatus,* or Indo-Pacific humpback dolphins, *Sousa chinensis*. The population estimates for November-December 1991 sum to 2265 $\pm$ S.E. 488 dolphins for the whole region at an overall density of 0.07 $\pm$ S.E.0.02 per km^2. Although the densities of dolphins observed in Torres Strait are within the range observed in some inshore areas in the Far North

Section of the Great Barrier Reef Marine Park, they were fairly low in comparison with the overall densities observed in similar large scale surveys in the Great Barrier Reef Marine Park and northern Western Australia.

RECOMMENDATIONS

1. That the continued collection and verification of dugong and turtle catch statistics from Torres Strait communities in both Australia and Papua New Guinea be given high priority. The Islanders should be encouraged to send dugong tusks to James Cook University so that the age-sex composition of the catch can be verified.

2. That the Papua New Guinean Government should be encouraged to enforce the ban on selling dugong meat in the Daru market.

3. That the dugong public education program be continued in the Australian communities and extended in collaboration with Papua New Guinea to the Papuan communities. The program should emphasise the vulnerability of the dugong to over-harvesting, the illegality of selling dugong meat and the current restrictions on dugong hunting in the sanctuary area and in the Great Barrier Reef Marine Park.

4. That the Papua New Guinea Government be encouraged to establish a dugong sanctuary in a high density dugong area in Papuan waters.

5. That in order to monitor numbers, this survey be repeated in November 1995 and at four yearly intervals thereafter. (November is the month when favourable weather conditions are most likely and in view of the high cost of transporting a suitable aircraft and survey crew to Torres Strait, it is likely to be a waste of money to attempt a survey at another time of the year). The survey crew should include at least two trained Islander observers.

6. That in order to evaluate the short-term repeatability of the survey technique, repeat surveys of Block 2A (the area with the highest density of dugongs in Torres Strait) should be resurveyed on five successive days in November 1993. This exercise would also provide an opportunity to train Islander observers.

7. That the Australian Department of Foreign Affairs be asked to approach their Indonesian counterparts about conducting a survey of the dugongs and seagrasses along the Irian Jayan coast west of Torres Strait as a cooperative initiative by both countries.

8. That a copy of this report be made available to each Community Council in Torres Strait. The report should be distributed in association with a personal presentation by a suitably-briefed Islander as part of the public education program and should be accompanied by a summary written for

non-scientists.

INTRODUCTION

The dugong, *Dugong dugon*, listed as vulnerable to extinction by the International Union for the Conservation of Nature (IUCN, 1986), has traditionally 'ranked highest among traditional Torres Strait foods' (Johannes and MacFarlane, 1991). In recent years, some local people (Johannes and MacFarlane, 1991) and scientists (e.g. Hudson, 1986; Marsh, 1986) have been concerned by an apparent decline of dugong catches in the area despite an increasing availability of motorised craft. During this period, turtle catches remained steady. As dugongs and turtles are hunted together and by the same methods, this suggests that fishing effort had not decreased and that the reduced dugong catches may reflect a decline in numbers (Johannes and MacFarlane, 1991).

A dedicated aerial survey of the major dugong hunting grounds in Torres Strait in November 1983 produced a minimum population estimate of 1,455 $\pm$ S.E. 276 dugongs (Marsh, 1986). It was appreciated that this was 'an underestimate, probably a gross underestimate of the Torres Strait dugong population' because the proportion of dugongs that were sighted under aerial survey conditions had not been calibrated. In 1987 and 1988, Marsh and Saalfeld (1988 and 1991) used an improved aerial survey technique to document the distribution and abundance of dugongs in Torres Strait. They corrected for perception bias (the proportion of animals visible in the transect which are missed by observers), and standardised for availability bias (the proportion of animals that are invisible due to water turbidity) with survey-specific correction factors. The resultant minimum population estimate in November 1987 was some 12,500 dugongs at an overall density of 0.4 km^{-2}.

On the basis of this survey and the population models of Marsh (1986), Marsh and Saalfeld (1991) estimated that the Torres Strait region could support an unselective harvest of between 300 and 700 dugongs per year. However, they could not predict whether the dugong harvest in Torres Strait was likely to be below the sustainable yield in the absence of adequate catch statistics and current information on the life history of the dugong. Marsh and Saalfeld (1988) recommended that the aerial survey be repeated at five-yearly intervals in order to monitor trends in the population, although they pointed out on the basis of a power analysis (Gerrodette, 1987) that it would probably be at least a decade before a trend could be established statistically.

Because of the availability of funding, the first repeat survey was held in November-December 1991, four rather than five years after the initial survey. As with the previous survey (Marsh and Saalfeld, 1988), sightings of cetaceans and sea turtles were recorded as well as dugongs although it is recognised that the technique is much less satisfactory for these animals than it is for dugongs. Accordingly, this report compares the distribution and abundance of both dugongs and sea turtles in Torres Strait in 1991 with the results of the 1987 survey (Marsh and Saalfeld, 1988, 1989) and provides information on the distribution and abundance of cetaceans in the survey area in November-December 1991. (The data for cetaceans collected in 1987 have not been analysed.)

METHODS

The western and central waters of Torres Strait and adjacent coastal waters of Cape York north of 10° 52'S were surveyed between November 16 and 30, and December 7 through 11 1991. During the first period, we were plagued by bad weather. Conditions suitable for surveying were experienced on only 6 of 13 possible flying days before we were forced to curtail the survey by aircraft malfunction. The weather conditions encountered during the 1991 survey are summarised in Table 1 along with those for the November 1987 survey; weather conditions for each day of the survey are summarised in Appendix Table 1, the glare and Beaufort sea state for each transect are detailed in Appendix Table 2.

Survey Design

The survey design (Figure 1) was similar to that used in November 1987 (Marsh and Saalfeld, 1988) except that:

(1) Because of the low density of dugongs observed in 1987, we halved the sampling intensity along the Papuan coast west of 143°E in 1991 by flying every second of the transects sampled in 1987.

and

(2) We did not fly south of the Escape River on the east coast of Cape York in 1991. This region was surveyed with funding from the Great Barrier Reef Marine Park Authority in 1987.

Navigation was performed using a Geographic Positioning System which was mounted in the aircraft.

For estimation of regional densities of dugongs, dolphins and sea turtles, the area was divided into 8 blocks (Figure 1) on the basis of sampling intensity and placement of transects. Block areas (Table 2) were estimated from 1:1,000,000 digitised topographic coverage (AUSLIG) using the Arcinfo GIS package. The areas of all islands were excluded from the block areas. The length of each transect was also estimated from the digitised maps using Arcinfo.

Survey methodology

The Partenavia 68B aircraft was flown at a groundspeed of 185 km h^{-1} (100 kn.) and at an altitude of 137 m (450 feet) ASL. The pressure altimeter was calibrated at each takeoff and landing. Transect width (200 m on each side of the aircraft at survey altitude) was demarcated by fibre glass rods attached to artificial wing struts. The actual width of each transect was estimated by calculating the mean survey height for that transect adding altimeter correction at each landing interpolated to the middle of the transect, assuming a combined transect width of 400 m at an altitude of 137 m.

The crew comprised a pilot navigator, a front right survey leader recorder, and two tandem observing teams, who occupied the middle and rear seats on opposite sides of the aircraft. Only two operational observers were available while the other observers were being trained.

The observers reported their observations of dugongs, turtles (usually not identified to species), cetaceans (not to species), sharks, rays and sea snakes in standard format into an intercom connected to a two track tape recorder. We recorded whether each sighting occurred in the top (furthest from aircraft), middle, or bottom third of the transect in order to increase the probability of distinguishing between different observations reported simultaneously by both members of a tandem team. Operational rear seat observers were visually screened from the mid seat observers and acoustically isolated from the remainder of the crew apart from each other. The rear seat observers and the mid seat observers reported their (independent) observations onto separate tracks of the tape recorder. Trainee rear seat observers could hear the reports of the mid seat observers. Data including aircraft height and position, weather conditions, the starting and finishing times for each transect, and the sightings of the mid seat observers were recorded by the survey leader using a microcomputer programmed as a data logger and timer.

The methodology is detailed in Marsh and Saalfeld (1989c) and Marsh and Sinclair (1989 a and b).

Correction Factors

Correction factors were calculated separately for dugongs, dolphins and turtles to compensate for perception bias (groups of animals visible on the transect line that were missed by observers) and for dugongs and turtles to compensate for availability bias (groups of animals that were unavailable to observers because of water turbidity) and their associated coefficients of variation as outlined in Marsh and Sinclair (1989a). The corrections for perception bias were calculated on the basis of the proportion of the relevant sightings seen by one (specified) member or both members of each tandem team using the Petersen mark-recapture model. The corrections for availability bias were calculated as follows:

Dugongs: By standardising the proportion of dugongs sighted during the survey against the proportion on the surface in a clear water area where all dugongs were potentially available (Marsh and Sinclair, 1989a);

Turtles: By standardising the proportion of turtles sighted during the survey against data from the November 1985 survey of blocks 8 to 13 in the northern waters of the Great Barrier Reef Marine Park (Marsh and Saalfeld, 1989b). The proportion of turtles sighted at the surface on this survey was the lowest of any survey we have undertaken, and has been used to standardise the minimum population estimates of turtles on other surveys of the Great Barrier Reef Marine Park and Torres Strait.

It was not possible to correct for availability bias for dolphins because of the lack of suitable data to use as a standard.

Analysis

Because transects were variable in area, the Ratio Method (Jolly 1969; Caughley and Grigg 1981) was used to estimate separately the density, population size and their associated standard errors for dugongs, dolphins and turtles for each block for each survey. Any statistical bias resulting from this method is considered inconsequential in view of the relatively high sampling intensity (Table 2; see Caughley and Grigg 1981). Input data were the estimated number of dugongs, turtles or dolphins for each tandem team per transect calculated using the correction factors described above. The resultant standard errors were adjusted to incorporate the errors associated with the appropriate estimates of the perception and availability correction factors and the mean group size (Tables 3,7,10) following the method of Jolly and Watson (1979) as outlined in Marsh and Sinclair (1989a). The results for the November 1987 survey were recalculated using the block areas and transect lengths obtained from the digitised maps to enable more accurate comparisons with the 1991 data.

The significance of the differences between the surveys conducted in 1987 and 1991 in the densities of (a) dugongs and (b) turtles were tested using analysis of variance both with and without the modal Beaufort sea state for each transect as the covariate. Blocks and times were treated as fixed factors and transect as a random factor nested within block. Input data for all analyses were corrected densities per square kilometre based on mean group sizes and the estimates of the correction factors for perception and availability bias, each line contributing one density per survey based on the combined corrected counts of both tandem teams. The densities were transformed ($\log_{10} x + 1$) for analysis to equalise the error variances.

Density diagrams, adjusted for sampling intensity, were produced using the Arcinfo GIS package. A 5 x 5 nm grid coverage was combined with the coastline coverage and then the corrected number of dugongs, turtles and cetaceans, as well transect length, calculated for each grid cell. Density within each grid cell was then calculated as:

Density = Corrected No. Dugongs/(transect length*0.4)

where 0.4 is the approximate transect width.

DUGONGS

Results

Group sizes

The distribution of dugong group sizes observed on the November-December 1991 survey did not differ significantly from that observed in November 1987 (Marsh and Saalfeld, 1988) (G with William's Correction = 5.813, P=0.12, 3 d.f.). The largest group (subjectively distinct clumping) seen in November-December 1991 was eight, compared with five in November-December 1987. These results are comparable with the November 1983 survey, where the largest group seen was six (Marsh, 1986). In all three surveys, more than 75% of the dugongs sighted were alone or in a group of two animals.

The proportion of calves seen was reasonably similar in the three surveys: 14.3% in November 1983; 13.6% in November, 1987; 11.8% in November-December 1991. Calving is diffusely seasonal in northern Australia and the calves stay with their mothers for at least 18 months (Marsh *et al.*, 1984). On all three surveys, more than 70% of the cow-calf pairs identified were unaccompanied by any other dugongs.

Distribution

Figure 2 is a map of the dugong sightings in 1991. Density is plotted in Figure 3 on a 5 x 5 nm grid. As in the previous surveys (Marsh, 1986; Marsh and Saalfeld, 1988), dugong density was highest in Block 2A, the seagrass beds around Badu and extending north across Orman Reef around Buru Island and east to Gabba Island (9°46'S, 142°37'E). The next highest density was observed in Block IB along the southern Papuan coast south of Boigu Island. Significantly more dugongs were sighted in Block 0 and in Block 3 (which includes part of the dugong sanctuary) in 1991 than in 1987 (Figure 4).

Population and density estimates

The values of the mean group sizes and correction factors used in obtaining the population estimates are summarised in Table 3. The raw data have been listed in the Appendix (Tables 3 and 4). Table 4 gives estimates of the density and numbers of dugongs per block for the 1987 and 1991 surveys together with the standard errors of these estimates. The population estimates for November-December 1991 sum to 24,225 $\pm$ S.E. 3,276 dugongs for the whole region at an overall density of 0.79 $\pm$ S.E 0.11 dugongs per km^2 compared with the revised estimate for the same region in November 1987 13,319 $\pm$ S.E. 2,136 dugongs at an overall density of 0.44 ± S.E. 0.07 dugongs per km^2; Table 4). Overall the density estimates were significantly higher in 1991 than in 1987 (Table 5a). Examination of Figures 4 and 5 indicates that the relative increase in dugong density was much greater along the Papuan coast (Blocks 0, 1A, 1B), in western Torres Strait (Block 3) and in southern Torres Strait (Block 5) in 1991 than in the other blocks. The addition of Beaufort sea state as a covariate in the analyses made no substantive difference to the results (Table 5a) indicating that the difference between the two surveys was unlikely to be due to the survey conditions, a conclusion strengthened by the contrast between the pattern of differences between surveys for dugongs and turtles (Figure 5).

The proportion of dugongs classified as on the surface in 1991 was higher than in 1987, however, the change in observed numbers cannot be attributed solely to the resultant change in the availability correction factor from 2.7203 ± S.E. 0.1196 in 1987 (Marsh and Saalfeld, 1988) to 3.2506 ± S.E. 0.1115 in 1991 (Table 3). Reanalysis of the data using the 1987 availability correction factor (Table 5b) changed the probability that the estimates were different only from 0.01 to 0.05.

Discussion

The minimum population estimate for the survey area in Torres Strait (Figure 1) in November-December 1991 (24,225 ± S.E. 3,276 dugongs), was significantly higher than the revised estimate for the same region in November 1987 (13,319 ± S.E. 2,136 dugongs) using the same aerial survey technique. This difference between surveys is in marked contrast to repeats of similar large scale surveys in other areas, the results of which have been remarkably consistent (Table 6). Our analyses suggest that this variation is unlikely to be due to a difference in survey conditions which were slightly worse in 1991 than in 1987 (Table 1) or to the change in the availability correction factor (Table 5 and Figure 4).

The difference between the 1987 and 1991 population estimates represents a population increase of 82% if the 1991 availability correction factor is used for the 1991 data; 52% using the 1987 availability correction factors for both surveys. This change cannot be due to natural increase in the absence of immigration. The catch statistics collected from schools in Torres Strait in 1990 (Nona, 1992) suggest that 21 of the 115 adult-sized females caught were pregnant which would represent a mean calving interval of about 5.9 years assuming a 13 month gestation. Size is a poor indicator of reproductive status in dugongs (Marsh *et al.*, 1984) so it is likely that not all these females were mature and that this is an overestimate of the calving interval. Marsh (1986) calculated that, even with the most optimistic combination of life history parameters (calving interval of 3 years and a pre-reproductive period of 10 years), a unharvested dugong population was unlikely to increase at more than about 5% per year i.e. 21.5% over the four year interval between surveys. We would expect the rate of increase in Torres Strait to be considerably less than this because of hunting. The recorded harvest of dugongs in the western, top western central and eastern islands in Torres Strait was 242 animals in 1990 and 358 in 1991 with an estimated 70 to 80 animals per year taken in the Torres Shire and northern peninsular region (Nona, 1992). In addition, an unknown number of dugongs are taken by the Papua New Guinean residents of Torres Strait. Sales of dugong meat in the Daru market have resumed in recent months (C. Baldwin, pers comm 1992) even though we understand that this is illegal.

We consider that the most likely explanation for the observed difference between surveys is that dugongs have migrated into the area. Such a migration is unlikely to have occurred from Australian waters as the nearest significant dugong populations are in the Mornington Island area in the Gulf of Carpentaria (where densities were high in December 1991, Marsh unpublished data) or in the Great Barrier Reef Marine Park from Shelburne Bay (11°S 53') south where densities November 1990 were similar to those in November 1984 (Table 6). In neither of these cases is the dugong population large enough to explain the increase observed in Torres Strait. Nothing is known of the distribution of seagrasses or dugongs along the Irian Jayan coast. However, the hypothesis that dugongs have migrated into Torres Strait from Indonesia is consistent with the relative increase in dugong density being much greater along the Papuan coast (Blocks 0, 1A, 1B), in western Torres Strait (Block 3) and in southern Torres Strait (Block 5) in 1991 than in the other blocks (Figures 4 and 5).

The likelihood of animals migrating into Torres Strait from other areas and the stimulus for such a migration are unknown, but the most plausible explanation would seem to be loss of seagrasses along the Irian Jayan coast. Seagrasses are susceptible to dieback events and there is anecdotal evidence of a massive dieback of seagrasses in Torres Strait in the mid 1970's (Johannes and MacFarlane, 1991). Cyclones can also destroy large tracts of seagrasses. There is anecdotal evidence to suggest that the density of dugongs increased in the Mornington Island area in the Gulf of Carpentaria (H. Marsh unpublished information) after the destruction of some 183 km^2 seagrass beds near the Sir Edward Pellew Islands some 170 km to the west in the Gulf of Carpentaria by cyclone Sandy (Thorogood *et al.*, 1990).

We consider that even the 1991 estimate of the dugong population of Torres Strait is more likely to be an underestimate than an overestimate. The correction for availability bias is based on the ratio of the proportion of dugongs sighted that are at the surface during the survey to the proportion sighted in a clear water area when all dugongs present were potentially available, and assumes that the proportion of dugongs at the surface is the same for all habitats and at all times (Marsh and Sinclair, 1989a). This assumption may not be valid in Torres Strait, where in contrast to the east coast of Australia where our other dugong surveys have been carried out, significant numbers of animals are seen in relatively deep water (Marsh and Saalfeld, 1988). Anderson's (manuscript) observations suggest a trend for dugongs to remain submerged longer in deeper water. A more accurate correction for availability bias in Torres Strait will require further investigation of dugong diving behaviour in this area.

Without up-to-date information on the life history parameters of dugongs in Torres Strait, an accurate estimate of the absolute abundance of dugongs in the area and accurate data on dugong catch levels throughout the region (including the Papuan coast), it is impossible to evaluate whether the current harvest is likely to be sustainable. Sensitivity analyses have repeatedly shown that changes in adult survivorship have a large influence on the rate of increase of populations of large, long-lived mammals (Eberhardt and Siniff, 1977) including dugongs (Marsh, in press). The data collected by Nona (1992) suggests that the hunters are mainly targeting adult-sized dugongs (only 34 of 235 dugongs (14.5%) caught between February 1990 and January 1991 inclusive were classified as 'young'). Current estimates of the dugong catch in the Australian region of Torres Strait was of the order of 500 animals in 1991 or about 2% of the estimated minimum population estimate.

The unexplained differences between the results of the surveys in 1987 and 1991 reinforce the difficulties in determining the status of populations by monitoring population size through surveys emphasised by Taylor and Gerrodette (in press). Taylor and Gerrodette suggest that for populations at low densities, a demographic approach can be more powerful than a direct estimation of population size through surveys. However, even a demographic approach can be applied only crudely in Torres Strait given the difficulty of collecting reliable data on life history parameters, especially adult survivorship. Under these circumstances we recommend that the continued monitoring (and verification) of the catch at the various Australian island communities be given a high priority. It is also clearly important to continue with the public education campaign in an attempt to pre-empt any increase in the dugong catch, and to encourage the Government of Papua New Guinea to do likewise.

Despite the limitations of aerial surveys for monitoring trends, we consider that it would also be useful to continue the large scale aerial surveys of Torres Strait at approximately four-year intervals. It would be especially useful if co-operative survey programs could be organised with Indonesia to obtain information about the distribution of dugongs and seagrasses in the shallow waters to the west of Torres Strait.

TURTLES

Results

Although sea turtles (especially large animals) can often be seen clearly from the air during low-level surveys particularly in calm seas and in clear water, with the exception of the leatherback, they are difficult for the non-specialist observer to identify to species.

Six species of sea turtles occur within Torres Strait: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), flatback (*Natator* (*Chelonia*) *depressus*), Pacific Ridley (*Lepidochelys olivacae*), and leatherback (*Dermochelys coriacea*) (Limpus and Parmenter, 1986). The leatherback and the Pacific Ridley occur only rarely, but the region contains significant feeding grounds for the other four species. Greens and hawksbills are the most common turtles found on the coral reefs of eastern Torres Strait; greens comprised 87% and hawksbills 10.8% of the turtles sampled by Parmenter in 1977-1979 (Limpus and Parmenter, 1986). Most of the turtles sighted during this survey were probably large green turtles.

Distribution

Figure 6 is a map of the turtle sightings in 1991, with density plotted in Figure 7. As in 1987, the highest densities of turtles were associated with reefs and the large expanse of sub-tidal seagrass beds in the central and western regions of Torres Strait north of about 10°S (Figures 6, 7 and 8).

Minimum population and density estimates

The values of the mean group sizes and correction factors used in obtaining the population estimates are summarised in Table 7. The raw data have been listed in the Appendix Tables 5 and 6. Table 8 gives estimates of the densities and numbers of turtles per block for the 1987 and 1991 surveys together with the standard errors of these estimates. The population estimates for November-December 1991 sum to 65244 $\pm$ S.E. 5338 turtles for the whole region at an overall density of 2.13 $\pm$ S.E.0.17 turtles per km^2 compared with the revised estimate for the same region in November 1987 (43692$\pm$ S.E. 4825 turtles at an overall density of 1.43 $\pm$ S.E. 0.16 per km^2; Table 8). Overall the density estimates were significantly higher in 1991 than in 1987 (Table 9a). Examination of Figures 5 and 8 indicates that the relative increase in turtle density was greatest in Blocks 1A, 1B and 2A in 1991. The addition of Beaufort sea state as a covariate in the analyses (Table 9a) made no substantive difference to the results indicating that the difference between the two surveys was unlikely to be due to sighting conditions.

A higher proportion of turtle sightings were classified as on the surface in 1991 than in 1987, however, the change in observed numbers cannot be attributed solely to the resultant change in the availability correction factor from 2.0391 $\pm$ S.E. 0.0716 in 1987 (Marsh and Saalfeld, 1989a) to 2.3029 $\pm$ S.E. 0.0696 in 1991 (Table 8) as reanalysis of the data using the 1987 availability correction factor made no substantive difference to the results.

Discussion

Aerial censuses of turtles present a number of major difficulties in addition to the problem of species identification. Even neonatal dugongs are large enough to be seen from our survey height (see Marsh and Sinclair, 1989b). In contrast, an unknown and variable proportion of turtles is too small to be seen from the air. For example, Parmenter (in Limpus and Parmenter, 1986) found that coral reef habitats in eastern Torres Strait support green turtles as small as 40cm curved carapace length (C.C.L.). Most (79.6%) were immature i.e. < 91cm C.C.L. In addition, Marsh and Sinclair (1989b) showed that in contrast to dugongs, the observed density of turtles depends on sea state even over a relatively small range of conditions; fewer turtles are seen in rougher seas.

Nonetheless, differences in sea state do not explain the higher density of sea turtles observed in Torres Strait in 1991 compared with 1987. In general, sea conditions were rather worse in 1991 than in 1987 (Table 1) and the addition of the modal Beaufort sea state for each transect as a covariate made the difference between surveys more, rather than less, significant (Table 5). This is contrast to the situation in the northern Great Barrier Reef surveys where significant differences between population and density estimates obtained from repeat surveys of the same area were removed by using Beaufort sea state and cloud cover as covariates (Marsh and Saalfeld, 1989c). Nor can the difference between years in observed turtle density by explained by the difference in the availability correction factors for the two surveys (Table 9b).

Thousands of green turtles migrate through Torres Strait each year on their way to nest at rookeries in eastern Torres Strait, the northern Great Barrier Reef and the islands of the Capricorn-Bunker Group in the southern Great Barrier Reef (Miller and Limpus 1991). The magnitude of this migration is correlated with an index of the Southern oscillation (Limpus and Nicholls, in press). Results of long-term monitoring of the green turtles nesting at Raine Island in the first week in December indicate that the size of the migration in 1987 and 1991 was similar (J.D. Miller pers comm). Thus the difference between surveys cannot be explained by the magnitude of the migration. In addition, the difference is the opposite to that expected from a difference in the timing of the surveys. The 1987 survey (November 10 to 21) was timed slightly earlier than the 1991 survey (November 16 and 30 and December 7 through 11) and therefore closer to the expected peak of migration.

Although the interaction between time and block was not significant (Table 9) indicating that the relative importance of the various parts of the survey region was reasonably consistent between surveys, Figure 8 suggests that the greatest regional difference between surveys was for Block 1A (Figure 1). In contrast to the dugong survey, there was little difference between the results of the two surveys for Blocks 0 and 3 (Figures 5 and 8), reinforcing the conclusion that the differences between the two surveys are not explained by sighting conditions.

We conclude that there also may have been a movement of large sea turtles into Torres Strait feeding grounds. A major dieback of seagrass along the Irian Jayan coast would have adversely affected green turtles as well as dugongs and could be a stimulus for the movement of both species. However, we regard the evidence for movements of turtles to be less convincing than for dugongs because data from other areas (e.g. Marsh and Saalfeld, 1989c) suggest that our survey technique is much less satisfactory for turtles than for dugongs.

CETACEANS

Results and Discussion

All the cetaceans sighted were dolphins. We were generally unable to confirm specific identifications: most of the animals appeared to be bottlenose dolphins, *Tursiops truncatus,* or Indo-Pacific humpback dolphins, *Sousa chinensis*.

The values of the mean group sizes and correction factors used in obtaining the population estimates are summarised in Table 10. The raw data have been listed in Appendix Tables 7 and 8. The population estimates for November-December 1991 sum to 2265 $\pm$ S.E. 488 dolphins for the whole region at an overall density of 0.07 $\pm$ S.E. 0.02 . Table 11 gives estimates of the densities and numbers of dolphins per block for the 1991 survey together with the standard errors of these estimates. The highest density observed was in Blocks 1A and 4 (Table 11 and Figure 9 and 10).

Although the densities of dolphins observed in Torres Strait are within the range observed in some inshore areas in the Far North Section of the Great Barrier Reef Marine Park (Marsh, 1990), they were fairly low in comparison with the overall densities observed in similar large scale surveys in the Great Barrier Reef Marine Park and northern Western Australia (Table 12).

We do not recommend the funding of dedicated aerial surveys of dolphins in Torres Strait at present as they do not present a management problem in this area. These results provide a baseline for future monitoring.

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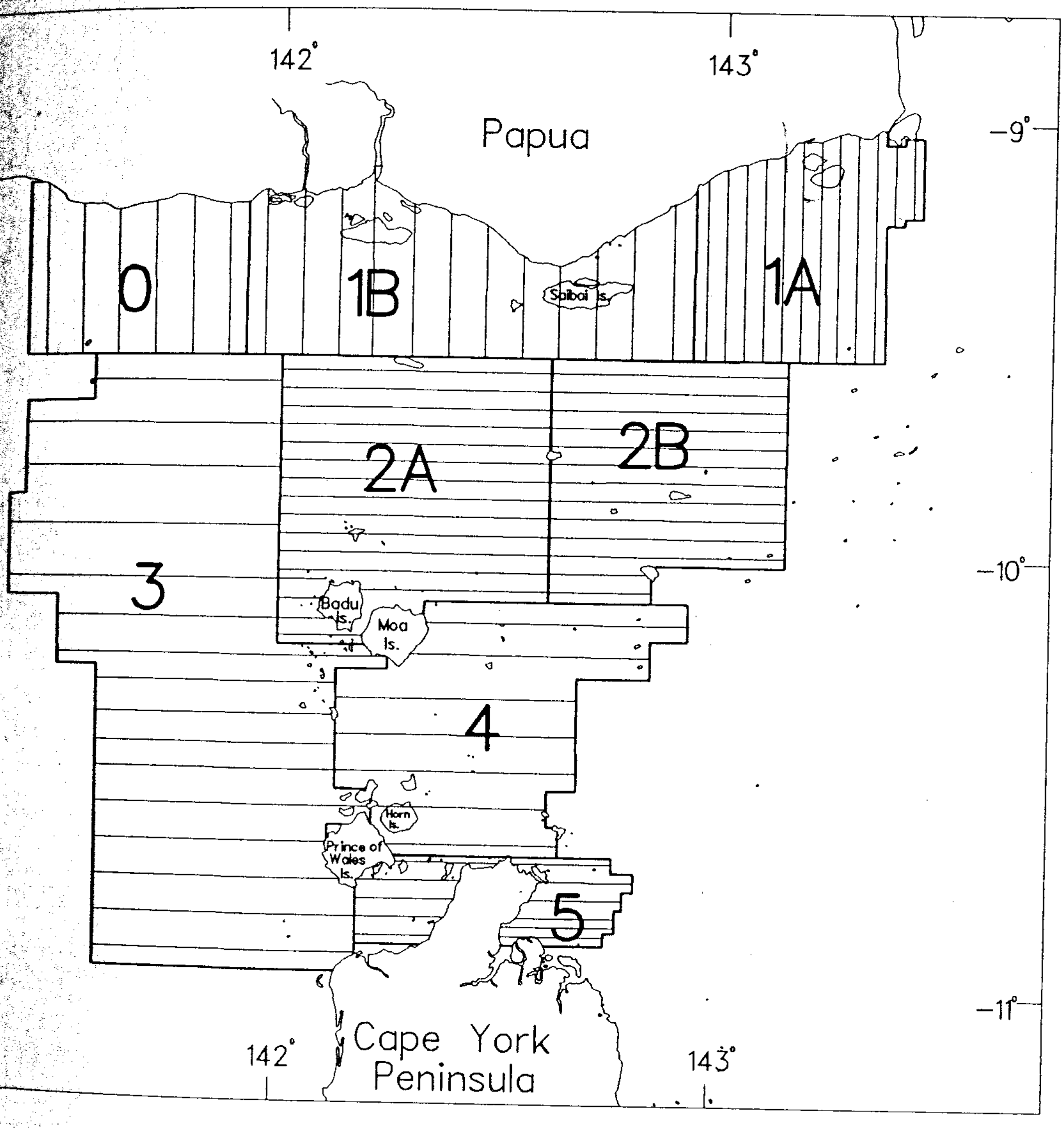

Figure 1. Survey area, showing the survey blocks (0-5) and transect lines for the November-December 1991 survey.

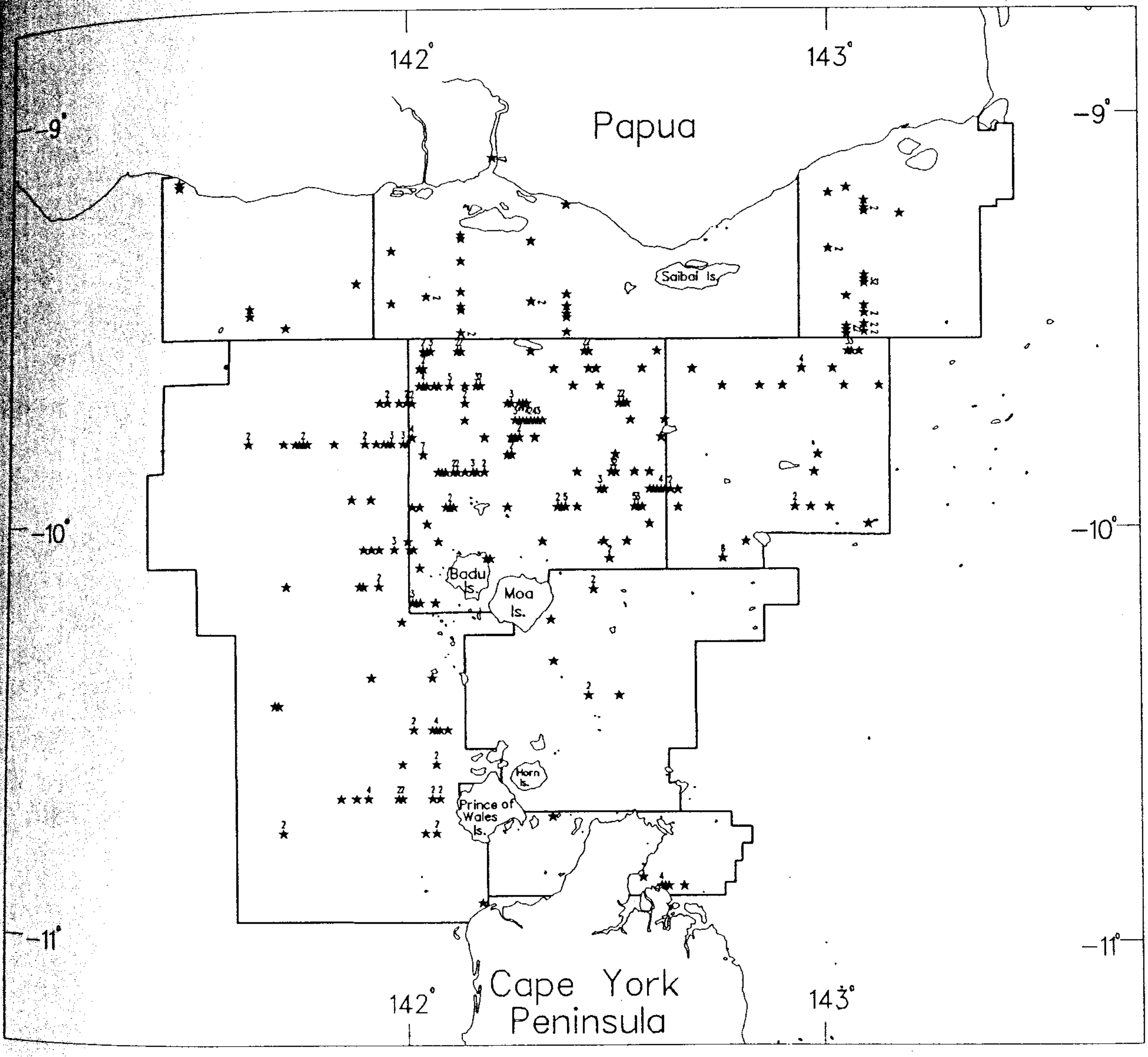

Figure 2. The Torres Strait survey area showing the positions of dugong sightings in November-December 1991. The numbers associated with the sightings do not necessarily reflect the sizes of the actual

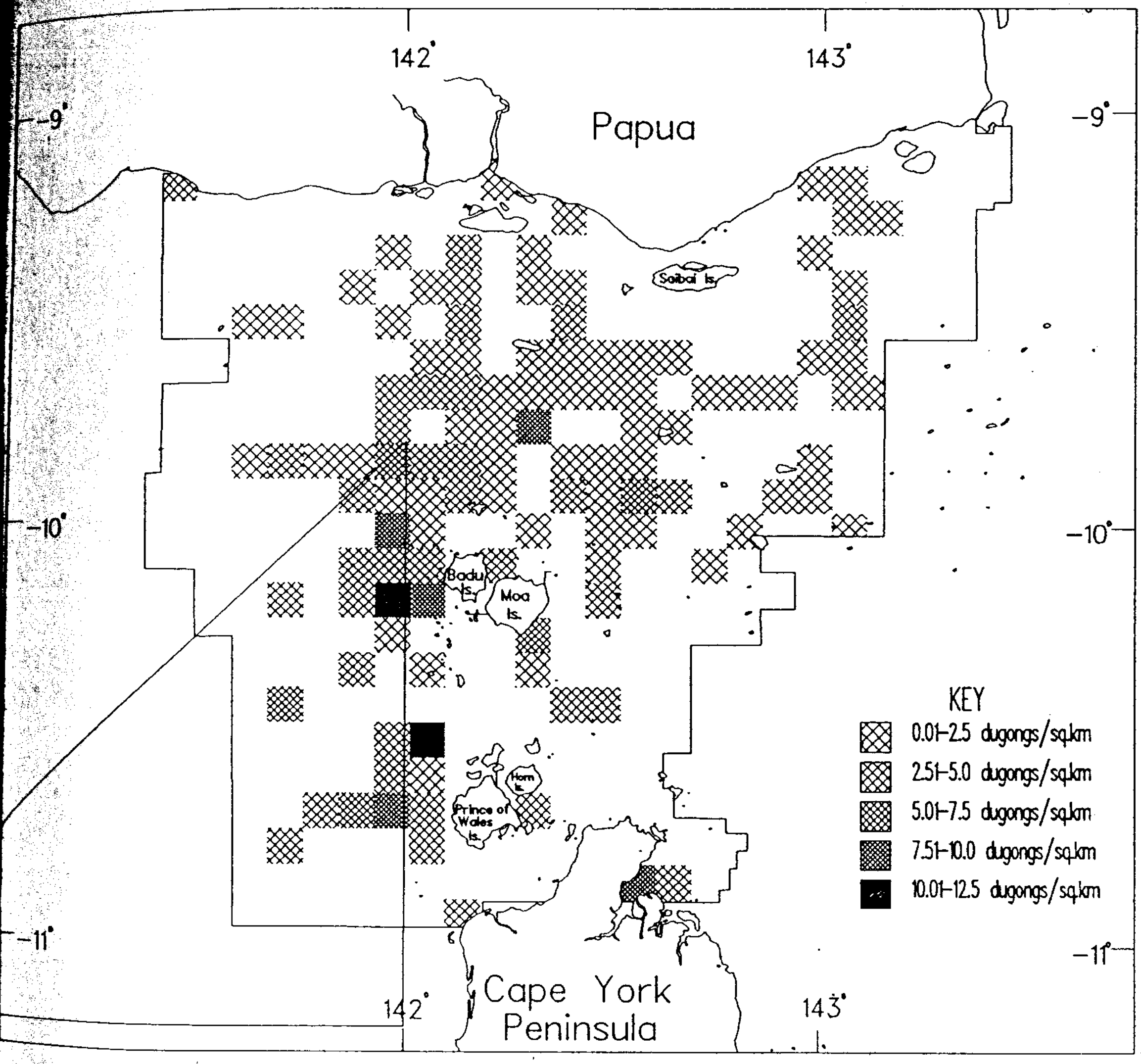

Figure 3. The Torres Strait survey area showing dugong density, adjusted for sampling intensity, calculated on a 5 x 5 nm square grid.

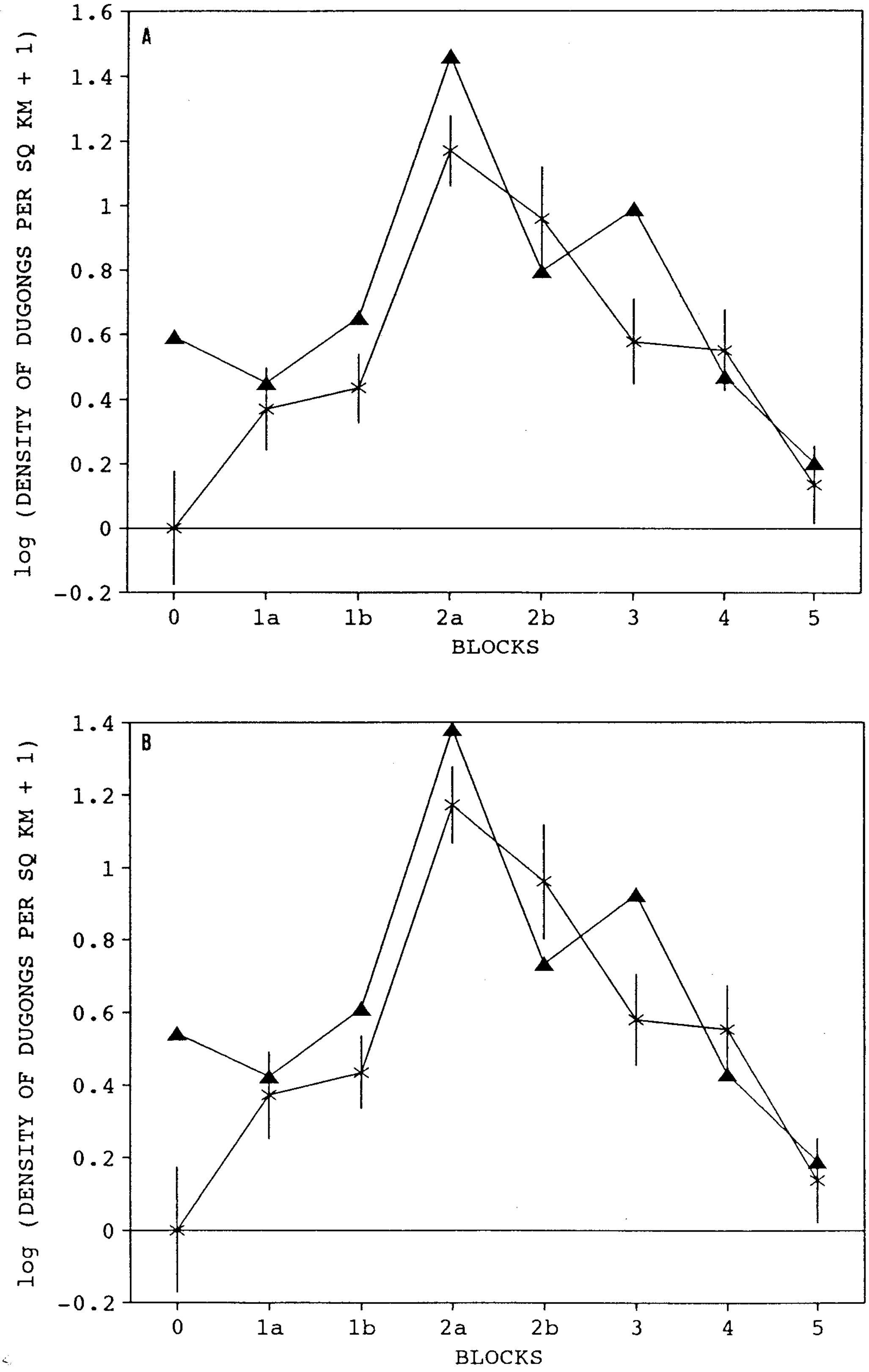

Figure 4. The mean (transformed) density of dugongs per block in 1987 (x) and 1991 (▲). The 1991 data have been calculated using (A) the 1991 and (B) the 1987 Corrections for Availability Bias. For clarity, the standard error bars for each block have been included on the values for 1987 only.

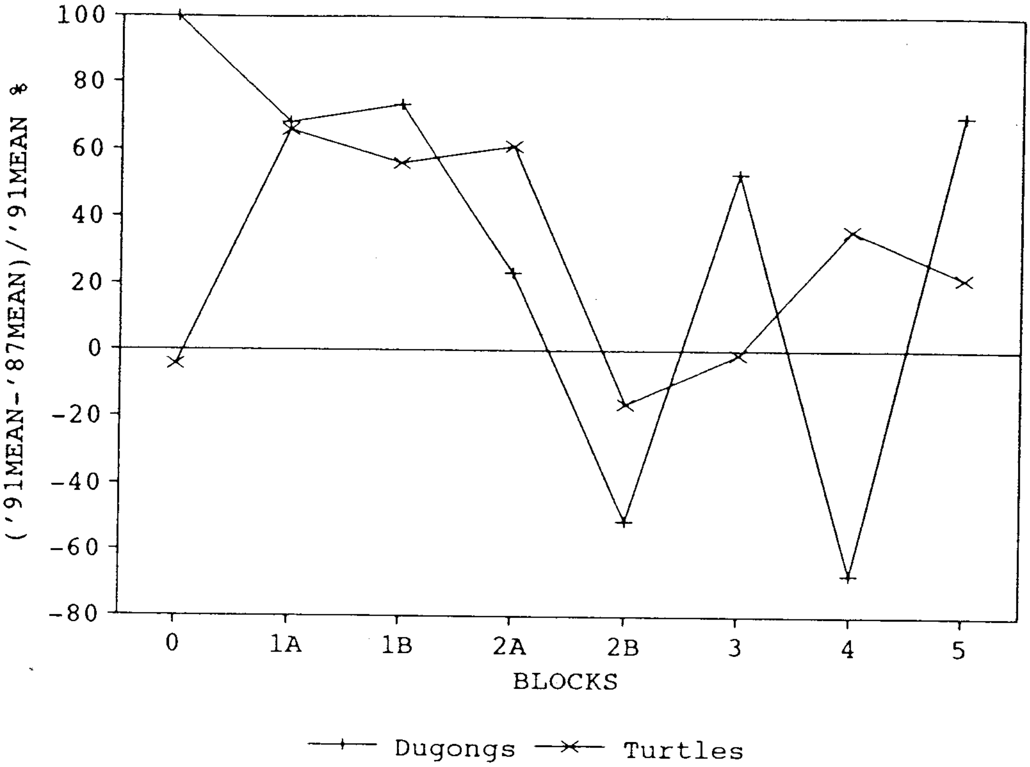

Figure 5. Comparison of the relative changes in dugong and turtle numbers between the 1987 and 1991 surveys for each block.

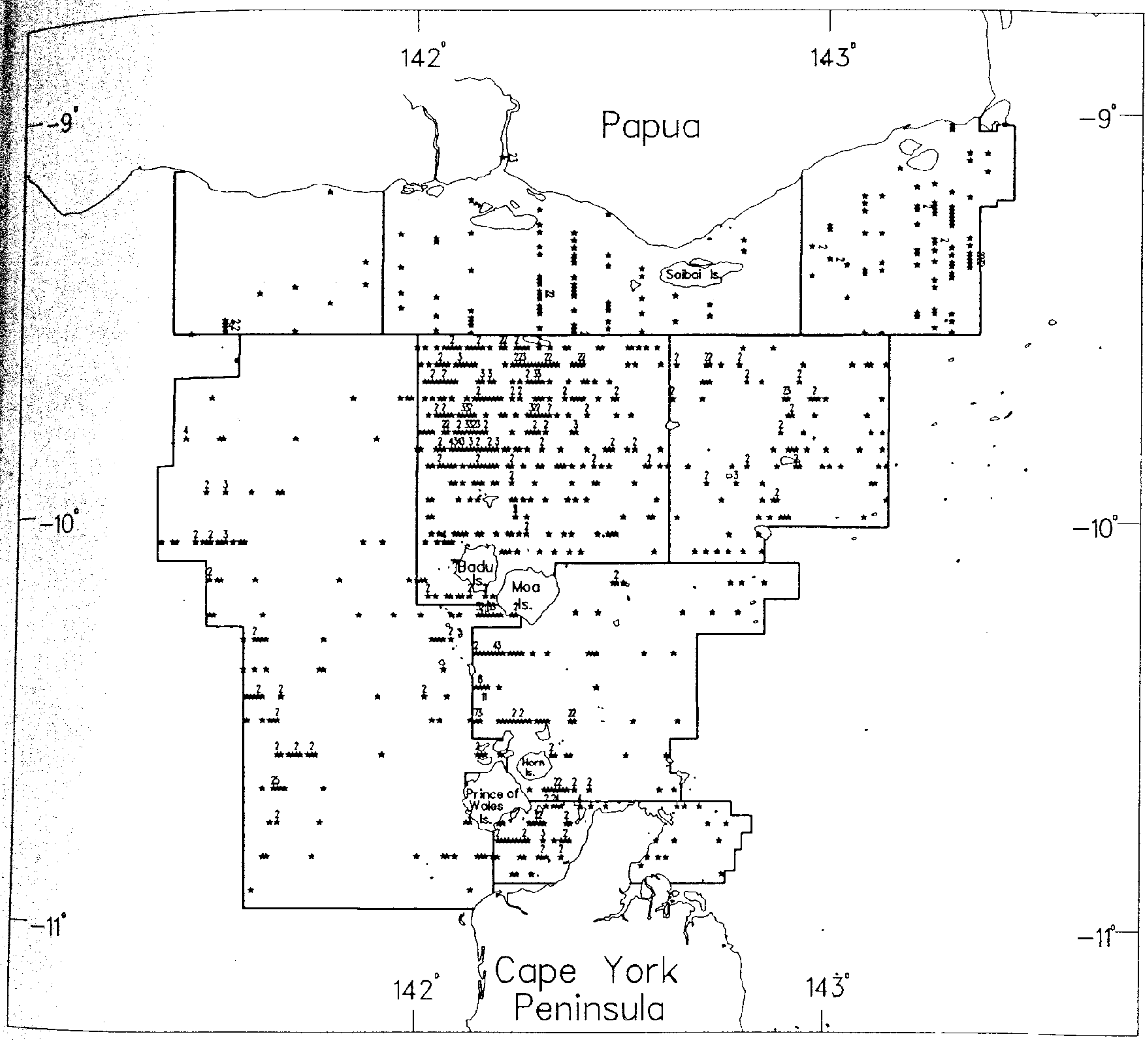

Figure 6. The Torres Strait survey area showing the positions of turtle sightings in November-December 1991. The numbers associated with the sightings do not necessarily reflect the sizes of the actual groupings observed.

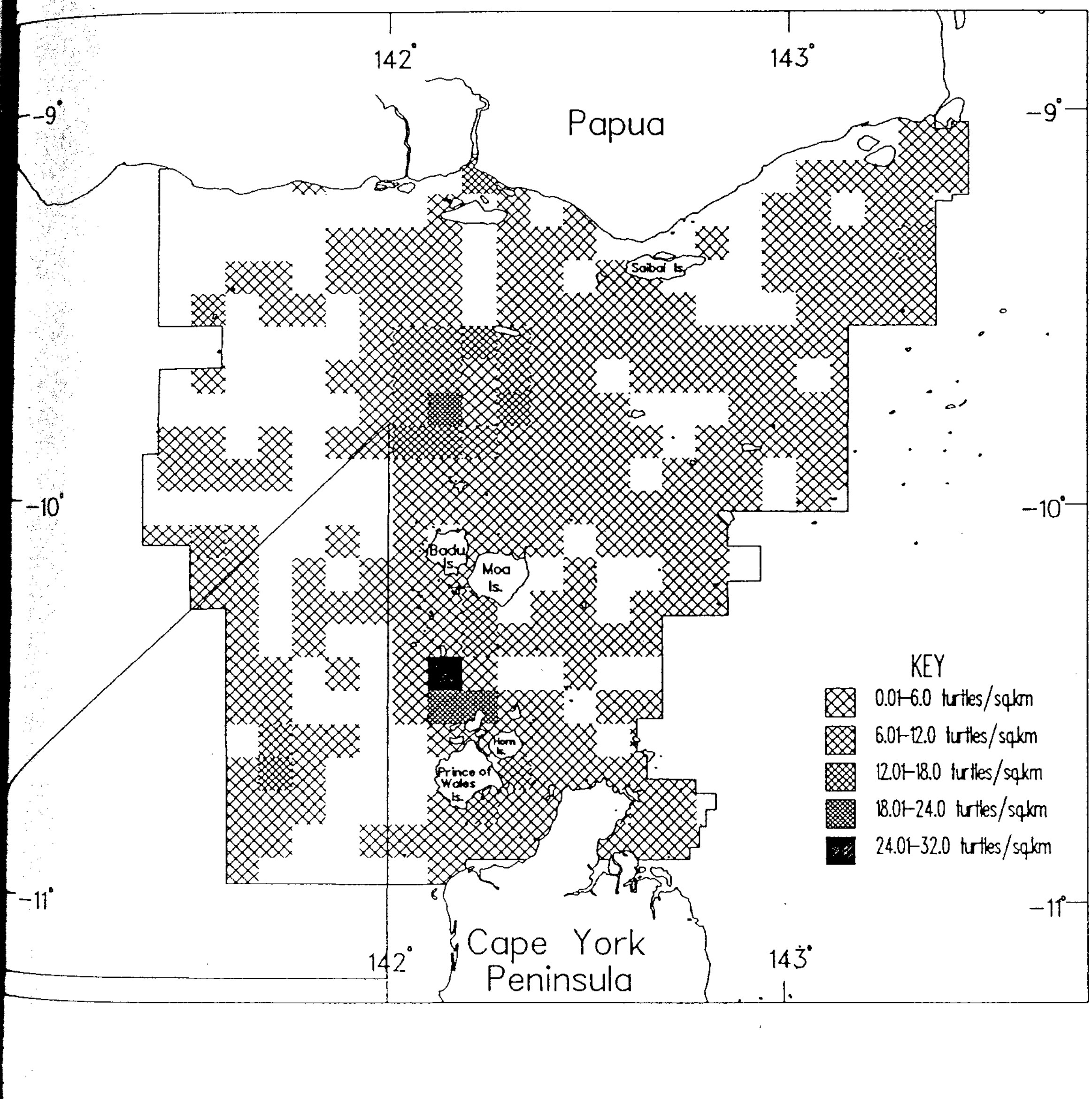

Figure 7. The Torres Strait survey area showing turtle density, adjusted for sampling intensity, calculated on a 5 x 5 nm square grid.

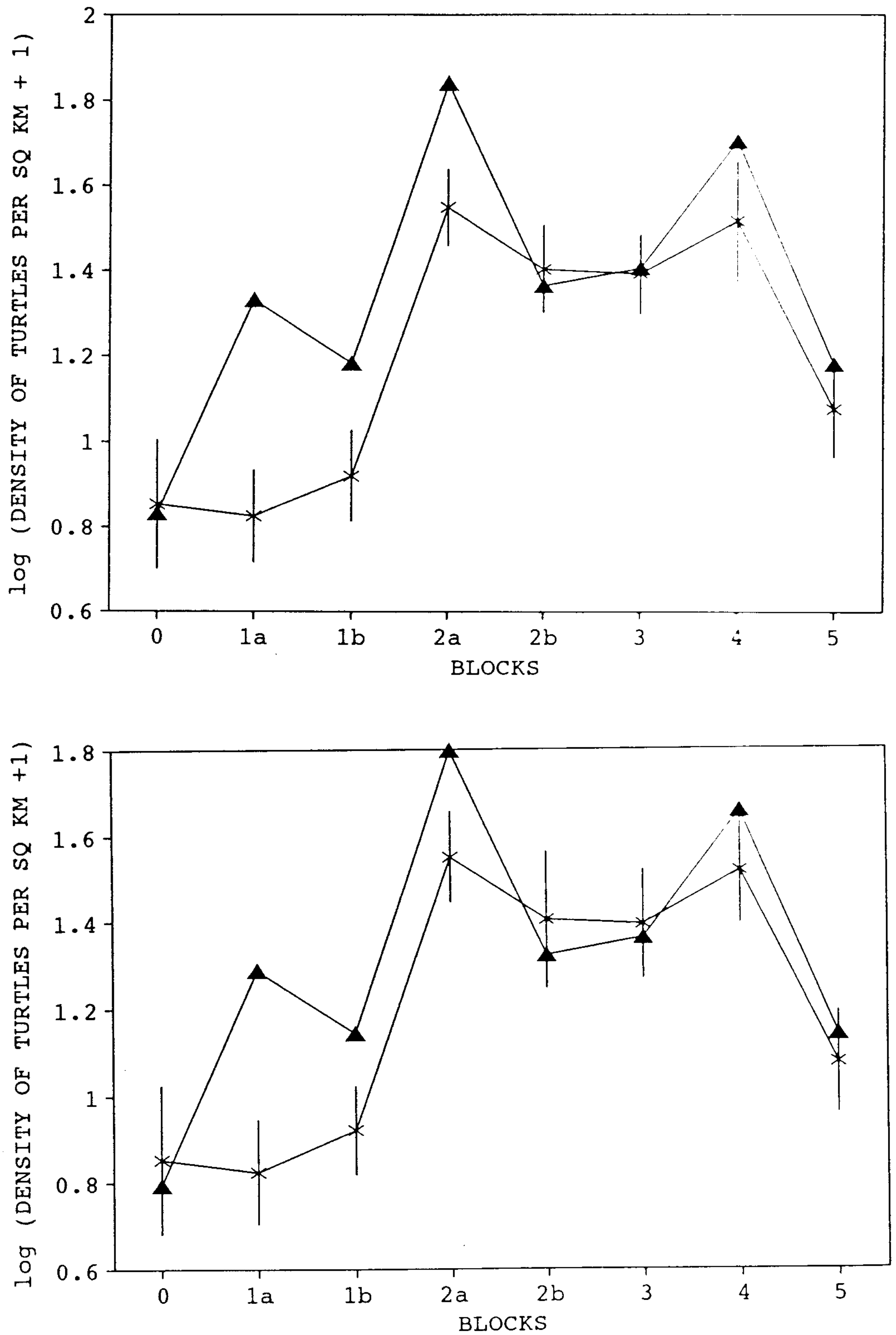

Figure 8. The mean (transformed) density of turtles per block in 1987 (x) and 1991 (▲). The 1991 data have been calculated using (A) the 1991 and (B) the 1987 Corrections for Availability Bias. For clarity, the standard error bars for each block have been included on the values for 1987 only.

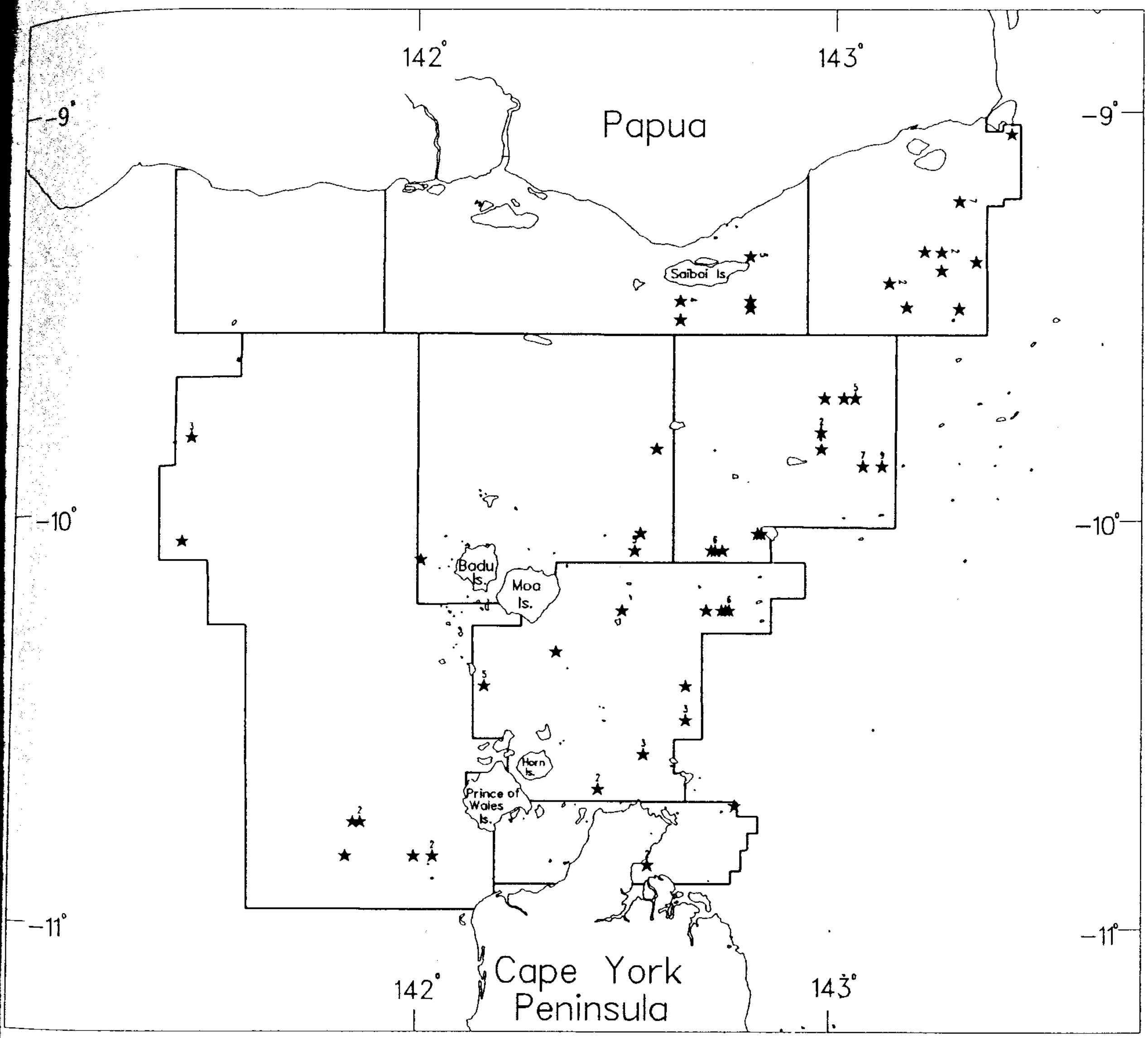

Figure 9. The Torres Strait survey area showing the positions of dolphin sightings in November-December 1991. The numbers associated with the sightings do not necessarily reflect the sizes of the actual groupings observed.

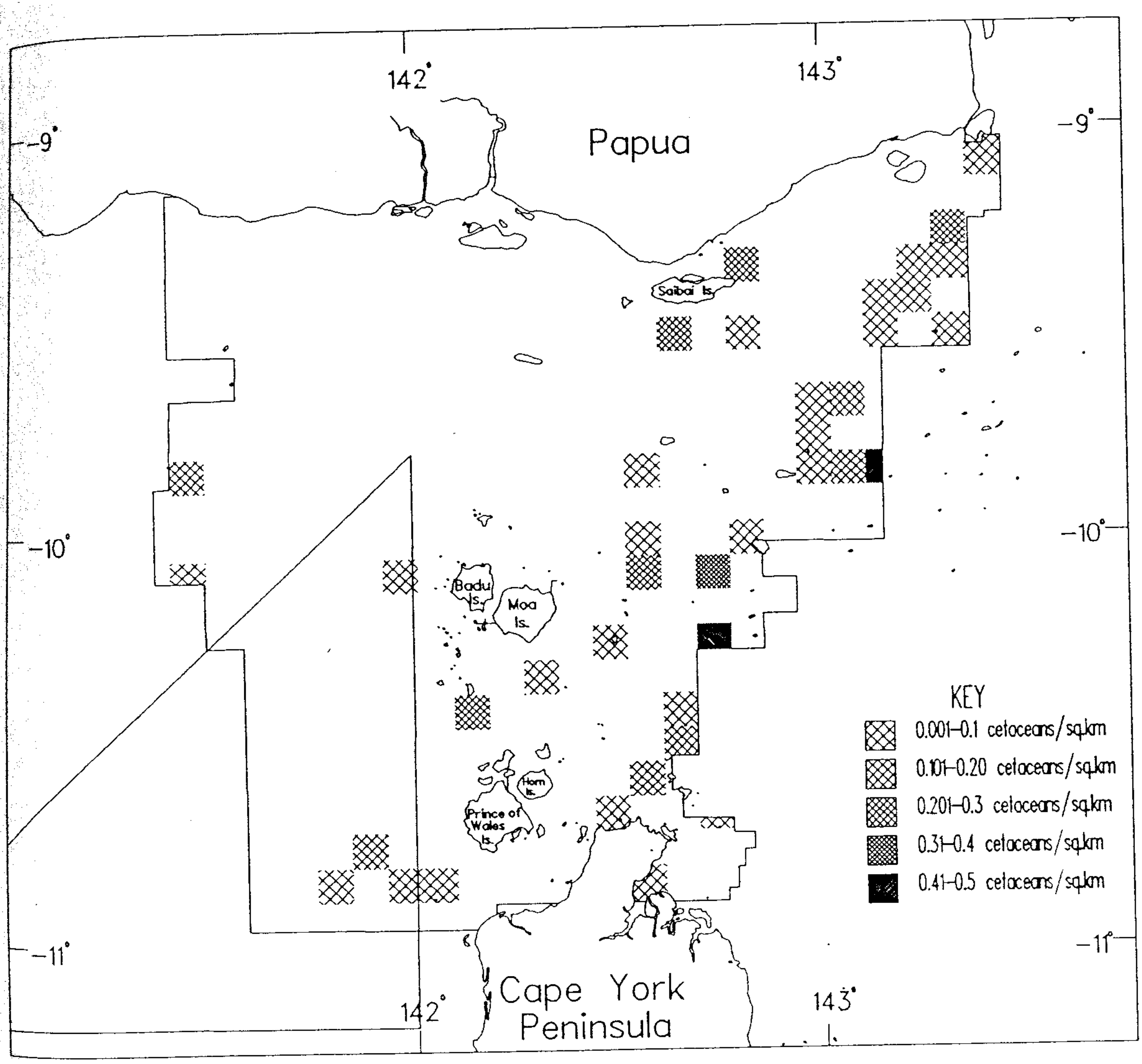

Figure 10. The Torres Strait survey area showing dolphin density, adjusted for sampling intensity, calculated on a 5 x 5 nm square grid.

TABLE 1: Weather conditions encountered during the two surveys. Values for Beaufort sea state and glare are the mean of the modes for each transect with range in parentheses. Glare is measured as: 0, none; 1, <25% of field of view affected; 2, 25-50%; 3 >50%.

	1987	1991
Wind speed (km h^{-1})	$\leq$15	$\leq$15
Cloud cover (oktas)	1-8	0-5
Minimum cloud height (m)	270-4000	460-750
Beaufort sea state	1.3(0-4)	1.9(0-4)
Glare North/West	1.4(0-3)	1.7(0-3)
South/East	0.75(0-3)	2.3(0-3)
Visibility (km)	N/A	$\geq$20

TABLE 2: Areas of survey blocks and sampling intensities for the 1991 survey.

Block	Area (km^2)	Sampling %
0	2172.0	4.1
1A	2657.6	8.1
1B	3784.1	4.2
2A	4338.7	8.4
2B	3290.4	8.4
3	9651.1	4.0
4	3635.5	4.5
5	1030.8	10.4
	30560.2	5.8

LE 3: Details of group size estimates and correction factors used in the population estimates for
dugongs for the 1991 survey.

cks	Group size mean (C.V.)	Numbers of observers		Perception correction factor estimate (C.V.)		Availability
ection factor						
.)		Port	Starboard	Port	Starboard	estimate
B:1.14-1.34	1.3516(0.0429)	2	2	1.0634(0.0158)	1.0814(0.0182)	3.2506(0.1115)
1B:1.12	1.3516(0.0429)	1	1	1.3514(0.0158)	1.3256(0.0182)	3.2506(0.1115)
.1-2.7	1.3516(0.0429)	1	1	1.1000(0.0188)	1.2581(0.0308)	3.2506(0.1115)
.8-2.13,3.5 ,3.6,3.6A; 3; 4; 5	1.3516(0.0429)	2	2	1.0500(0.0188)	1.1100(0.0308)	3.2506(0.1115)

e: Blocks 0, 1A and 1B were flown with different observer teams from the remaining blocks, hence the different perception correction factors.

TABLE 4: Estimated (a) numbers and (b) density of dugongs per block in 1987 and 1991. Values [cut off] given +/- standard error.

Block	1987 Survey	1991 Survey (with 1987 Availability Correction Factor)	1991 Survey (with 1991 Availability Correction Factor)
(a)			
0	0	571.7+/-6.2	695.1+/-237.9
1[1]	1130.8+/-278.1		
1A		1396.4+/-836.8	1668.6+/-998.6
1B		3100.3+/-1282.9	3704.7+/-1528.7
2A	6423.5+/-1679.2	7626.4+/-1523.1	9113.2+/-1798.0
2B	2019.2+/-572.7	1227.3+/-336.1	1466.5+/-399.1
3	2821.6+/-1101.6	5640.0+/-1648.0	6739.5+/-1958.4
4	848.4+/-347.3	433.6+/-165.5	518.2+/-196.9
5	75.6+/-54.7	267.8+/-231.9	320.0+/-276.9
Total	13319+/-2136	20274+/-2760	24225+/-3276.2
(b)			
0	0	0.27+/-0.09	0.32+/-0.11
1[1]	0.18+/-0.04		
1A		0.52+/-0.31	0.63+/-0.38
1B		0.82+/-0.33	0.98+/-0.40
2A	1.48+/-0.39	1.76+/-0.35	2.10+/-0.41
2B	0.61+/-0.17	0.37+/-0.10	0.45+/-0.12
3	0.29+/-0.11	0.58+/-0.17	0.70+/-0.20
4	0.23+/-0.10	0.12+/-0.05	0.14+/-0.05
5	0.07+/-0.05	0.26+/-0.10	0.31+/-0.27
Total	0.44+/-0.07	0.66+/-0.09	0.79+/-0.11

[1] All of Block 1 was flown at a sampling intensity of about 8% in 1987. In 1991, the western p[art] of the block (1B) was flown at about half the intensity of the eastern section (1A). The resu[lts] have been presented separately.

ABLE 5: Summary of analysis of variance comparing observed dugong density in Torres Strait in 1987 and 1991 using (a) 1991 availability correction factor and (b) 1987 availability correction factor for 1991 sightings.

(1) Without covariates. (2) With Beaufort sea state as a covariate. Data was transformed $\log_{10}(x+1)$

(a)

Sources of variation	d.f. (1)	d.f. (2)	F (1)	F (2)	Significance of F (1)	Significance of F (2)
Blocks[2]	7	7	8.79	8.90	0.0001	0.0001
Time[1]	1	1	6.85	7.03	0.0105	0.0096
Transect nested in Block[1]	86	86	2.14	2.09	0.0003	0.0004
Block by Time[1]	7	7	1.63	1.66	0.1377	0.1288
Residual	86	85				
Regression[1]		1		0.54		0.4638

(b)

Sources of variation	d.f. (1)	d.f. (2)	F (1)	F (2)	Significance of F (1)	Significance of F (2)
Blocks[2]	7	7	8.80	8.92	0.0001	0.0001
Time[1]	1	1	3.90	4.35	0.0516	0.0401
Transect nested in Block[1]	86	86	62.182	2.13	0.0002	0.0001
Block by Time[1]	7	7	1.65	1.68	0.1321	0.1260
Residual	86	85				
Regression[1]		1		0.54		0.4638

[1] Tested against Transect nested in Block by Time
[2] Tested against Transect nested in Block

TABLE 6: Comparison of the population estimates obtained from repeat surveys of the same area using the fixed-width transect technique.

LOCATION	SURVEY DATE	POPULATION ESTIMATE ± s.e.	REFERENCE
Western Gulf of Carpentaria[1]	August, 1984	16,816 ± 2946	Bayliss and Freeland 1989
	February 1985	16,846 ± 3257	
Cape Bedford - Cape Melville[2]	November 1984	2,899 ± 454	Marsh and Saalfeld 1989b
	November 1985	2,542 ± 634	
Campbell Point - Hunter Point[2]	April 1985	2,172 ± 552	Marsh and Saalfeld 1989b
	November 1985	1,938 ± 491	
Cape Bedford- Hunter Point[2]	November 1985	8,100 ± 1073	Marsh and Saalfeld 1989b and unpublished
	November 1990	10,742 ± 1579	

1 Northern Territory, Australia
2 Northern Great Barrier Reef region, Queensland Australia

TABLE 7: Details of group size estimates and correction factors used in the population estimates for turtles for the 1991 survey.

Blocks	Group size mean (C.V.)	Numbers of observers		Perception correction factor estimate (C.V.)		Availability correction factor estimate (C.V.)
		Port	Starboard	Port	Starboard	
0; 1B:1.14-1.34	1.0445(0.0075)	2	2	1.0634(0.0178)	1.0814(0.0388)	2.3029(0.0696)
1A; 1B:1.12	1.0445(0.0075)	1	1	1.3514(0.0178)	1.3256(0.0388)	2.3029(0.0696)
2A:2.1-2.7	1.0445(0.0075)	1	1	1.6204(0.0224)	1.9878(0.0444)	2.3029(0.0696)
2A:2.8-2.13,3.5 .5A,3.6,3.6A; B; 3; 4; 5	1.0445(0.0075)	2	2	1.2280(0.0224)	1.4457(0.0444)	2.3029(0.0696)

ote: Blocks 0, 1A and 1B were flown with different observer teams from the remaining blocks, hence the different perception correction factors.

TABLE 8: Estimated (a) numbers and (b) density of turtles per block in 1987 and 1991. Values are given +/- standard error.

Block	1987 Survey	1991 Survey (with 1987 Availability correction factor)	1991 Survey (with 1991 Availability correction factor)
(a)			
0	1446.0+/-561.0	1419.0+/-843.7	1602.5+/-952.7
1[1]	3647.3+/-615.0		
1A		3405.2+/-741.4	3845.8+/-836.1
1B		6102.9+/-1513.7	6892.5+/-1707.4
2A	8170.2+/-1078.2	19734.7+/-2711.0	22287.7+/-3050.2
2B	4392.9+/-855.6	3579.8+/-503.1	4042.9+/-566.1
3	15265.6+/-3207.4	12340.1+/-1977.4	13936.5+/-2226.8
4	8888.2+/-3180.4	9075.5+/-2640.1	10249.7+/-2979.2
5	1883.1+/-540.5	2113.5+/-633.7	2387.0+/-715.2
Total	43692+/-4825	57770+/-4737	65244+/-5338
(b)			
0	0.67+/-0.26	0.65+/-0.39	0.74+/-0.44
1	0.57+/-0.10		
1A		1.28+/-0.28	1.45+/-0.31
1B		1.61+/-0.4	1.82+/-0.45
2A	1.88+/-0.25	4.59+/-0.62	5.14+/-0.70
2B	1.33+/-0.26	1.09+/-0.15	1.23+/-0.17
3	1.58+/-0.33	1.28+/-0.21	1.44+/-0.23
4	2.44+/-0.87	2.50+/-0.73	2.82+/-0.82
5	1.83+/-0.52	2.05+/-0.62	2.32+/-0.69
Total	1.43+/-0.16	1.89+/-0.16	2.13+/-0.17

[1] This block was flown in 1987 at high sampling intensity. As the sampling intensity and block area varied for this block, it was not split for comparison with 1A and 1B in 1991.

LE 10: Details of group size estimates and correction factors used in the population estimates for dolphins.

ks	Group size mean (C.V.)	Numbers of observers Port	Starboard	Perception correction factor estimate (C.V.) Port	Starboard	Availability correction factor estimate (C.V.)
B:1.14-1.34	2.3529(0.3027)	2	2	1.0989(0.0523)	1.1200(0.0518)	1.0000(0.0000)
1B:1.12	2.3529(0.3027)	1	1	1.4286(0.0523)	1.4000(0.0518)	1.0000(0.0000)
2.1-2.7	2.3529(0.3027)	1	1	1.1429(0.0398)	1.0588(0.0071)	1.0000(0.0000)
2.8-2.13,3.5 A,3.6,3.6A; 3; 4; 5	2.3529(0.3027)	2	2	1.0549(0.0398)	1.0128(0.0071)	1.0000(0.0000)

e: Blocks 0, 1A and 1B were flown with different observer teams to the remaining blocks, hence the different perception correction factors.

TABLE 11: Estimated densities and number of dolphins for the 1991 survey. The values are +/- standard error incorporating the errors resulting from sampling and in estimating mean group size and correction factors.

Block	Density per km^2	Numbers
0	0	0
1A	0.15 +/- 0.05	408.8 +/- 136.0
1B	0.08 +/- 0.06	310.0 +/- 223.0
2A	0.04 +/- 0.02	175.7 +/- 92.9
2B	0.09 +/- 0.04	289.5 +/- 124.7
3	0.04 +/- 0.02	429.5 +/- 230.4
4	0.17 +/- 0.08	606.4 +/- 302.3
5	0.04 +/- 0.03	45.7 +/- 33.4
Total	0.07 +/- 0.02	226.5 +/- 487.8

TABLE 12: Comparison of the dolphin densities observed in Torres Strait in November 1991 with those obtained from other areas in northern Australia using the same aerial survey techniques. Values are +/- standard errors.

Location	Dolphins (km^{-2})
Torres Strait[1]	0.07 +/- 0.02
Great Barrier Reef Region	
Inshore Southern Section	0.11 +/- 0.01
Inshore Central Section	0.21 +/- 0.03
Cairns Section south of Cape Bedford	0.21 +/- 0.03
Cairns-Far North Sections north of Cape Bedford	0.21 +/- 0.02
Western Australia[2]	
Shark Bay	0.19 +/- 0.02
Ningaloo-Exmouth Gulf	0.16 +/- 0.04

[1] Marsh (1990)
[2] Marsh and Saalfeld unpublished

APPENDIX

E 1: Details of weather conditions encountered during the survey.

	Session	Wind Speed (knots)	Wind Direction	Cloud Cover (oktas)	Cloud Height (ft)	Beaufort Sea State mode(range)	Glare[1] North mode(range)	Glare[1] South mode(range)
/91	1	8	E	1	2000	2.0(0.0-2.5)	2.0(1.0-3.0)	3.0(1.0-3.0)
	2	8	E	0	-	1.0(0.0-2.0)	1.0(0.0-2.0)	1.0(0.0-2.0)
/91	1	8	E	3	2000	2.0(0.0-2.0)	2.0(1.0-3.0)	2.0(1.0-3.0)
	2	0	-	0	-	1.5(0.0-2.0)	1.0(1.0-2.0)	2.0(2.0-3.0)
/91	1	15	E	1	1500	3.0(1.0-4.0)	2.0(1.0-3.0)	3.0(2.0-3.0)
/91	1	10	E	1	2000	3.0(2.0-4.0)	2.0(1.0-3.0)	3.0(1.0-3.0)
	2	10	E	3	2000	2.0(1.0-4.0)	2.0(1.0-3.0)	3.0(2.0-3.0)
/91	1	12	E	2,2	2500,30000	3.0(1.0-4.0)	2.0(1.0-3.0)	3.0(1.0-3.0)
	2	10	E	4	2500	3.0(1.0-4.0)	2.0(1.0-2.0)	3.0(2.0-3.0)
/91	1	10	SSE	2,1	2000,30000	3.0(1.0-4.0)	2.0(1.0-3.0)	2.0(1.0-3.0)
	2	20	SSE	3	2000	2.0(1.0-3.0)	2.0(1.0-2.0)	3.0(1.0-3.0)
2/91	1	0	-	4	1500	0.0(0.0-2.0)	1.0(0.0-3.0)	3.0(1.0-3.0)
	2	5	WNW	5	1500	2.0(0.5-3.0)	2.0(1.0-3.0)	2.0(1.0-3.0)
2/91	1	10	WNW	5	30000	0.0(0.0-3.0)	1.0(0.0-3.0)	2.0(0.0-3.0)
	2	0	-	3	25000	0.5(0.5-3.5)	2.0(1.0-3.0)	2.0(1.0-3.0)

= no glare
= 0 ≤ 25% field of view glare affected
= 25 ≤ 50% field of view glare affected
= > 50% field of view glare affected

TABLE 2: Beaufort Sea State and Glare (for the north/west and south/east sides of the aircraft) each transect.

Scale : 0 = no glare
1 = 0 ≤ 25% field of view glare affected
2 = 25 ≤ 50% field of view glare affected
3 = > 50% field of view glare affected

Note : Transects are numbered as follows:

<u>Blocks 0, 1A, 1B</u>
East to West : 1A - 1A, 1.0, 1.1 - 1.10
1B 1.12 - 1.34
0 1.36 - 1.46
<u>Block 2A</u>
North to South : 2.1 - 2.13, 3.5, 3.05A, 3.06, 3.06A
<u>Block 2B</u>
North to South : 2.14 - 2.25, 2.13
<u>Block 3</u>
North to South : 3.1 - 3.16
<u>Block 4</u>
North to South : 4.01 - 4.07
<u>Block 5</u>
North to South : 4.08 - 4.12, 5.1 - 5.4, 5.4A, 5.5

Transect No.	Beaufort Sea State mode(range)	Glare North/West mode(range)	Glare South/East mode(range)	Cloud Cover
Block 0				
1.36	0.5-1.0	2.0	1.0	1.0-3.0
1.38	1.0	3.0	2.0	1.0
1.40	0.5-3.5	2.0	2.0	0.0-1.0
1.42	0.5-2.5	3.0	2.0	1.0
1.44	1.0-3.0	2.0-3.0	1.0	0.0
1.46	2.5-3.0	3.0	2.0	0.0-1.0
Block 1A				
1.A	0.0	2.0	2.0-3.0	3.0-6.0
1.00	0.0	0.0-1.0	1.0-2.0	3.0-4.0
1.01	0.0(0.0-0.5)	1.0	3.0(1.0-3.0)	3.0-4.0
1.02	0.0-1.0	3.0	3.0(2.0-3.0)	5.0-6.0
1.03	0.5(0.5-2.0)	1.0	2.0-3.0	4.0
1.04	0.5-1.5	1.0-2.0	2.0-3.0	4.0-4.0
1.05	1.0	1.0	2.0-3.0	2.0-4.0
1.06	0.5-1.5	1.0-2.0	1.0-2.0	2.0-4.0
1.07	0.5-2.0	0.0-2.0	1.0-3.0	2.0-3.0
1.08	1.5-2.0	3.0	2.0	3.0-7.0
1.09	2.0	2.0	2.0	1.0-2.0
1.10	2.5-3.0	3.0	1.0	2.0-7.0
Block 1B				
1.12	2.0(2.0-3.0)	1.0-3.0	2.0	0.0-5.0
1.14	2.0(1.0-2.5)	1.0	2.0	3.0-5.0
1.16	1.0(0.0-2.0)	0.0(0.0-1.0)	1.0(0.0-1.0)	5.0-6.0

TABLE 2: continued

Transect No.	Beaufort Sea State mode(range)	Glare North/West mode(range)	Glare South/East mode(range)	Cloud Cover
1.18	0.5-2.0	1.0	2.0	4.0
1.20	0.5(0.0-2.0)	1.0	1.0-2.0	3.0-7.0
1.22	2.0(0.0-2.0)	2.0	2.0-3.0	2.0-3.0
1.24	1.0(0.0-1.0)	1.0-3.0	1.0	2.0-3.0
1.26	0.0(0.0-0.5)	0.0	2.0	1.0-3.0
1.28	0.0(0.0-0.5)	1.0	2.0	2.0-4.0
1.30	0.0(0.0-0.5)	0.0	3.0	1.0-4.0
1.32	0.5(0.5-1.0)	1.0-2.0	1.0-2.0	2.0-3.0
1.34	0.5	1.0	1.0-2.0	3.0-4.0
Block 2A				
2.01	2.0(1.0-2.0)	2.0(1.0-3.0)	2.0(1.0-3.0)	4.0-7.0
2.02	2.0(1.0-2.5)	2.0-3.0	2.0(1.0-3.0)	3.0-7.0
2.03	2.0(1.5-2.0)	3.0(2.0-3.0)	3.0(2.0-3.0)	0.0-6.0
2.04	1.0(1.0-2.0)	1.0-3.0	1.0(1.0-3.0)	0.0-8.0
2.05	1.0(0.0-2.5)	1.0(1.0-3.0)	1.0(1.0-3.0)	0.0-6.0
2.06	1.0(1.0-2.0)	1.0(1.0-2.0)	1.0(1.0-2.0)	0.0
2.07	0.5(0.5-2.0)	0.0-1.0	1.0	0.0-2.0
2.08	0.5(0.5-2.0)	1.0(1.0-2.0)	2.0(1.0-2.0)	0.0
2.09	1.5(0.0-2.0)	0.0(0.0-1.0)	1.0(0.0-2.0)	0.0
2.10	0.5(0.0-2.0)	0.0-2.0	2.0(1.0-2.0)	0.0
2.11	3.0(2.0-3.5)	2.0	3.0	0.0
2.12	3.0(2.0-4.0)	2.0(1.0-2.0)	3.0(2.0-3.0)	0.0
2.13	3.0(2.0-3.0)	1.0	2.0-3.0	0.0-2.0
3.05	3.0(1.0-3.0)	2.0(1.0-2.0)	2.0-3.0	0.0-2.0
3.05A	3.0(2.0-3.0)	2.0(1.0-2.0)	3.0(2.0-3.0)	3.0-4.0
3.06	2.0(2.0-3.5)	2.0(2.0-3.0)	3.0	1.0-4.0
3.06A	3.0(2.5-3.0)	2.0	3.0	4.0
Block 2B				
2.13	3.0(2.0-3.0)	1.0	2.0-3.0	0.0-2.0
2.14	2.0(1.0-2.0)	2.0	2.0(2.0-3.0)	3.0
2.15	2.0(0.0-2.0)	1.0-3.0	2.0(1.0-2.0)	0.0-3.0
2.16	1.5(1.0-2.0)	2.0	3.0(2.0-3.0)	0.0-3.0
2.17	1.5(0.5-2.0)	1.0(1.0-3.0)	2.0(2.0-3.0)	0.0-3.0
2.18	0.5(0.5-1.5)	1.0	2.0-3.0	2.0
2.19	1.0(0.0-1.0)	2.0	2.0	0.0
2.20	1.5(0.5-2.0)	1.0	2.0-3.0	0.0
2.21	1.5(0.5-1.5)	2.0(1.0-2.0)	2.0	0.0-1.0
2.22	1.5(1.0-2.0)	1.0	3.0	0.0-3.0
2.23	2.0(0.5-2.0)	2.0	2.0	1.0-3.0
2.24	1.5(1.0-3.0)	2.0(2.0-3.0)	3.0	0.0
2.25	2.5(2.0-2.5)	1.0	3.0	0.0-2.0
Block 3				
3.01	3.0(3.0-4.0)	1.0-2.0	2.0	2.0-3.0
3.02	3.0(2.0-4.0)	1.0	3.0	0.0
3.03	3.5(2.0-4.0)	1.0	1.0-2.0	0.0-2.0
3.04	3.0	2.0	3.0	0.0-2.0
3.05	3.0(1.0-3.0)	2.0(1.0-2.0)	2.0-3.0	0.0-2.0
3.06	2.0(2.0-3.5)	2.0(2.0-3.0)	3.0	1.0-4.0

TABLE 2: continued

Transect No.	Beaufort Sea State mode(range)	Glare		Cloud Cover
		North/West mode(range)	South/East mode(range)	
3.07	2.5(1.0-3.0)	2.0	3.0	1.0-4.0
3.08	2.0(2.0-3.5)	2.0	3.0	2.0
3.09	3.0(2.0-4.0)	2.0	3.0	0.0-2.0
3.10	3.5(3.0-4.0)	2.0	3.0	0.0
3.11	3.0(2.5-4.0)	2.0	3.0	0.0-0.5
3.12	2.0(2.0-3.5)	2.0(2.0-3.0)	2.0(2.0-3.0)	2.0
3.13	3.0(2.0-3.5)	2.0(1.0-3.0)	2.0(1.0-3.0)	1.0
3.14	3.0(2.0-3.5)	2.0-3.0	3.0	1.0-3.0
3.15	3.0(2.0-3.5)	2.0	2.0-3.0	1.0-3.0
3.16	3.0(2.0-3.5)	2.0	3.0	2.0-3.0
Block 4				
4.01	3.0(1.0-3.0)	2.0	2.0-3.0	0.0-2.0
4.02	3.0(1.0-4.0)	1.0-3.0	2.0(1.0-2.0)	2.0
4.03	2.0(2.0-3.0)	2.0	3.0	1.0-2.0
4.04	3.0(1.0-3.0)	2.0	3.0	2.0
4.05	3.0(2.0-3.0)	2.0	3.0	0.0-1.0
4.06	2.5(2.5-3.0)	1.0-2.0	1.0-2.0	0.0-3.0
4.07	3.0(2.0-4.0)	2.0(2.0-3.0)	3.0(2.0-3.0)	0.0-4.0
Block 5				
5.01	2.5(1.0-2.5)	2.0	3.0	2.0
5.02	3.0(1.0-3.0)	2.0	3.0	1.0
5.03	2.0(2.0-3.0)	2.0	3.0	2.0-5.0
5.04	2.0-3.0	1.0	1.0	0.0-3.0
5.04A	3.0(2.0-3.0)	1.0	3.0	0.0
5.05	2.0-3.0	2.0	3.0	1.1
4.08	2.0(1.0-4.0)	2.0(2.0-3.0)	3.0(2.0-3.0)	2.0-6.0
4.09	3.0(1.0-3.0)	1.0-3.0	2.0(2.0-3.0)	0.0-4.0
4.10	3.0	2.0	3.0	0.0-4.0
4.11	3.0	2.0(2.0-3.0)	3.0(2.0-3.0)	0.0-3.0
4.12	3.0	2.0	3.0	0.0-4.0

TABLE 3: Raw data for dugong sightings for the survey.

Note : Transects are numbered as follows:

<u>Blocks 0, 1A, 1B</u>
East to West : 1A - 1A, 1.0, 1.1 - 1.10
1B 1.12 - 1.34
0 1.36 - 1.46

<u>Block 2A</u>
North to South : 2.1 - 2.13, 3.5, 3.05A, 3.06, 3.06A

<u>Block 2B</u>
North to South : 2.14 - 2.25, 2.13

<u>Block 3</u>
North to South : 3.1 - 3.16

<u>Block 4</u>
North to South : 4.01 - 4.07

<u>Block 5</u>
North to South : 4.08 - 4.12, 5.1 - 5.4, 5.4A, 5.5

Transect No.	No. of observers		No. of groups of dugongs					
			Port			Starboard		
	Port	Starboard	Mid	Rear	Tandem	Mid	Rear	Tandem
1.A	1	1	0			0		
1.00	1	1	0			0		
1.01	1	1	0			0		
1.02	1	1	0			0		
1.03	1	1	0			0		
1.04	1	1	0			0		
1.05	1	1	0			1		
1.06	1	1	0			0		
1.07	1	1	11			4		
1.08	1	1	2			3		
1.09	1	1	1			1		
1.10	1	1	0			0		
1.12	1	1	0			0		
1.14	2	2	0	0	0	0	0	0
1.16	2	2	0	0	0	0	0	0
1.18	2	2	0	0	0	0	0	0
1.20	2	2	0	0	0	0	0	0
1.22	2	2	0	0	0	0	0	0
1.24	2	2	0	1	0	1	0	4
1.26	2	2	0	1	1	0	0	1
1.28	2	2	0	0	8	3	1	2
1.30	2	2	0	0	2	0	2	3
1.32	2	2	0	0	1	0	0	0
1.34	2	2	0	0	0	0	0	2
1.36	2	2	0	0	0	0	0	1
1.38	2	2	0	0	0	0	0	0
1.40	2	2	0	0	1	0	0	0
1.42	2	2	1	0	0	0	0	1
1.44	2	2	0	0	0	0	0	0

TABLE 3: continued

Transect No.	No. of observers Port	Starboard	No. of groups of dugongs Port Mid	Port Rear	Port Tandem	Starboard Mid	Starboard Rear	Starboard Tandem
1.46	2	2	0	0	1	0	0	1
2.01	1	1	5			5		
2.02	1	1	5			2		
2.03	1	1	6			8		
2.04	1	1	5			6		
2.05	1	1	29			9		
2.06	1	1	4			4		
2.07	1	1	2			2		
2.08	2	2	2	0	4	1	2	8
2.09	2	2	8	0	0	2	0	0
2.10	2	2	10	0	0	5	0	0
2.11	2	2	0	0	0	1	0	1
2.12	2	2	1	0	2	2	0	0
2.13	2	2	0	0	3	0	0	1
2.14	2	2	2	0	1	1	1	0
2.15	2	2	0	1	2	1	0	1
2.16	2	2	2	0	2	1	0	0
2.17	2	2	0	0	0	0	0	0
2.18	2	2	0	0	0	0	0	0
2.19	2	2	0	0	0	0	0	0
2.20	2	2	0	0	1	0	0	0
2.21	2	2	0	0	1	0	0	0
2.22	2	2	0	0	0	2	0	0
2.23	2	2	1	0	0	2	0	1
2.24	2	2	0	0	0	0	0	1
2.25	2	2	1	0	0	0	0	0
3.01	2	2	0	0	0	0	0	0
3.02	2	2	2	0	2	0	0	1
3.03	2	2	2	1	7	2	0	4
3.04	2	2	1	0	1	0	0	0
3.05	2	2	3	0	0	3	0	1
3.05A	2	2	0	0	1	0	0	0
3.06	2	2	0	0	1	0	0	3
3.06A	2	2	1	0	1	0	2	1
3.07	2	2	0	0	1	0	0	0
3.08	2	2	0	0	0	0	0	0
3.09	2	2	0	1	0	0	0	1
3.10	2	2	1	1	0	0	0	0
3.11	2	2	2	0	0	3	0	0
3.12	2	2	0	0	1	0	1	0
3.13	2	2	1	0	3	1	1	3
3.14	2	2	0	0	1	0	0	2
3.15	2	2	0	0	0	0	0	0
3.16	2	2	0	0	1	0	0	0
4.01	2	2	1	0	0	0	0	0
4.02	2	2	0	0	1	0	0	0
4.03	2	2	0	0	0	1	0	0

TABLE 4: Raw data used to calculate correction factors for dugongs for the surveys (Note: where appropriate data from the Torres Strait surveys were combined with data from the Mornington Island survey using the same observers).

(a) Correction for perception bias

Blocks : lines	No. of groups of dugongs					
	Port			Starboard		
	Mid	Rear	Tandem	Mid	Rear	Tandem
0; 1B:1.14-1.34	11	13	37	19	14	43
1A; 1B:1.12 (these sightings also include those for the Mornington Island survey by the same observers)	11[1]	13[1]	37[1]	92[1]	14[1]	43[1]
2A:2.01-2.07	44[2]	4[2]	40[2]	29[2]	8[2]	31[2]
2A:2.08-2.13; 2B 3; 4; 5	44	4	40	29	8	31

[1] These transects had only one observer so perception bias is based on the mid-seat observer for the transects done by the four person team that surveyed Blocks 0 and 1B and the survey of Mornington Island conducted immediately after this survey.

[2] These transects had only one observer so perception bias is based on the mid-seat observer for the transects done by the four person team that did Blocks 2B, 3, 4 and 5.

(b) Correction for availability bias

Blocks : lines	No. of dugongs in groups of less than 10		
	Surface	Under	Total
All blocks and lines;	227	192	419

TABLE 3: continued

Transect No.	No. of observers Port	Starboard	No. of groups of dugongs Port Mid	Port Rear	Port Tandem	Starboard Mid	Starboard Rear	Starboard Tandem
4.04	2	2	0	0	2	0	0	0
4.05	2	2	0	0	0	0	0	0
4.06	2	2	0	0	0	0	0	0
4.07	2	2	0	0	0	0	0	0
4.08	2	2	1	0	0	0	0	0
4.09	2	2	0	0	0	0	0	0
4.10	2	2	0	0	0	0	0	0
4.11	2	2	0	0	0	0	0	0
4.12	2	2	0	0	0	0	0	0
5.01	2	2	0	0	0	0	0	0
5.02	2	2	0	0	0	0	0	0
5.03	2	2	0	0	0	0	0	0
5.04	2	2	0	0	0	0	0	0
5.04A	2	2	1	0	0	0	0	0
5.05	2	2	1	0	1	1	1	2
Total			115[1]	6	54	78[1]	11	46

Note : Transects in Blocks 0, 1A and 1B had different observers from the remainder of the survey.

[1] includes data from Transects 1A to 1.12 and Transects 2.01 to 2.07 which had only two observers and were thus not used in calculation of perception correction factors.

TABLE 5: Raw data for turtle sightings for the survey.

Note : Transects are numbered as follows:

<u>Blocks 0, 1A, 1B</u>
East to West : 1A - 1A, 1.0, 1.1 - 1.10
1B 1.12 - 1.34
0 1.36 - 1.46

<u>Block 2A</u>
North to South : 2.1 - 2.13, 3.5, 3.05A, 3.06, 3.06A

<u>Block 2B</u>
North to South : 2.14 - 2.25, 2.13

<u>Block 3</u>
North to South : 3.1 - 3.16

<u>Block 4</u>
North to South : 4.01 - 4.07

<u>Block 5</u>
North to South : 4.08 - 4.12, 5.1 - 5.4, 5.4A, 5.5

Transect No.	No. of observers		No. of groups of turtles					
	Port	Starboard	Port			Starboard		
			Mid	Rear	Tandem	Mid	Rear	Tandem
1.A	1	1	0			1		
1.00	1	1	1			1		
1.01	1	1	11			7		
1.02	1	1	13			6		
1.03	1	1	8			11		
1.04	1	1	6			4		
1.05	1	1	0			1		
1.06	1	1	3			2		
1.07	1	1	5			3		
1.08	1	1	0			2		
1.09	1	1	2			2		
1.10	1	1	2			1		
1.12	1	1	0			0		
1.14	2	2	0	0	0	1	1	0
1.16	2	2	0	1	0	0	1	0
1.18	2	2	1	0	0	0	1	0
1.20	2	2	1	0	0	2	1	1
1.22	2	2	3	0	4	0	1	2
1.24	2	2	3	0	2	0	5	8
1.26	2	2	3	1	3	2	5	5
1.28	2	2	7	0	3	4	5	4
1.30	2	2	1	1	2	0	3	2
1.32	2	2	0	0	2	0	2	1
1.34	2	2	1	0	2	0	1	0
1.36	2	2	2	0	0	0	0	0
1.38	2	2	0	0	0	1	1	0
1.40	2	2	0	0	1	0	0	1
1.42	2	2	0	0	1	0	0	0
1.44	2	2	4	0	5	7	0	0

TABLE 5: continued

Transect No.	No. of observers Port	No. of observers Starboard	No. of groups of turtles Port Mid	Port Rear	Port Tandem	Starboard Mid	Starboard Rear	Starboard Tandem
1.46	2	2	1	0	0	0	0	0
2.01	1	1	23			23		
2.02	1	1	31			23		
2.03	1	1	26			16		
2.04	1	1	27			12		
2.05	1	1	26			19		
2.06	1	1	19			23		
2.07	1	1	33			28		
2.08	2	2	9	5	7	9	8	7
2.09	2	2	8	0	0	8	0	0
2.10	2	2	7	0	0	9	0	0
2.11	2	2	0	0	1	2	3	1
2.12	2	2	3	4	7	3	3	4
2.13	2	2	3	3	2	3	3	1
2.14	2	2	0	0	0	1	0	1
2.15	2	2	1	2	4	2	3	5
2.16	2	2	2	0	2	3	0	0
2.17	2	2	1	4	0	3	2	3
2.18	2	2	0	3	2	2	0	0
2.19	2	2	0	0	3	0	1	1
2.20	2	2	0	2	3	3	0	0
2.21	2	2	4	2	2	2	2	0
2.22	2	2	1	1	1	1	2	1
2.23	2	2	0	0	0	0	2	3
2.24	2	2	1	1	2	1	2	1
2.25	2	2	0	0	0	2	0	0
3.01	2	2	0	0	0	0	0	0
3.02	2	2	0	0	2	3	0	0
3.03	2	2	1	2	1	1	1	1
3.04	2	2	2	0	2	0	0	2
3.05	2	2	11	3	4	8	1	2
3.05A	2	2	1	0	0	0	0	0
3.06	2	2	2	2	5	0	1	1
3.06A	2	2	2	4	2	1	3	0
3.07	2	2	3	5	3	6	5	4
3.08	2	2	3	3	6	2	1	0
3.09	2	2	2	1	1	2	1	0
3.10	2	2	5	1	2	2	1	1
3.11	2	2	4	1	2	2	1	0
3.12	2	2	4	1	5	2	3	5
3.13	2	2	3	5	7	1	0	7
3.14	2	2	1	0	5	0	0	1
3.15	2	2	1	3	3	1	1	3
3.16	2	2	0	2	0	0	0	0
4.01	2	2	0	0	1	5	0	2
4.02	2	2	2	0	1	1	0	1
4.03	2	2	7	4	6	2	3	5

TABLE 5: continued

Transect No.	No. of observers Port	Starboard	No. of groups of turtles Port Mid	Port Rear	Port Tandem	Starboard Mid	Starboard Rear	Starboard Tandem
4.04	2	2	4	2	3	8	7	2
4.05	2	2	14	4	13	8	6	7
4.06	2	2	1	2	0	3	0	1
4.07	2	2	8	2	1	3	3	2
4.08	2	2	1	3	4	2	4	3
4.09	2	2	2	1	4	4	0	1
4.10	2	2	3	2	8	4	3	2
4.11	2	2	0	1	4	4	1	0
4.12	2	2	0	2	1	0	0	0
5.01	2	2	1	0	1	1	0	0
5.02	2	2	0	0	0	0	2	0
5.03	2	2	0	1	1	1	1	0
5.04	2	2	1	1	0	0	1	0
5.04A	2	2	0	0	1	0	0	0
5.05	2	2	0	0	0	1	0	0
Total			392[1]	88	160	334[1]	108	105

Note: Transects in Blocks 0, 1A and 1B had different observers from the remainder of the survey.

[1] includes data from Transects 1A to 1.12 and Transects 2.01 to 2.07 which had only two observers and were thus not used in calculation of perception correction factors.

TABLE 6: Raw data used to calculate correction factors for turtles for the surveys (Note: where appropriate data from the Torres Strait surveys were combined with the data from the Mornington Island survey using the same observers).

(a) Correction for perception bias

Blocks : lines	No. of groups of turtles					
	Port			Starboard		
	Mid	Rear	Tandem	Mid	Rear	Tandem
0; 1B:1.14-1.34	107	20	95	92	45	68
1A; 1B:1.12 (these sightings also include those for the Mornington Island survey by the same observers)	107[1]	20[1]	95[1]	92[1]	45[1]	68[1]
2A:2.01-2.07	129[2]	85[2]	137[2]	134[2]	81[2]	82[2]
2A:2.08-2.13; 2B 3; 4; 5	129	85	137	134	81	82

[1] These transects had only one observer so perception bias is based on the mid-seat observer for the transects done by the four person team that surveyed Blocks 0 and 1B and the survey of Mornington Island conducted immediately after this survey.

[2] These transects had only one observer so perception bias is based on the mid-seat observer for the transects done by the four person team that did Blocks 2B, 3, 4 and 5.

(b) Correction for availability bias

Blocks : lines	No. of turtles in groups of less than 10		
	Surface	Under	Total
All blocks and lines;	660	585	1245

LE 7: Raw data for cetacean sightings for the survey.

: Transects are numbered as follows:

ks 0, 1A, 1B

to West	:	1A - 1A, 1.0, 1.1 - 1.10
		1B 1.12 - 1.34
		0 1.36 - 1.46
ck 2A		
th to South	:	2.1 - 2.13, 3.5, 3.05A, 3.06, 3.06A
ck 2B		
th to South	:	2.14 - 2.25, 2.13
ck 3		
th to South	:	3.1 - 3.16
ck 4		
rth to South	:	4.01 - 4.07
ck 5		
rth to South	:	4.08 - 4.12, 5.1 - 5.4, 5.4A, 5.5

ansect No.	No. of observers		No. of groups of cetaceans					
	Port	Starboard	Port			Starboard		
			Mid	Rear	Tandem	Mid	Rear	Tandem
.A	1	1	0			1		
.00	1	1	0			0		
.01	1	1	0			1		
1.02	1	1	1			1		
1.03	1	1	1			1		
1.04	1	1	1			0		
1.05	1	1	1			0		
1.06	1	1	0			1		
1.07	1	1	0			0		
1.08	1	1	0			0		
1.09	1	1	0			0		
1.10	1	1	0			0		
1.12	1	1	0			0		
1.14	2	2	1	0	0	0	0	2
1.16	2	2	0	0	0	0	0	0
1.18	2	2	1	1	0	0	0	0
1.20	2	2	0	0	0	0	0	0
1.22	2	2	0	0	0	0	0	0
1.24	2	2	0	0	0	0	0	0
1.26	2	2	0	0	0	0	0	0
1.28	2	2	0	0	0	0	0	0
1.30	2	2	0	0	0	0	0	0
1.32	2	2	0	0	0	0	0	0
1.34	2	2	0	0	0	0	0	0
1.36	2	2	0	0	0	0	0	0
1.38	2	2	0	0	0	0	0	0
1.40	2	2	0	0	0	0	0	0
1.42	2	2	0	0	0	0	0	0
1.44	2	2	0	0	0	0	0	0

TABLE 7: continued

Transect No.	No. of observers Port	Starboard	No. of groups of cetaceans Port Mid	Port Rear	Port Tandem	Starboard Mid	Starboard Rear	Starboard Tandem
1.46	2	2	0	0	0	0	0	0
2.01	1	1	0			0		
2.02	1	1	0			0		
2.03	1	1	0			0		
2.04	1	1	0			0		
2.05	1	1	0			0		
2.06	1	1	0			0		
2.07	1	1	1			0		
2.08	2	2	0	0	0	0	0	0
2.09	2	2	0	0	0	0	0	0
2.10	2	2	0	0	0	0	0	0
2.11	2	2	0	0	0	0	0	0
2.12	2	2	0	0	1	0	0	0
2.13	2	2	0	0	2	0	0	2
2.14	2	2	0	0	0	0	0	0
2.15	2	2	0	0	0	0	0	0
2.16	2	2	0	0	0	0	0	0
2.17	2	2	1	0	0	1	0	1
2.18	2	2	0	0	0	0	0	0
2.19	2	2	0	0	0	1	0	0
2.20	2	2	0	0	1	0	0	0
2.21	2	2	0	0	0	0	0	2
2.22	2	2	0	0	0	0	0	0
2.23	2	2	0	0	0	0	0	0
2.24	2	2	0	0	0	0	0	0
2.25	2	2	0	0	2	0	0	0
3.01	2	2	0	0	0	0	0	0
3.02	2	2	0	0	0	0	0	0
3.03	2	2	0	0	1	0	0	0
3.04	2	2	0	0	0	0	0	0
3.05	2	2	1	0	0	0	0	0
3.05A	2	2	0	0	0	1	0	0
3.06	2	2	0	0	0	0	0	0
3.06A	2	2	0	0	0	0	0	0
3.07	2	2	0	0	0	0	0	0
3.08	2	2	0	0	0	0	0	0
3.09	2	2	0	0	0	0	0	0
3.10	2	2	0	0	0	0	0	0
3.11	2	2	0	0	0	0	0	0
3.12	2	2	0	0	0	0	0	0
3.13	2	2	0	0	0	0	0	0
3.14	2	2	0	0	0	0	0	2
3.15	2	2	2	0	1	0	0	0
3.16	2	2	0	0	0	0	0	0
4.01	2	2	0	0	0	0	0	0
4.02	2	2	0	0	5	0	0	0
4.03	2	2	1	0	0	0	0	0

TABLE 7: continued

Transect No.	No. of observers Port	Starboard	No. of groups of cetaceans Port Mid	Rear	Tandem	Starboard Mid	Rear	Tandem
4.04	2	2	0	0	2	0	0	0
4.05	2	2	0	0	1	0	0	0
4.06	2	2	0	1	0	0	0	0
4.07	2	2	0	0	1	0	0	0
4.08	2	2	0	0	0	0	0	0
4.09	2	2	0	0	0	0	0	0
4.10	2	2	0	0	0	0	0	0
4.11	2	2	0	0	0	0	0	0
4.12	2	2	0	0	0	0	0	0
5.01	2	2	0	0	0	1	0	0
5.02	2	2	0	0	0	0	0	0
5.03	2	2	0	0	0	0	0	0
5.04	2	2	0	0	0	0	0	0
5.04A	2	2	0	0	0	1	0	0
5.05	2	2	0	0	0	0	0	0
Total			12[1]	2	17	10[1]	0	9

Note: Transects in Blocks 0, 1A and 1B had different observers from the remainder of the survey.

[1] includes Transects 1A to 1.12 and Transects 2.01 to 2.07 which had only two observers and were thus not used in calculation of perception correction factors.

TABLE 8: Raw data used to calculate correction factors for cetaceans for the surveys (Note: where appropriate data from the Torres Strait surveys were combined with the data from the Mornington Island survey using the same observers).

(a) Correction for perception bias

Blocks : lines	No. of groups of cetaceans					
	Port			Starboard		
	Mid	Rear	Tandem	Mid	Rear	Tandem
0; 1B:1.14-1.34	3	3	7	6	4	10
1A; 1B:1.12 (these sightings also include those for the Mornington Island survey by the same observers)	3[1]	3[1]	7[1]	6[1]	4[1]	10[1]
2A:2.01-2.07	5	1	7	5	1	17
2A:2.08-2.13; 2B 3; 4; 5	5[2]	1[2]	7[2]	5[2]	1[2]	17[2]

[1] These transects had only one observer so perception bias is based on the mid-seat observer for the transects done by the four person team that surveyed Blocks 0 and 1B and the survey of Mornington Island conducted immediately after this survey.

[2] These transects had only one observer so perception bias is based on the mid-seat observer for the transects done by the four person team that did Blocks 2B, 3, 4 and 5.

(b) Correction for availability bias
- This was not able to be calculated for cetaceans.