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Another dolphin in peril? Photo-identification, occurrence, and distribution of the endangered Indian Ocean humpback dolphin (*Sousa plumbea*) in Algoa Bay

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Abstract

1. In South Africa, the humpback dolphin (*Sousa plumbea*) has been recognized as the most endangered marine mammal, with a low abundance, a discontinuous distribution, and numerous threats. This research was initiated in 2008 to estimate the number of individual humpback dolphins in Algoa Bay, as well as studying their residency patterns and distribution.
2. The last boat-based study on humpback dolphins, conducted 24 years ago, formed an important reference against which to compare current findings. This study reveals that since the 1990s the number of identified animals decreased from 70 to 50 individuals, and the mean group size of humpback dolphins has also decreased, from seven to three animals.
3. Humpback dolphin behaviour was predominantly that of foraging and travelling, although the overall frequency of foraging still seems to have decreased since early 1990s.
4. Although the species was seen almost all year round, the number of sightings per survey was lowest in January, March, and April. The number of sightings per kilometre surveyed substantially decreased from 0.018 sightings per kilometre in 2008 to 0.004 in 2011, and the number of animals per kilometre also decreased from 0.042 to 0.009. The re-sighting rates were low, ranging from one to eight times, with 52% of identified dolphins seen only once throughout the study period. Only 6% of the individuals were seen more than three times.
5. Reduced humpback dolphin numbers and sighting rates could be indicative of the rise in anthropogenic activities, such as shipping and recreational boating, as well as a rise in pollution from vessels and urban development.
6. Conservation strategies, such as a Biodiversity Management Plan for the species, are urgently needed in Algoa Bay, especially in the south-west part of the bay, between Cape Recife and the Port Elizabeth Harbour, where the species occurs most frequently.

KEYWORDS
behaviour, encounter rates, endangered species, group size, photo-identification, residency patterns, *Sousa plumbea*, South Africa

1 | INTRODUCTION

The Indian Ocean humpback dolphin (*Sousa plumbea*) has been well researched in South African waters. Several studies have been conducted on its abundance (Atkins & Atkins, 2002; James, Bester, Penry, Gennari, & Elwen, 2015; Jobson, 2006; Karczmarski, Cockcroft, & McLachlan, 1999; Keith, Peddemors, Bester, & Ferguson, 2002), distribution (Atkins, Pillay, & Peddemors, 2004; Durham, 1994; Karczmarski, Cockcroft et al., 1999; Karczmarski, Winter, Cockcroft, & McLachlan, 1999; Melly, McGregor, Hofmeyr, & Plön, 2017), diet (Barros & Cockcroft, 1991), genetics (Mendez et al., 2013), life history (Plön, Cockcroft, & Froneman, 2015), and health assessment (Cockcroft, 1991; Lane et al., 2014; Plön, Albrecht, Cliff, & Froneman, 2012). This species has recently been recognized as separate from the Indo-Pacific humpback dolphin (*Sousa chinensis*), based on molecular and morphological studies (Jefferson & Rosenbaum, 2014; Mendez et al., 2013).

The Indian Ocean humpback dolphin (hereafter referred to just as the humpback dolphin) is distributed from the Bay of Bengal in India, to False Bay, South Africa (Braulik, Findlay, Cerchio, & Baldwin, 2015; Jefferson & Rosenbaum, 2014; Mendez et al., 2013). It is restricted to inshore coastal waters, and like many other coastal cetaceans, is highly vulnerable to environmental disturbances resulting from coastal development and human activities (e.g. chemical and acoustic pollution, overfishing, coastal construction, and boat traffic; Braulik et al., 2015; Parra, Corkeron, & Marsh, 2006; Plön, Cockcroft et al., 2015). Along the KwaZulu-Natal coastline (KZN, east coast of South Africa), gillnets are used to protect bathers from shark attacks, resulting in the incidental mortality of dolphins, which impacts on the long-term survival of this species in the country (Atkins et al., 2016).

In South Africa, the humpback dolphin has been recognized as the most endangered marine mammal (Mammal Red List assessment by the Endangered Wildlife Trust) because of its low abundance (<1000 individuals; Karczmarski, 1996), discontinuous distribution, and numerous threats (Braulik et al., 2015; Plön, Atkins, et al., 2015). This species has been recently assessed as a separate species from *S. chinensis* using the International Union for Conservation of Nature (IUCN) Red List Criteria (Jefferson & Rosembaum, 2014), and has recently been listed as 'Endangered' (Braulik, Findlay, Cerchio, Baldwin, & Perrin, 2017).

The two largest assessed populations of humpback dolphins in South Africa (Richard's Bay, KZN; Algoa Bay, Eastern Cape) have shown a large decrease in their abundance (Atkins et al., 2016) and group size over the last two decades (Koper, Karczmarski, Du Preez, & Plön, 2015; Melly et al., 2017). In Algoa Bay, the last dedicated boat-based study on humpback dolphins was conducted between 1991 and 1994. Therefore, to fill the data gap for this species, this research aimed to estimate the number of individual humpback dolphins inhabiting the bay, study their residency patterns, investigate their distribution and occurrence, as well as characterize their habitat use.

2 | METHODS

2.1 | Study area

Algoa Bay (Eastern Cape, South Africa) has approximately 90 km of coastline (3100 km^2), flanked on the west by Cape Recife and on the east by Cape Padrone (Figure 1). It is the easternmost bay on the southern coastline of South Africa, and is relatively shallow (with a depth of <70 m; Goschen & Schumann, 2011). The bay is influenced by the warm Agulhas Current, which flows through the Mozambique Channel as a series of eddies before flowing south-westerly along the South African continental shelf (Roberts, van der Lingen, Whittle, & van den Berg, 2010; Shannon, 1989). Sea surface temperatures generally range between 16°C and 21°C (Schumann, Churchill, & Zaaymann, 2005); however, the bay is subject to intermittent wind-induced coastal upwellings, which can reduce water temperatures to below 13°C (Lutjeharms, 2006; Schumann, 1982).

The bay contains two groups of islands: the Bird Island group (situated approximately 2 km south of Cape Padrone), comprising Bird Island, Black Rocks, Seal Island, and Stag Island; and the St Croix Islands (bordering the eastern side of Coega Harbour), comprising St Croix, Jahleel, and Brenton Rocks. The Bird Island Group has been a Marine Protected Area (MPA) since 2004, and in 2009 an experimental purse-seine fishing exclusion zone of 20 km in radius was established around St Croix Island. Bird Island and St Croix Island were also proclaimed as part of Addo Elephant National Park in 2005 (Figure 1).

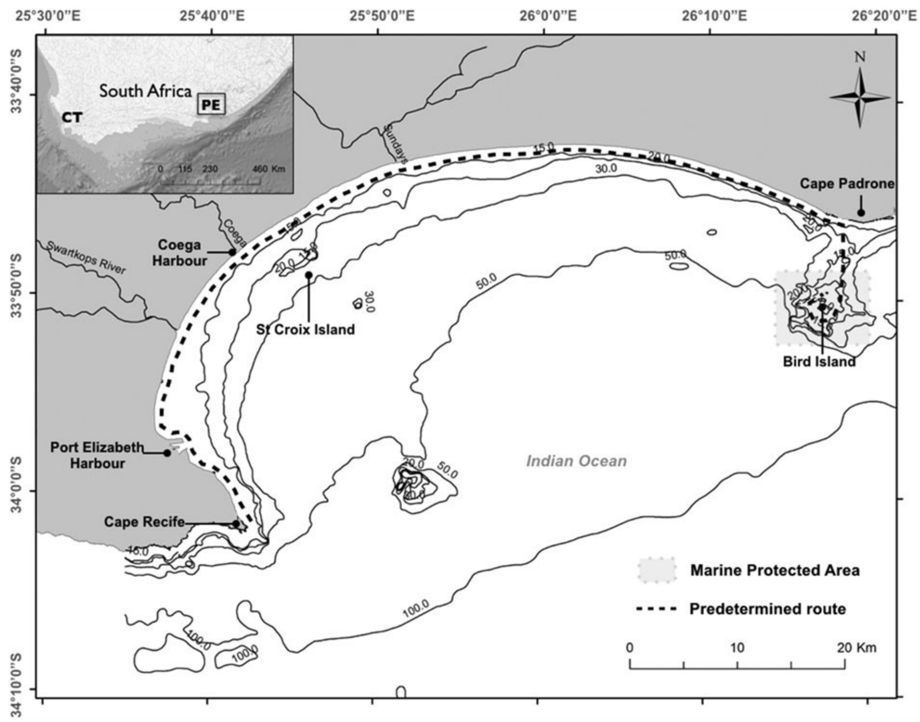

FIGURE 1 The Algoa Bay study area in South Africa. The predetermined survey route followed during the boat-based surveys (<30 m depth), including the Marine Protected Area established around Bird Island, is shown by the dashed line. CT, Cape Town; PE, Port Elizabeth

2.2 | Data collection

Boat-based surveys were conducted in Algoa Bay (South Africa) from June 2008 to May 2011. Surveys followed a single transect that ran parallel with the coast, at approximately 500 m from the shore (Figure 1). The surveys were carried out using an 8.5-m semi-rigid boat, at an approximate speed of 6–9 knots, in calm sea conditions (<Beaufort 4), and systematically covering the entire coastline over four or five survey days (depending on the weather conditions). Data were collected by four experienced observers who each scanned an area of approximately 180° ahead, such that the full 360° was covered twice. Scanning for dolphins was done with the naked eye and covered an estimated radius of ~500 m from the boat. Sea surface temperature and water depth were measured using the on-board depth sounder, whereas wind direction, force, and the Beaufort sea state were assessed from the boat by the observers. This was done for each sighting, as well as every half an hour during the survey.

When a dolphin group was encountered, the location of the sighting was recorded using a hand-held Global Positioning System (GPS; Garmin GPSMAP 76CSx). A group of dolphins was defined as all individuals seen within an approximately 100 m radius and engaged in the similar behavioural activity (Irvine, Scott, Wells, & Kaufmann, 1981; Wells, Scott, & Irvine, 1987). The size of the group (minimum, maximum, and best estimate of the number of animals present) was continuously assessed by multiple visual counts made by the observers. The composition of the group (number of adults, juveniles, and calves) was also recorded. Adults were approximately 2.5 m in length with a well-pronounced dorsal hump. Juveniles were approximately 2 m in length, and visibly less robust than adults, whereas calves were approximately two-thirds or less than the length of an adult, and generally had visible foetal folds and a light-grey skin colour (Karczmarski, 1999). The calves were mostly accompanied by an adult, whereas juveniles would swim independently (Karczmarski, 1999; Weir, 2009). The predominant behavioural activity was also recorded and defined as outlined by Shane (1990), into five categories: travelling, foraging, socializing, milling, and resting.

Photo-identification pictures of individuals were taken with a digital Canon EOS 40D camera (with a Canon EF 100–400 mm *f*/4.5–5.6 L IS USM lens). Pictures were, as far as possible, taken perpendicular to the body axis of the dolphin, and concentrated on the hump and the dorsal fin. Individual humpback dolphins were identified using the natural marks present on their dorsal fins and humps (Weir, 2009; Würsig & Jefferson, 1990). All pictures were classified into three quality grades (Q1, excellent; Q2, good; and Q3, poor; following Urian, Hohn, & Hansen, 1999). The distinctiveness (D) of each individual dorsal fin was also graded on a scale of one to three, where D1 was very distinctive, D2 distinctive, and D3 not distinctive (following Urian et al., 1999). Only pictures of distinctive dorsal fins (D1 and D2) and of excellent (Q1) or good (Q2) quality were used for further analysis (Urian et al., 1999; Urian et al., 2015). Finally, pictures of dorsal fins were classified based on the location of the predominant features found on the dorsal fins (following Urian et al., 1999). Left and right dorsal fins were matched using the main features observed along the leading or trailing edge of the dorsal fin. As this study was part of a larger study focusing on the distribution of six cetacean species in Algoa Bay (Melly et al., 2017), there was a maximum time limit of 20 minutes to record the data and take photographs of individual dorsal fins.

2.3 | Data analysis

A one-way ANOVA was used to investigate variations of the mean group size over time. The encounter rate was calculated as the number of sightings per kilometre of survey effort. The seasonal occurrence was calculated as the number of sightings per kilometre for each month. Data from June 2008 to May 2011 were also pooled by seasons: summer, December–February; autumn, March–May; winter, June–August; spring, September–November (following Melly et al., 2017). The monthly and annual variations of the frequency of sightings were tested using a χ^2 test. Statistical analyses were conducted using SAS/STAT 9.3 (SAS Institute, 2012). Simple linear regression was carried out to assess the overall trend of the encounter rate (the number of sightings per kilometre). Sighting locations were mapped using ARCGIS 10.0 (ESRI® Inc., 2014). The closest distance between sightings and the shore was also calculated in ARCGIS 10.0 using the spatial join feature (CLOSEST option).

The spatial distribution of *S. plumbea* within the study area was assessed using a kernel density estimator (KDE) analysis in R 3.3.0 (R Development Core Team, 2016), using ADEHABITATHR 0.4.14 (Calenge, 2006). This analysis provides estimates of utilization densities (UDs), which are density probability functions that describe the relative use of space by animals, within a defined area, and is based on a sample of animal locations (Van Winkle, 1975). The UDs of individuals were estimated by using the locations of each sighting at the time that they were initially encountered. Sequential positions were not used as they can bias the home-range estimates (White & Garrot, 1990).

A bivariate normal kernel UD was used to determine home-range areas (95% UD) and core areas (50% UD). The least-squares cross-validation (LSCV) method was then used to find a smoothing parameter value, or bandwidth, for the kernel (Seaman & Powell, 1996). The LSCV method examines various bandwidths and selects the bandwidth that gives the lowest mean integrated squared error for the density estimate (Seaman & Powell, 1996). The LSCV method was chosen for this study as it was found to give the best results in most cases with greater accuracy and lower biases (Seaman & Powell, 1996; Worton, 1989).

3 | RESULTS

During the study period, 106 surveys were conducted, corresponding to a total of 3873 km of sampling effort within the inshore areas (at depths of <30 m). Out of a total of 500 sightings of cetaceans observed during the study period (Melly et al., 2017), 10% were of humpback dolphins (n = 50), with a total of 153 individual humpback

TABLE 1 Summary of the survey effort, showing the number of surveys conducted, the number of surveys in which humpback dolphins were seen, the number of sightings, and number of animals observed

Years	No. surveys	No. with *Sousa*	Sightings	Animals
2008	21	8	13	30
2009	44	14	23	68
2010	31	12	13	53
2011	10	1	1	2
Total	**106**	**35**	**50**	**153**

dolphins (Table 1). Data were collected in sea surface temperatures ranging from 15°C to 24.5°C (mean = 19.1°C, SE = 0.3°C), and at an average depth of 6.6 m (SE = 0.32 m, min–max = 2–13 m).

Group sizes were small, with an average of three animals (mean = 3.1, SE = 0.5), varying from one to 23 animals (Figure 2). Solitary dolphins were observed in 28% of the sightings, and approximately 82% of the sightings had a group size of between one and three animals (Figure 2). Mother–calf pairs were seen in nine sightings, of which one sighting had three calves. The group size did not vary significantly between months (one-way ANOVA, $F = 0.45$, $P = 0.90$) or years (one-way ANOVA, $F = 0.46$, $P = 0.71$).

Predominant behaviours were recorded for 84% of the sightings, as other sightings were too brief to accurately assign behaviour. Significantly more groups were observed foraging (42.8%) and travelling (35.7%) than milling (16.7%), mating (2.4%), and socializing (2.4%) ($\chi^2 = 29.4$, $df = 4$, $P < 0.001$). Overall, there was no clear geographical pattern of behaviours observed in the study area.

3.1 | Spatial distribution

Humpback dolphins were observed close to shore, at a mean distance of 414 m (SE = 48.21 m, median = 373 m, min–max = 76–1300 m). The

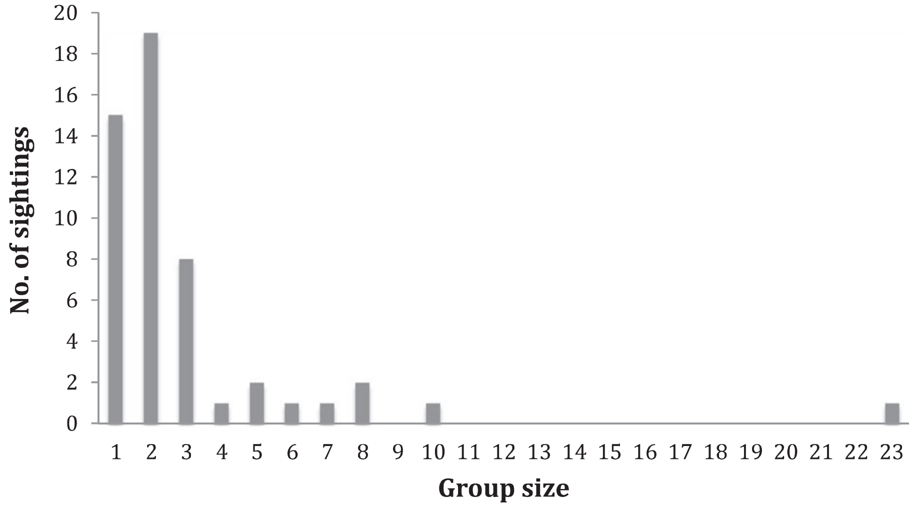

FIGURE 2 Number of sightings per group size of humpback dolphins (*Sousa plumbea*) observed in Algoa Bay between June 2008 and May 2011. Note: there were no sightings recorded with group sizes of 11–22 individuals

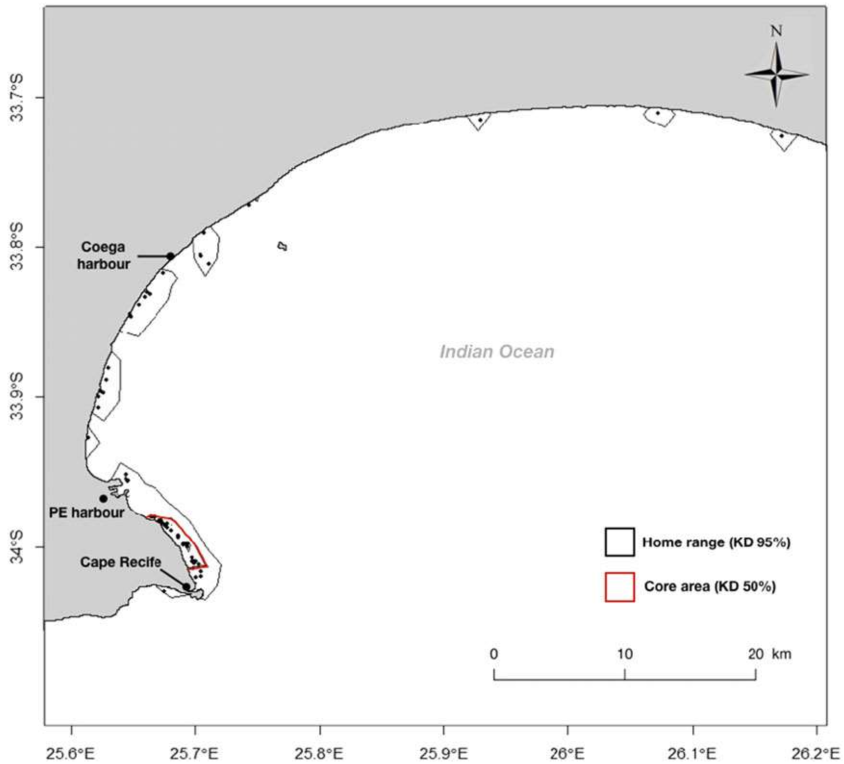

FIGURE 3 Sighting distribution of humpback dolphins (*Sousa plumbea*, black dots) in Algoa Bay, recorded between 2008 and 2011, including the results of the kernel density analysis. The areas delineated with black outlines represent the home range of *S. plumbea* (the 95% kernel range), and the area delineated in red represents the core area (50% kernel range)

spatial distribution of humpback dolphins reveals that 94% of the sightings were recorded in the south-western half of the bay between Cape Recife and Coega Harbour, 64% of which were recorded between Cape Recife and Port Elizabeth Harbour. Consequently, the core habitat (50% kernel range) was located within this area (Figure 3).

3.2 | Occurrence and encounter rates

Humpback dolphins were seen almost all year round during the study period, excluding May and September. The number of sightings per kilometre was lower in January, March, and April (Figure 4), but there was no overall significant monthly variation (χ^2 = 14, *df* = 9, *P* = 0.12); however, a significant annual variation in the frequency of sightings was observed (χ^2 = 19.44, *df* = 3, *P* = 0.0002), with 46% of the sightings recorded in 2009, 26% in 2008 and 2010, and only 2% in 2011 (Table 1). The number of sightings per kilometre was also low, and decreased markedly over time from 0.018 sightings per kilometre in 2008 to 0.004 sightings per kilometre in 2011 (Figure 5).

3.3 | Photo-identification and residency patterns

Using the highest quality images available (*n* = 197, Q1 + Q2), 50 individuals were identified over the 3 years. Twenty-two animals were identified in 2008, 23 in 2009, and five in 2010. All identified animals were adults, with the exception of one juvenile. The number of re-sightings was low, ranging from one to eight times. Of the dolphins identified, 52% were seen only once throughout the study period, and only three of the individuals were seen more than three times (Figure 6). Sixty percent of the individuals were re-sighted within 1 year of the initial sighting, and 38% of the individuals were re-sighted within 2 years. Only one individual was re-sighted in each of the three years of the study period.

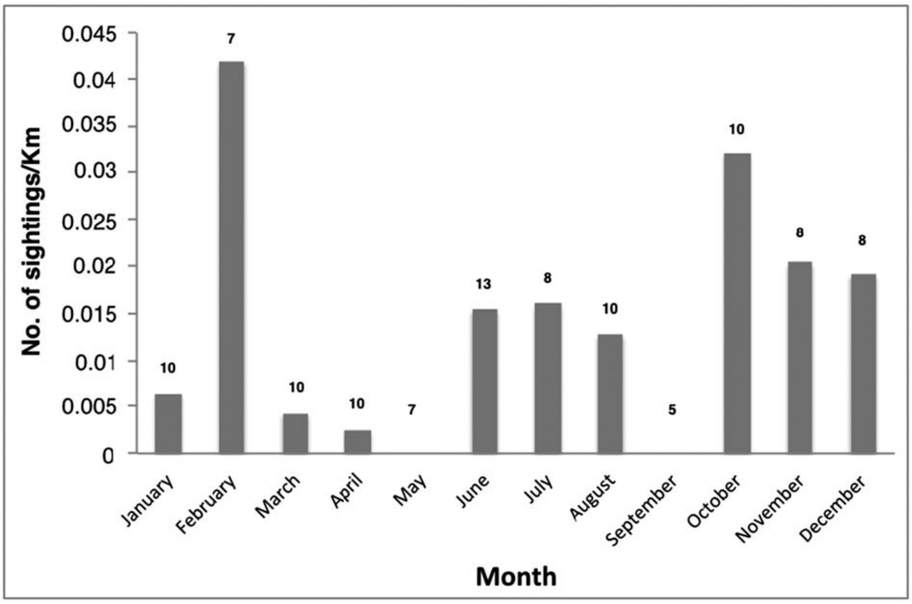

FIGURE 4 Number of sightings of humpback dolphins (*Sousa plumbea*) observed per kilometre of effort conducted each month during the study period (2008–11). The total number of surveys conducted for each month is given above each bar

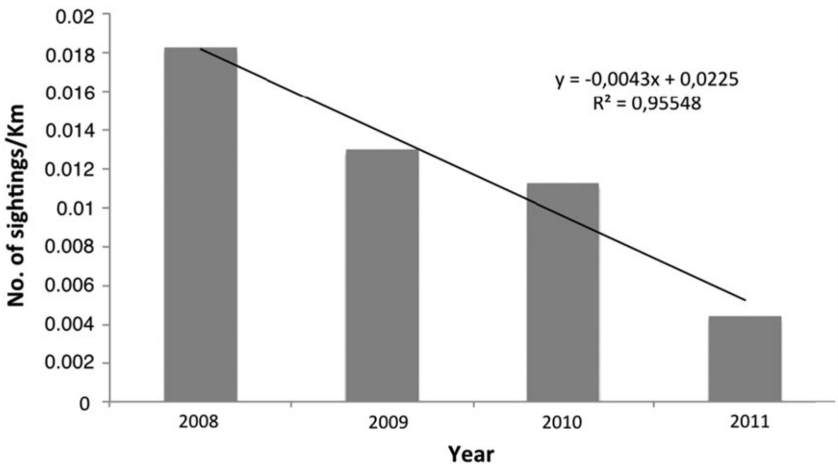

FIGURE 5 Number of sightings of humpback dolphins (*Sousa plumbea*) observed per kilometre of effort between 2008 and 2011. The best-fitting line from simple linear regression (black line) is also illustrated, showing the trend of decline

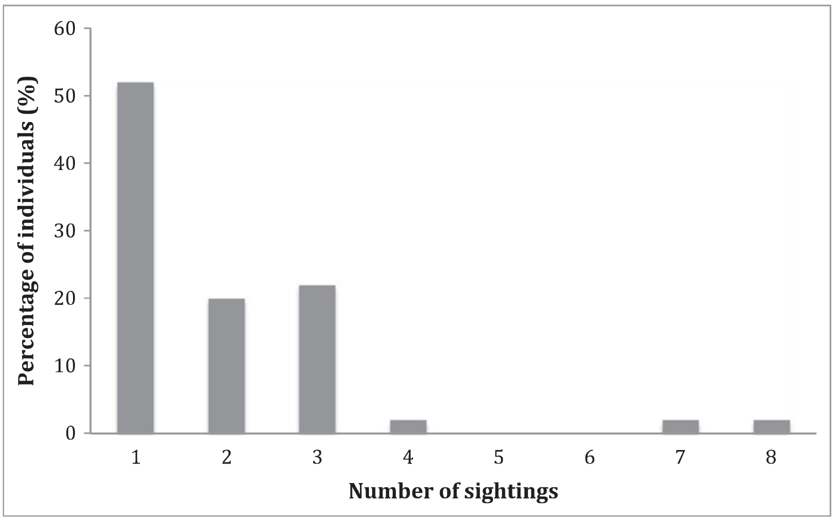

FIGURE 6 Sighting frequencies for humpback dolphins (*Sousa plumbea*) identified between 2008 and 2011

4 | DISCUSSION

Algoa Bay is recognized as a refuge for humpback dolphins off the South African coast; however, this study has indicated that there has been a sharp decline in sightings over the last two decades, with 70 dolphins identified in the early 1990s (Karczmarski, Cockcroft, et al., 1999; Karczmarski, Winter, et al., 1999), and only 50 identified between 2008 and 2011.

This study has revealed a large decrease in the average group size of humpback dolphins, from seven animals in the early 1990s (Karczmarski, Cockcroft, et al., 1999) to three animals in the present study. The same decline in group size was observed during land-based surveys conducted in Algoa Bay between 2010 and 2011, which also noted a possible decline in the number of calves (Koper et al., 2015). Group sizes of approximately three individuals have, however, been recorded along the south-western coastline of South Africa in recent years (Conry, 2017; James et al., 2015; Vinding, 2016). Typically, this species is known to occur in groups of fewer than 10 individuals, close to shore, and in shallow waters of less than 20 m in depth (Jefferson & Karczmarski, 2001). An exception is the humpback dolphins found off the Mozambique coast, near Maputo, which have an average of 15 individuals per group (SD = 7.32 individuals; Guissamulo & Cockcroft, 2004).

In addition to smaller group numbers and fewer individuals identified, this study has indicated an overall decrease in humpback dolphin sighting frequencies, and a decrease in the number of re-sightings, compared with the previous study by Karczmarski, Winter, et al. (1999) in the early 1990s (65% versus 38%, respectively). Low sighting rates have also been observed in other areas along the South African coastline (Durham, 1994; James et al., 2015; Jobson, 2006; Keith et al., 2002). The low re-sighting rate and the high proportion of individuals seen only once indicate that there are fewer animals in Algoa Bay than was previously estimated. It is possible that not all of the individuals have been accounted for as a result of movement of individuals between Algoa Bay and the neighbouring areas, such as St Francis Bay, located about 90 km away (Karczmarski, Winter, et al., 1999; Bouveroux, unpublished data). A recent study focusing on the movement patterns of humpback dolphins along the entire South African coastline has revealed that significant movements of individuals can occur, over distances ranging from 30 to 500 km (Vermeulen et al., 2017). Poor-quality photographs and individuals that have less distinctive markings could have also decreased the re-sighting rate.

The predominant behaviour recorded in this study was foraging. The same predominant behaviour was also recorded in the early 1990s, but our study shows that the frequency of foraging has decreased from 63% (Karczmarski, Cockcroft, et al., 1999) to 43% (in the present study). This decrease of time devoted to foraging and feeding could be a result of many factors, such as lower food availability, increases in marine noise, and/or an increase in competition for food with the Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in the bay.

Rishworth, Strydom, and Warren (2014) reported a reduction in overall fish abundance, and a simplification of the fish community towards lower-level trophic feeders in Algoa Bay, as a result of the effects of overfishing over the past three decades. Between 2008 and 2009, fishing intensity increased in Algoa Bay, possibly leading to lower fish stocks (Pichegru et al., 2012). Studies conducted on foraging effort and patterns in African penguins (*Spheniscus demersus*) also suggest that coastal prey availability is moderate to low in the western parts of Algoa Bay (Pichegru et al., 2012; van Eeden, Reid, Ryan, & Pichegru, 2016), where most of the humpback dolphin sightings were recorded in the present study.

Coastal species such as *Sousa* spp. are facing several threats, and are strongly affected by human activities such as noise disturbance, collisions with vessels, chemical pollution, prey depletion from overfishing, habitat degradation, and entanglement in fishing gear and shark nets (especially in South African waters; Atkins et al., 2016; Collins, 2015; Jefferson & Curry, 2015; Jefferson & Smith, 2016; Karczmarski et al., 2016; Wang et al., 2016).

The construction (2002–2009) and operation of the Coega Port is likely to have resulted in an increase in the underwater noise in the Algoa Bay marine ecosystem. Engineering activities associated with ports generate high sound pressures that can affect cetacean species over 20 km away (Tougaard, Carstensen, Teilmann, Skov, & Rasmussen, 2009). Studies have also shown that humpback dolphins may alter their behaviours and their acoustic signalling in the presence of boats (Ng & Leung, 2003; Van Parijs & Corkeron, 2001). This is because marine activities and noise are known to reduce the efficiency of echolocation, the passive sound detection of prey, and the communication between individuals, which in turn results in increased physiological and biological stress (Nowacek, Thorne, Johnston, & Tyack, 2007). Therefore, it is possible that humpback dolphins in Algoa Bay have been affected by the increase in chronic noise exposure and increased shipping traffic associated with the development and operation of the Coega Port. Along with the construction of Coega Port, there has also been an increase in industrial development and population growth along the western shoreline. These anthropogenic activities would also negatively affect the inshore marine resources, as a result of increased chemical pollution and resource use (such as fishing, recreational boating, swimming, etc.).

Another hypothesis that could explain the decline in the abundance and/or the shift in the distribution of humpback dolphins in Algoa Bay is competition for food and habitat with other species. Several other cetacean species use Algoa Bay, either all year round or seasonally (Melly et al., 2017). The most abundant species is the Indo-Pacific bottlenose dolphin, with a population estimate of 28 482 animals, which is often observed in large groups of >100 animals (Melly et al., 2017; Reisinger & Karczmarski, 2010). In South Africa, there is some overlap in prey species selection between humpback dolphins and bottlenose dolphins (Barros & Cockcroft, 1991; Browning, Cockcroft, & Worthy, 2014; Cockcroft & Ross, 1990). In addition, both species share the same habitat, although bottlenose dolphins are also found further offshore and in deeper waters. Competitive interactions between species are either 'directly' observed through aggressive behaviours or 'indirectly' observed when a species applies a negative pressure on the available resources, when they share common prey species. The degree to which one species dominates another may vary depending on their ecological similarity, where in general the larger species dominates the smaller species (which is the case between bottlenose and humpback dolphins; Wedekin, Daura-Jorge, & Simoes-Lopes, 2004). Aggressive behaviours were not observed during this study, but have been reported between bottlenose and humpback dolphins (*Sousa* spp.) in South Africa (Saayman & Tayler, 1979) and in Australia (Corkeron, 1990). During recent fieldwork conducted in Algoa Bay, there have been two occasions where humpback dolphins were observed leaving the area when large groups of bottlenose dolphins arrived (Bouveroux, unpublished data). Since 2008, the group sizes of bottlenose dolphins in Algoa Bay have significantly increased, from an average group size of 18 dolphins to an average of 76 individuals per group in 2016 (Bouveroux, Caputo, Froneman, & Plön, in press), which could result in a habitat shift for humpback dolphins. Therefore, direct competition between the two dolphin species for prey availability and/or habitat use, as well as the increase in anthropogenic activities and pollution, may be responsible for the decline in the abundance and/or shift in the distribution of humpback dolphins in Algoa Bay.

5 | CONCLUSION

Fewer dolphins were identified in Algoa Bay during this study. This is significant as Algoa Bay was previously identified as having the largest population of humpback dolphins in South Africa. The smaller group size recorded and the low sighting and re-sighting rates also suggest a large decline in the abundance of humpback dolphins in Algoa Bay. Therefore, conservation strategies must urgently be put in place in Algoa Bay and along the entire South African Coast, through the development of a Biodiversity Management Plan (BMP), which are designed to ensure the long–term survival of the species. For example, a BMP has previously been implemented for the most endangered species in South Africa, the African penguin *Spheniscus demersus* (DEA, 2013). Conservation management options for humpback dolphins along the South African coastline have been highlighted already, including the development of a BMP (Vermeulen et al., 2017). These include the following recommended actions.

1. Continuing efforts to mitigate the loss from shark nets are urgently needed. The bather protection nets along the KZN coastline continue to contribute to unsustainable humpback dolphin mortalities (5–10% of the population per year; Atkins, Cliff, & Pillay, 2013; Atkins et al., 2016). Alternatives to shark nets need to be investigated.
2. The identification of 'hot spots' for humpback dolphins, with the implementation of a Special Area for Conservation (SAC, as implemented in European waters), is needed. The ideal location for an SAC for humpback dolphins in Algoa Bay would be between Cape Recife and Port Elizabeth Harbour, the core habitat area, where the species occurs more frequently.
3. The prohibition of approaching the species with any type of watercraft at distances of less 500 m, to reduce the negative effect of engine noise on dolphin behaviour and to reduce the risk of collisions with dolphins.
4. Increased public awareness and education to ensure that these animals are not harassed along the more popular stretches of the Algoa Bay coast.

Finally, increased research efforts in Algoa Bay and along the shore to St Francis Bay (90 km away) are highly recommended to obtain more data on the movement patterns and residency of humpback dolphins. Further research also needs to be conducted in Algoa Bay to assess the availability of food as well as to investigate the potential interspecies competition between bottlenose and humpback dolphins. The study of the social structure of this population is necessary to determine how the population must be considered in terms of a management unit. These further research efforts will help to narrow down the causes of population decline and will help to direct management and conservation decisions going forwards.

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