

Seabird predation by individual seals at Ichaboe Island, Namibia

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Cape fur seals (*Arctocephalus pusillus pusillus*) prey on Cape gannets (*Morus capensis*), Cape cormorants (*Phalacrocorax capensis*), bank cormorants (*P. neglectus*), crowned cormorants (*P. coronatus*) and African penguins (*Spheniscus demersus*) at Ichaboe Island (26°17'22"S, 14°56'36"E), Namibia. Between September 1991 and May 2000, 2774 predatory events were recorded; these involved 932 gannets, 1217 cormorants and 544 penguins. One-third of predation events noted were on seasonally abundant fledgling gannets and cormorants. Four individual seals specializing in seabird predation did not conform to this pattern of predation, differing in bird species targeted. Seabird predation may be learnt from other seals, or forms an extension of play behaviour predominantly in subadult males. Seabird predation does not seem to be a common, stereotyped behaviour in seals; rather, individuals develop their own preferences and techniques.

Key words: Cape fur seals, seabirds, predation, Ichaboe Island.

INTRODUCTION

Seabird predation

Several species of pinniped are known to prey on penguins to varying degrees (Table 1). The Cape fur seal (*Arctocephalus pusillus pusillus*) preys not only on the African penguin (*Spheniscus demersus*) (Table 1), but also on Cape gannets (*Morus capensis*) and cormorants (*Phalacrocorax* spp.) (Shaughnessy 1978; Marks *et al.* 1997; Navarro 2000); predation by Cape fur seals on seabirds was noted as far back as 1937 (Rand 1959).

Seabird predation by seals is hypothesized to be an extension of play behaviour (Bonner & Hunter 1982). Some individuals are regarded as regular penguin predators (Cobley & Bell 1998), exploiting a temporary food resource (Penney & Lowry 1967; Rogers & Bryden 1995) or exploiting a specialist niche (Walker *et al.* 1998). It is also evident that the method of predation by pinnipeds differs between species as well as individuals (*e.g.* Marks *et al.* 1997; Cobley & Bell 1998; Walker *et al.* 1998).

Ad libitum sampling – also referred to as incidental, opportunistic, informal or anecdotal sampling – is most often used for events that are significant, but rare, such as predation (Mann 1999). The majority of published records of predation by pinnipeds (Table 1) were recorded on an *ad libitum* basis.

Predation by Cape fur seals on gannets,

penguins, Cape cormorants, bank cormorants, crowned cormorants, Hartlaub's gulls *Larus hartlaubii* and one white-breasted cormorant *P. carbo lucidus* (Ministry of Fisheries and Marine Resources, Namibia, unpubl. data) has been recorded at Ichaboe Island, Namibia. In this paper, the behaviour of specific seals is discussed with regard to specialization in prey selection at Ichaboe Island.

Study area

Ichaboe Island (26°17'22"S, 14°56'36"E; Fig. 1) covers 6.5 ha and lies 48 km north of Lüderitz, Namibia, and 1.4 km offshore (Nelson 1978; Simmons *et al.* 1998). The island is rocky and unvegetated, with the highest point, Mount Stromboli, at 7 m above sea level (Fig. 1). Though coastal fog is prevalent, the annual rainfall is <10 mm (Simmons *et al.* 1998). Ichaboe Island supports breeding populations of numerous threatened seabird species (Table 2), most of which have shown alarming declines since the 1950s. For instance, the breeding population of African penguins has declined by 60% in less than 10 years (Crawford *et al.* 2001) and bank cormorants by 72% in four years (Crawford *et al.* 1999); the area occupied by breeding Cape gannets has decreased by 90% over 40 years (Crawford 2000). These populations face a host of threats and are continuing to decline (du Toit *et al.* 2002).

A small colony of up to 1000 Cape fur seals haul out on Little Ichaboe, an islet 200 m to the south-

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Table 1. Pinniped species that take various species of penguins as prey.

Pinniped species	Penguin species	References
Leopard seal, <i>Hydrurga leptonyx</i>	Gentoo penguin, <i>Pygoscelis papua</i> Macaroni penguin, <i>Eudyptes chrysolophus</i> Adélie penguin, <i>P. adeliae</i>	Penney & Lowry 1967 Rogers & Bryden 1995 Rogers & Bryden 1995
Weddell seal, <i>Leptonychotes weddellii</i>	Gentoo penguin	Cobley & Bell 1998
Antarctic fur seal, <i>Arctocephalus gazella</i>	Gentoo penguin, Macaroni penguin King penguin, <i>Aptenodytes patagonicus</i>	Bonner & Hunter 1982 Hofmeyr & Bester 1993
Subantarctic fur seal, <i>A. tropicalis</i>	Rockhopper penguin, <i>E. chrysocome</i>	Hofmeyr & Bester 1993
New Zealand fur seal, <i>A. forsteri</i>	Rockhopper penguin	Csordas & Ingham 1965
South American sea lion, <i>Otaria byronia</i>	Magellanic penguin, <i>Spheniscus magellanica</i>	Lanting 1988
Australian sea lion, <i>Neophoca cinerea</i>	Little penguin, <i>Eudyptula minor</i>	King 1983
Hooker's sea lion, <i>Phocarcctos hookeri</i>	Gentoo penguin	Robinson <i>et al.</i> 1999
Cape fur seal, <i>A. pusillus pusillus</i>	African penguin, <i>S. demersus</i>	Cooper 1974; Rebelo 1984; Randall <i>et al.</i> 1988; Williams 1988

west of the main island (Fig. 1). On account of the small number of pups born there annually (between 20 and 300), this colony is not considered to be a true breeding colony (David 1995).

Ichaboe Island is surrounded by a 3 m high sea wall which prevents seals from gaining access and prevents the commercially valuable guano, produced by the numerous seabirds, from being washed off. Five ramps allow penguins access to the island over the wall; these form access points where the penguins congregate on the seaward side of the wall (Fig. 1).

METHODS

Observations

Incidental observations of seabird predation by seals in the vicinity of Ichaboe Island were carried out between October 1991 and October 1999, on the island for at least nine or 10 months (mainly November to August) of the year. Indicators of predatory activity, identified at the start of the study, were used as cues to alert the observer to a predatory event. The date, time, direction and estimated distance from the shore, weather and sea conditions, seal size and sex, bird species and age, and the duration of the predatory event were recorded whenever possible.

Systematic 'focal-event sampling' was carried out from November 1999 to May 2000 and is an adaptation of the scan-sampling method described by Altmann (1974). Events were recorded in a systematic way; session onsets and termination were independent of the behaviour being investigated (in this case, predation). A subgroup

of the seal population was observed, specifically those involved in preying on birds. Therefore, behavioural criteria (*i.e.* predation) determined the focal individual, hence the term, 'focal-event sampling'.

Focal-event sampling involved scanning the coastal waters around the island for cues to predatory events with 7 × 50 binoculars in a clockwise direction. Each scan lasted approximately two minutes. Scans were done every 15 minutes from dawn to dusk (DDU) on alternate days from 11 November 1999 to 11 May 2000, except in conditions of poor visibility such as fog. These DDU surveys were carried out such that the first scan was done just before sunrise and the last scan once the sun had set. During the six months of systematic observations, a total of 4129 scans (equivalent to 137.6 hours of observation) were done over 86 days. An average of 48.6 (S.D. = 10) scans were carried out per scan-day.

In addition to the focal-event sampling, 162.5 hours of continuous observations were conducted throughout the same season (November 1999 to May 2000) during 107 sessions over 57 days. These observations were carried out for periods lasting between 15 minutes and five hours (mean = 1.5 hours), searching in all directions for cues to predation. Incidental observations of predatory events continued outside of the systematic observation periods from November 1999 to May 2000.

All systematic observations (focal-event sampling and continuous observations) were carried out from an elevated (9 m a.s.l.) observation hut (Fig. 1) affording a 343° view of the sea surround-

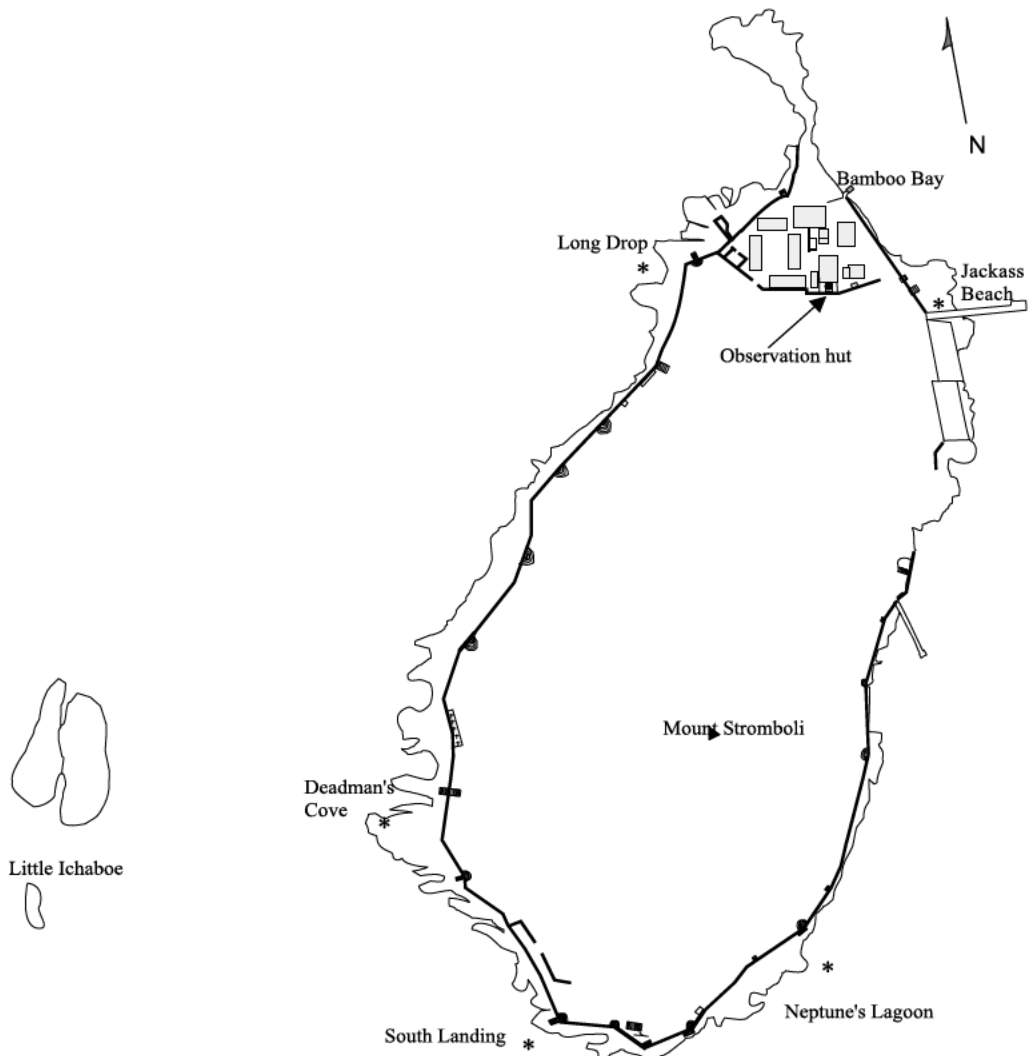


Fig. 1. Map of Ichaboe Island showing position of places of importance to the study. Penguin access points are marked by an asterisk.

ing the island. It is assumed that all predatory events occurring in the vicinity of the island during systematic observation periods were recorded.

Data collection

Seals were categorized according to easily recognizable size classes (large, medium and small) which correspond with adult, subadult and young seals, using descriptions of Rand (1956). The head and neck of a seal is often visible during the interaction, and seals often hold one fore-flipper vertically above the surface of the water for a while, especially just after preying on a bird. The size class of seals was estimated by judging the

size of the seal's neck and flippers against the size of the bird carcass. Male seals have a thicker neck and a more pronounced forehead than the females, and their flippers are larger and broader in relation to the body. In older males, the head and neck are also paler (Bonner 1981; King 1983).

On a few occasions, predation was filmed underwater, using a SONY DCR-VX1000E digital video camera. Where possible, bird carcasses were collected to identify the species and age of the bird, and also to record the anatomical portion of the bird that was consumed or removed by the seal. The injuries of birds, when considered seal-inflicted, were noted and drawn on injury sheets.

Table 2. Peak active nest counts of seabirds at Ichaboe Island during the 1999–2000 breeding season (Ministry of Fisheries and Marine Resources, Namibia, unpubl. data).

Species	Date	Breeding pairs
Cape cormorants, <i>P. capensis</i>	18 Dec 1999	18 112
Cape gannets, <i>M. capensis</i>	17 Dec 1999	16 453 (aerial census)
African penguins, <i>S. demersus</i>	20 Oct 1999	1 731
Bank cormorants, <i>P. neglectus</i>	20 Jan 2000	737
Crowned cormorants, <i>P. coronatus</i>	20 Nov 1999	260
Kelp gulls, <i>Larus [dominicanus] vetula</i>	18 Dec 1999	74
White-breasted cormorants, <i>P. lucidus</i>	20 Nov 1999	9

In 1996, the breeding colony of gannets on Ichaboe Island occupied 0.56 ha (Crawford 2000); density counts conducted on the same day (MFMR, unpubl. data) gave a total of 25 034 nests. A fledging success of 0.74 chicks per nest (Nelson 1978) was assumed.

Three of the seals that regularly preyed on seabirds from 1991 were individually recognizable by their fore-flipper characteristics (here referred to as seals A, C and D); another seal (seal B) was recognizable by its size, specific behavioural patterns and small area of regular activity. Between October 1991 and May 2000, eight seals that regularly took seabirds, including the above-mentioned individuals, were shot under licence of the MFMR, Namibia, and seven carcasses retrieved (the carcass of seal A was lost). The stomach contents of these individuals were examined for seabird remains.

If the relevant behaviour has been recorded and adequately described, this information is valid as long as the method of observation in no way affects the behaviour in question. Behavioural data can therefore be used irrespective of the actual method of observation (whether systematic or not), therefore all records (from systematic and incidental sampling) were pooled. However, since sampling effort is unquantified for incidental observations, rates, frequencies and proportions cannot be accurately calculated (Mann 1999).

RESULTS

Seabird species preyed upon

Between September 1991 and May 2000, 2774 predation events were observed, which involved 1217 cormorants, 932 gannets and 544 penguins, at a ratio of approximately 5:4:2, respectively (the remainder of predations involved unidentified

birds). The ratio of bird numbers for these taxa on Ichaboe Island, as calculated from the 1999 peak active nest counts, was approximately 5:4:0.4, respectively (Table 2). One-third of predations noted were on seasonally abundant fledgling gannets and cormorants.

Injured birds

The majority (60%) of injured birds observed were penguins. Of 211 injured penguins observed between September 1991 and May 2000, 109 are believed to have sustained their injuries during attacks by seals. A further 35 penguins died of various injuries, and seals were implicated in nineteen of these by the nature of the injury. Injuries such as straight slashes to the neck, chest and abdomen accounted for 44% of penguin injuries or scars; these were attributed to predation attempts by seals.

Predatory behaviour

All observed predations took place in the water. Typically, the seal would approach the bird from below, grabbing it by the chest, neck or head. The bird was then thrashed on the surface, resulting in the skin being torn loose and flung over the head or legs to expose the viscera and breast muscles ('degloved', Marks *et al.* 1997). Underwater video footage showed that the seal submerges with the carcass, trying to free pieces of meat underwater. Occasionally, young seals were seen in the company of a seal preying on birds. Seals seemed to tolerate one another and did not fight over carcasses. Groups of two or three seals sometimes preyed on birds close to one another.

Seals of different size categories prey on different species of birds (Table 3). The size of the seal was recorded in 54% ($n = 1497$) of the predatory interactions seen. Seals of medium size

Table 3. Numbers of different seabird species killed by seals in different size categories (age categories are in brackets). The sex of young seals cannot be determined from a distance.

Seal sizes	Penguins	Gannets	Cormorants	Total	% Identified as male
Large (adult)	35	54	0	91	100
Medium (subadult)	307	390	560	1269	43.58
Small (young)	8	23	105	136	–

(subadults) were responsible for 84.8% of these predations. No adult seals were seen taking cormorants, whereas 77.2% of the records of birds taken by young seals were cormorants (Table 3). The majority (63.2%) of seals preying on birds were identified as males.

Specialized predatory behaviour

Seal A, a large subadult male seal, was seen preying on 33 adult penguins on 10 days between 6 January and 26 April 1992, catching up to seven birds in one day. This seal operated only to the east and east-northeast of the island, with two of three birds taken less than 100 m from the shore. Seal A would patrol offshore from Jackass Beach (Fig. 1), one of the main access points for penguins, catching satiated adults in the late afternoon as they return to the island. This seal was not observed preying on any cormorants or gannets.

A subadult male seal (seal B) was observed preying on 60 Cape cormorants, 20 bank cormorants and a further 14 unidentified cormorants on 17 days between 24 November 1992 and 2 May 1993. The target prey was adult cormorants diving for nesting material within Bamboo Bay (Fig. 1), with 95% of birds taken less than 100 m from the island. Seal B caught up to 15 birds a day and made seven failed predation attempts. Nine birds killed by seal B were not fed upon; seven of these killings occurred on the same day. This seal was not observed preying on gannets or penguins.

Seal B was shot on 2 May 1993 (Table 4), and thereafter predation on adult cormorants declined to fewer than 10 per year for the duration of the study.

Seal C, a subadult male seal, was seen taking 230 birds on 67 days from 25 March 1996 to 02 December 1998, of which 41 were gannets (93% fledglings), 47 penguins (66% adults) and 142 cormorants (73% fledglings). Of the cormorants, one was a bank cormorant and 103 were Cape cormorants. On 25 March 1998, seal C killed twenty-one Cape cormorant fledglings within 160 minutes, at a predation rate of 7.9 birds/h. On another occasion, seal C killed four Cape cormorant fledglings within nine minutes without feeding on the carcasses.

Seal C preyed on birds throughout the day with 206 of 230 birds (89.6%) taken within 200 m of the main island. Cormorant predations occurred at distances of ≤ 250 m predominantly to the northeast and east of the island; penguin and gannet predations were seen as far as 700 m distant. This seal hunted birds up and down the channel east of Ichaboe Island, once chasing a group of penguins, and on another occasion seemed to play with a gannet fledgling before killing and eating it.

Seal D, another subadult male, preyed on 42 penguins (22 adults and two juveniles recognized) and one Cape cormorant on 29 days between 15 January 1997 and 27 October 1998, taking up to five penguins in one day. Almost all predations

Table 4. Seals shot and recovered while preying on seabirds at Ichaboe Island.

Date shot	Seal	Age	Sex	Length (cm)	Girth (cm)	Mass (kg)	Stomach contents
2 May 93	Seal B	Subadult	Male	141	88	57	2.5 kg cormorant remains
2 May 93	Seal E	Adult	Male	190	127.5	150	Few gannet feathers
19 Aug 97		Subadult	Male	145	98	72	1.5 kg penguin remains
20 Aug 97		Subadult	Male	120	81	42	55 g penguin skin and feathers
27 Oct 98	Seal D	Subadult	Male	166	127	116	550 g penguin skin and feathers
2 Dec 98	Seal C	Subadult	Male	168	114	112	6 kg penguin and gannet remains
17 Mar 99		Subadult	Male	165	125		1.35 kg penguin remains.

(93%) by seal D were fairly evenly spaced around the island at 100–200 m distant. Penguins were ambushed as they approached the island in the late afternoon, although this seal was also seen preying on birds in the morning and early afternoon. Seal D was not observed taking any gannets as prey.

In April and May of 1993, carcasses of at least 13 gannet fledglings and one adult gannet were found only eviscerated. A further three fledglings were found alive with their abdomens ripped open. A single adult male seal (Seal E) was believed to be responsible for targeting the birds' viscera, and after his removal on 2 May 1993 (Table 4), no further gannets sported such wounds.

Among the seals shot were one adult and six subadult males, all considered in good condition, although seals C and D had worn canines. Their stomachs contained up to 6 kg of seabird remains (Table 4).

DISCUSSION

Seabird predation by seals

While seal predation on penguins is well documented (Table 1), reports concerning predation on gannets and cormorants are few (Shaughnessy 1978; Marks *et al.* 1997; Navarro 2000). Seabird predation occurs at low levels, with small subgroups, such as subadult males, specializing in this behaviour (Marks *et al.* 1997). This is supported by the present study as not all seals at Little Ichaboe preyed on seabirds – at least 80% of the predators identified fell in the subadult age-group, and the predators were predominantly male.

Relating the ratio of seabird species preyed upon to their relative abundance on the island, it seems as though penguins are targeted as prey. Penguins may be easier to catch than gannets and cormorants, and may be a more rewarding catch, being heavier. In addition, since penguins spend more time in the water, they are more accessible as prey, and are therefore not necessarily targeted in relation to availability, though individual seals may target certain seabird species as prey (see below).

Injured birds

Although over 60% of injured birds were penguins, it would be easier to sight injured individuals due to the relatively small local population; also, their access to and from the island is restricted to a few ramps. No failed predation attempts on

penguins were witnessed; however, these would not be as obvious as with the other birds. It is possible that predation evasion is higher for flying birds than for penguins. Furthermore, penguins, which are physically more robust, seem to survive severe injuries that would incapacitate flying birds, hence the larger number of penguins with injuries and scars.

Sharks and killer whales (*Orcinus orca*) have historically been noted or implicated as predators of the African penguin (Randall *et al.* 1988; Randall & Randall 1990), but few of these predators have been observed offshore at Ichaboe Island since 1991. Though Randall *et al.* (1988) maintained that fur seals cannot produce narrow, deep cuts with their conical teeth, 68% of all penguin injuries recorded between October 1999 and May 2000 were of this type. Also, none of the obviously shark-inflicted injuries discussed by Randall *et al.* (1988) were seen on penguins at Ichaboe Island, except for straight slashes, which are regularly observed on carcasses preyed upon by seals. Penney & Lowry (1967) and Bonner & Hunter (1982) attribute deep abdominal cuts on penguins to seal bites; the same applies to this study.

Behaviour

Unlike the incident noted by Rebelo (1984), no seal was observed attacking birds on land during a 10-year period when the island was near-constantly manned. The sea wall surrounding Ichaboe Island generally serves to exclude seals from the island, although on occasion seals use the ramps provided for penguins to gain access to the island. A seal intent on taking a bird would be able to do so at the access points for the penguins, where they congregate on the seaward side of the wall. The possibility of seals taking birds on land is therefore not excluded.

Seabirds generally recognize seals as a threat, and display anti-predator behaviour (Randall & Randall 1990). Penguins change direction and swim away from seals, while adult gannets and cormorants are reluctant to dive in the vicinity of seals, and take off from the water when approached by a seal. In contrast, gannet and cormorant fledglings do not associate seals with danger and even curiously approach a seal preying on another bird. Therefore, a higher number of fledglings than adults are preyed upon in quick succession, often by the same seal that does not necessarily feed on every bird it kills.

King (1983) describes young male seals in particular as active and noisy, and engaging in play. Seals often play in the surf zone adjacent to Little Ichaboe; the birds killed in this area may have been taken opportunistically in the same way as pieces of kelp or floating objects are taken and thrashed (Bonner & Hunter 1982). Curious seals investigating their environment 'test-bite' objects. It is possible that some birds are killed in this way, and that seals may find birds to be 'tasty morsels' (Navarro 2000), later taking them as prey.

Young seals that are inexperienced seem to prefer to attack cormorants, but are not always successful. On the other hand, experienced seals preying on seabirds may have eaten their fill or preyed on a few birds already, subsequently killing birds without feeding on them. This behaviour may be instinctive, in that a seal that has become accustomed to killing birds may continue to do so once satiated. However, birds are not a common prey item for Cape fur seals (Marks *et al.* 1997; David *et al.* 2003) and at the individual level, deviation from expected behavioural patterns may be found. This suggests predation as an extension of play behaviour on the part of the seals (Bonner & Hunter 1982) as seals 'playing' with birds would not necessarily consume them. On one occasion, a seal chasing a penguin did not seem to be swimming at full speed, and once it caught up with the bird, killed it without feeding. This incident supports the concept of play behaviour culminating in a kill. Play behaviour associated with seabird predation has also been observed during an incident involving two killer whales at Mercury Island (Williams *et al.* 1990).

Younger seals sometimes accompany seals that are regular bird predators and may assimilate this behaviour, and even continue feeding on the carcass once the main predator has left it. Marks *et al.* (1997) relate an anecdote of a seal they considered to be a female apparently trying to teach two juveniles how to feed on Cape cormorant fledglings at Dyer Island. A similar incident was noted at Malgas Island, where one seal was apparently trying to teach two younger seals to deglove Cape cormorant fledglings (R.A. Navarro, pers. comm.). Hiruki *et al.* (1999) noted incidents of leopard seals interacting while hunting, with one seal capturing and releasing fur seal (*A. gazella*) pups to another. Hiruki *et al.* (1999) could not confirm co-operative hunting but related that leopard seals tolerated one another while hunting; the same holds true for this study regarding Cape fur

seals preying on seabirds. Seals therefore seem to not only tolerate one another while hunting, but interact. It is likely that younger seals learn seabird predatory behaviour from more experienced seals by observing this behaviour and playing with the bird carcass. These young seals may then become regular bird predators themselves.

Age and sex of seals

Although adult males can be easily identified, adult and subadult females would both be classed as 'subadult' following the classification system used in this study. Owing to the marked sexual dimorphism of the Cape fur seal (Shaughnessy 1979), the females reach maturity before the males. Since the females may be pregnant or suckling their pups, they are more focused in their foraging effort than males and forage at known feeding grounds (David *et al.* 2003). If birds were a sufficient and adequate food source for mothers to maintain themselves and rear their pups, it is likely that some mothers would frequently prey on seabirds in the vicinity of Ichaboe Island. This cannot be ruled out due to the difficulty of identifying female seals from a distance, although none of the predators were positively identified as females, and all of the shot seals were males. That females may feed on birds during feeding trips away from the island also cannot be ruled out. If so, the behaviour is probably restricted to larger females, since well-developed neck muscles may be required for thrashing a large bird. Mecenero *et al.* (in press) found that seabirds featured negligibly in the diet of female Cape fur seals, and Harcourt (1993) suggests that adult male South American sea lions are able to utilize a food source (South American fur seals) that the smaller females are unable to exploit.

Male seals attain sexual maturity while still quite young, but cannot compete with the bulls for a territory until the age of about 10 years (David 1995), and are therefore not socially mature (Stewardson *et al.* 1998). They form aggregations of their own age-groups and haul out on other outcrops of rock (David 1995; De Villiers *et al.* 1997). If these seals do not join the main body of seals at the fishing grounds, but remain in the vicinity of the island, they may develop such habits as taking birds. Several other studies on seabird predation by seals also found the predators to be predominantly male (Shaughnessy 1978; Bonner & Hunter 1982; Williams 1988; Rebelo 1984; Hofmeyr & Bester 1993; David *et al.* 2003). A

review by Riedman (1990) suggests that predation on birds is restricted to adult or subadult male pinnipeds as was found in the present study. In a recent study by David *et al.* (2003), 94 Cape fur seals that attacked gannets at Malgas Island were males aged 2–10 years. Colour-tagging by sex and cohort of pups born on Little Ichaboe would greatly assist in elucidating the age-group and sex of seals mainly involved in seabird predation at Ichaboe Island.

Specialized predatory behaviour

The predation behaviour of the individually recognizable seals revealed prey selection. Some individual seals may even prefer a specific anatomical portion of their prey, such as the bull observed taking only the viscera of gannet fledglings at Ichaboe Island. A bull seal observed at Malgas Island in 1988 killed at least 61 gannet fledglings using the same technique: a single abdominal bite (Navarro 2000). This is an indication of specialized behaviour, with the seals displaying a preference for a particular portion of the bird (the viscera) and developing a technique that is used repeatedly. Had the seal involved in this behaviour at Ichaboe not been shot, it is likely that it would have been responsible for many more deaths of these birds. The same is true for the other seals that were culled.

Specialization and individual preferences for specific prey were shown for leopard seals by Hiruki *et al.* (1999). Other authors (Penney & Lowry 1967; Cooper 1974; Bonner & Hunter 1982; Williams 1988; Hofmeyr & Bester 1993; Cobley & Bell 1998; Walker *et al.* 1998) also ascribed seabird predation to a few individuals whose techniques or preferences may differ (Cooper 1974; Bonner & Hunter 1982; Rogers & Bryden 1995).

The data on the four seals A–D offer insights into individual seal preferences and behaviours concerning seabird predation. Seal C took birds that were seasonally abundant, notably juvenile cormorants between March and June, juvenile gannets mainly from March to April and penguins year-round. In contrast, seal A was active within a small area, and preyed on adult penguins during a time when cormorant and gannet fledglings, which may be relatively easier to catch, were abundant. Seal D, on the other hand, took penguins over a wider spatial and temporal range, while seal B was seen preying mainly on adult cormorants from November to January. Seals A and B seemed to specialize more, each exploiting a particular niche

– seal A ambushing satiated penguins in the late afternoon as they return to the island, and seal B preying on adult cormorants diving for nesting material within a small area.

The predations carried out by seals that were individually recognizable were generally recorded close to the island, but this does not necessarily imply that these seals do not operate further offshore. Most observations were island-based and it became more difficult to identify seals at increasing distances from the island. In addition, due to the incidental nature of the observations, it was not possible to ascertain how many of each bird species fell prey to individual seals. Nevertheless, those seals that could be individually identified displayed various degrees of prey preference.

CONCLUSION

Four very different strategies of seal predation are evident, indicating that predation on seabirds is not a common, stereotyped behaviour, but rather that individuals develop their own preferences and techniques. Some individual seals find seabirds easy prey, and may become regular seabird predators. What may have initially started as play behaviour, or taking birds opportunistically, may develop into a habit, with birds eventually forming a large part of the diets of those individual seals that specialize in seabird predation.

The quantification of seabird predation as a mortality factor contributing to seabird population declines at Ichaboe Island should be combined with a comparison with other mortality factors (such as that resulting from oiling, and interactions with commercial fisheries) and resource constraints in order to aid in management decisions.

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