CHAPTER 2. SEAL-SEABIRD PREDATORY BEHAVIOUR

INTRODUCTION

Seal-seabird predation

Several species of pinniped are known to prey on penguins (Hofmeyr & Bester 1993), to varying degrees. Leopard seals, *Hydrurga leptonyx*, have been recorded preying on gentoo penguins, *Pygoscelis papua*, macaroni penguins, *Eudyptes chrysolophus*, and Adélie penguins, *P. adeliae* (Penney & Lowry 1967, Rogers & Bryden 1995). Weddell seals, *Leptonychotes weddellii*, have been observed preying on gentoo penguins (Cobley & Bell 1998), as have Antarctic fur seals, *Arctocephalus gazella*, which also prey on macaroni penguins (Bonner & Hunter 1982) and king penguins, *Aptenodytes patagonicus* (Hofmeyr & Bester 1993). Other pinniped predators of seabirds include the Subantarctic fur seal, *A. tropicalis*, and the New Zealand fur seal, *A. forsteri*, both of which take rockhopper penguins, *E. chrysocome*. Magellanic penguins, *Spheniscus magellanica*, and little penguins, *Eudyptula minor* are preyed upon by the South American sea lion, *Otaria byronia*, and Australian sea lion, *Neophoca cinerea*, respectively (*vide* Hofmeyr & Bester 1993). Hooker's sea lions, *Phocarctos hookeri*, prey on gentoo penguins (Robinson, Wynen & Goldsworthy 1999).

The Cape fur seal, *A. pusillus pusillus*, is noted not only as a predator of the African penguin, *S. demersus* (Cooper 1974; Rebelo 1984; Randall *et al.* 1988; Williams 1988), but also of gannets (*Morus capensis*) and cormorants (*Phalacrocorax* spp.) (Shaughnessy 1978; Marks, Brooke & Gildenhuys 1997; Navarro 2000).

Seabird predation by seals has been hypothesised to be an extension of play behaviour (Bonner & Hunter 1982) and is described as an unusual event (Cooper

1974). 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 from the literature that the method of predation by pinnipeds differs between species as well as individuals.

Predation at Ichaboe Island

Predation by Cape fur seals on gannets, penguins, Cape and bank cormorants has been recorded; there is also a record of a white-breasted cormorant and Hartlaub's gulls (*Larus hartlaubii*) taken by seals. The regularity of incidental sightings of such predatory events has highlighted the need for further research, as the impact of seal-seabird predation may increase with the continued decline in local seabird population numbers.

This chapter deals with the behavioural aspects of seabird predation by Cape fur seals at Ichaboe Island, Namibia, and considers differences among bird species preyed upon, as well as between individual seals.

METHODS

Observations

Seal-seabird predatory events were recorded opportunistically around Ichaboe Island from September 1991 to October 1999. Systematic (using scan sampling and continuous observations) as well as opportunistic observations were made from November 1999 to May 2000 (see Chapter 3 for detail on the methods of observation).

For all predatory interactions observed, the behaviour of the predator and the birds in the vicinity was identified, as well as other conditions associated with such predatory events. Specific behaviours indicative of predatory activity which served to attract the observer's attention were named "predation cues" (P.A. Bartlett, pers. comm.).

The most visible cue was a "gannet cloud", the formation of a group of gannets that maintain their position over a specific area with no fishing activity such as plunge-diving (P.A. Bartlett, pers. comm.). The term "gannet cloud" therefore refers to a group of gannets that are hovering, but not diving, and that are not necessarily in association with cormorants. Individual gannets fly out from the island to join the cloud, and others "peel off" (possibly once their curiosity is satisfied and no fish was seen) and return to the island. The cloud may therefore not be comprised of the same individuals but remains roughly the same size while the stimulus lasts. This behaviour was noted to be associated with seal-seabird predatory activity (P.A. Bartlett, pers. comm.). No specific reference to gannet clouds could be found in the literature. Kelp gulls swooping over something in the water below the gannet cloud confirm some form of predatory activity, as the gulls try to scavenge pieces of the prey. The number of gannets within a cloud was counted using binoculars and a tally-counter.

A seal thrashing prey (shaking it violently from side to side, or tossing the prey through the air) on the surface was positive confirmation of a predation and formed an important cue, as was a seal attacking a bird.

Further cues included:

- × bird carcasses adrift with kelp gulls in attendance;
- × washed up bird carcasses that had been preyed upon;
- × a group of kelp gulls scooping or scavenging;
- × pieces of prey brought ashore by kelp gulls;
- × gull calls;
- × other bird species scavenging (white-chinned petrels *Procellaria aequinoctialis* and giant petrels *Macronectes* spp.);
- × an oily slick on the surface of the water (resulting from the fat of the bird);
- × injured birds.

These were usually secondary cues serving to confirm predatory activity. No cues were used on their own (except for thrashing, attack and carcasses of birds that had been preyed upon by seals) to indicate seal-seabird predation. A combination of cues was used.

The date, time, direction and estimated distance from the island shore, weather and sea conditions, seal age and sex, bird species and age, and the duration of the predatory event were recorded whenever possible. Predatory events were observed using a pair of binoculars, and behavioural notes taken. During continuous observations, it was possible to identify whether the same individual seal carried out successive attacks. On a few occasions, predations were also filmed underwater, using a SONY DCR-VX1000E digital video camera. Where possible, carcasses were collected, in order 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. Between

October 1999 and May 2000, 30 carcasses of birds taken by seals were collected and photographed. During the same period 50 injured penguins were observed ashore at Ichaboe. The extent of their injuries was recorded on injury sheets.

Juvenile birds were distinguished from adults by their plumage, in the case of gannets and penguins, and by their eye-colour (which is dark in juveniles) for cormorants. The species and ages of cormorants that fell prey to seals could only be confirmed upon collection and inspection of the carcass; this involved donning a wetsuit and often single-handedly launching a vessel to paddle or motor to the drifting carcass. For this reason, the prey was often only identified as a gannet, a penguin or a cormorant.

Seals were categorised according to easily recognisable size classes (large, medium and small) which correspond with adult, subadult and young seals. 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 lighter in colour (Bonner 1981; King 1983).

Since 1991, only three of the seals that were seabird predators were individually recognisable by their fore-flipper characteristics (known as "Blunt Flipper", "Broad Flipper" and "Ragged Flipper"); another seal ("U") was recognisable by its age and specific behavioural patterns.

Between October 1991 and May 2000, eight seals (including the above-mentioned individuals) specialising in seabird predation were shot (MFMR policy) and seven were retrieved.

Data analysis

The data from predations carried out by known individual seals were analysed to determine patterns such as predation rate per hour (h^{-1}), time between successive predations involving a particular bird species, and individual seal preferences regarding bird species.

Predation rates (h^{-1}) were calculated from predation sessions by the same seal individual where more than three successive predations occurred less than an hour apart. The predation rates per day (d^{-1}) were calculated for those days on which predations took place (predation-days), and not averaged over the entire period. As the predatory behaviour is independent of the method of observation, all records were pooled.

The results are given as a mean ± one standard deviation (SD), and as percentages and ratios. Where more than two independent groups were compared, a Kruskal-Wallis ANOVA was used to test the null hypothesis that the means of the groups were equal.

RESULTS

Bird species preyed upon

Between September 1991 and May 2000, 2774 predations were observed, of which 1217 involved cormorants, 932 gannets and 544 penguins (a ratio of approximately 5:4:2). These included 61 birds that were injured but not killed, 48 killed without the seal feeding on the carcass and 16 failed predation attempts. More than one seal attended the bird carcass on 25 occasions, and on 13 occasions more than one predation took place simultaneously. Though most predations were noticed only once the seal had already seized the prey, there were 161 incidents where the

attack was witnessed. On six occasions a seal was seen chasing a penguin. Six incidents were noted of a seal taking a gannet from the air, shortly after take-off from the water. Three of these incidents occurred in wind speeds between 34 and 40 knots (Beaufort Scale 8). Thirty-six incidents took place within the surf zone adjacent to Little Ichaboe (where the seal colony is situated), where the seals often play (pers. obs).

Predation cues

Kelp gulls swooping or scavenging were a first cue indicating predatory activity in 41.1% of cases. Carcasses (23.7%) and gannet clouds (20.6%) were the next most abundant cues. Seals were seen attacking birds in 5.7% of the predations noted, and though thrashing of prey was rarely (4.2%) the first cue to attract the attention of the observer (Figure 2.1), but was noted in 35.2% of all predations seen. The presence of kelp gulls was an important cue for penguin and cormorant predations (58.5% and 48.9% respectively), and was the first cue in 24.4% of gannet predations. Cormorants formed 63.2% of carcasses seen as a first cue to predatory activity (Figure 2.1).

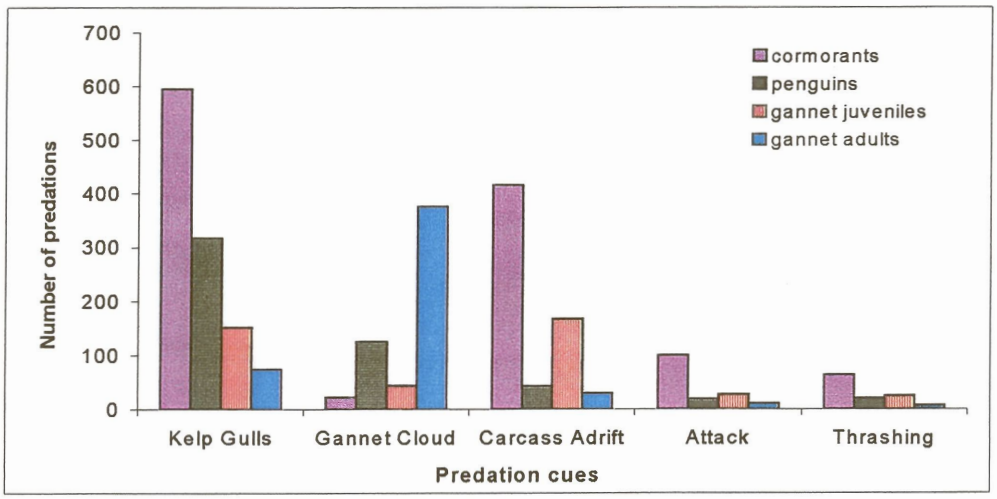

Figure 2.1. Number of predations per bird species associated with different predation cues.

A gannet cloud of up to 500 birds may form in less than a minute. The average size of 155 gannet clouds was 275 ± 92 individual birds (Figure 2.2). Gannet clouds were associated with 75.4% of predations involving an adult gannet and 10.7% of juvenile gannet predations had gannet clouds. Over 74% of gannet clouds indicated that a gannet had fallen prey to a seal and 80% of these involved an adult gannet (Figure 2.1). Gannet clouds were associated with over 70% of predations noted at wind speeds of 28 to 54 knots (7 to 10 on the Beaufort Scale; Figure 2.3).

Figure 2.2. An example of a gannet cloud. These birds are not involved in fishing activity but are investigating seal-seabird predatory activity.

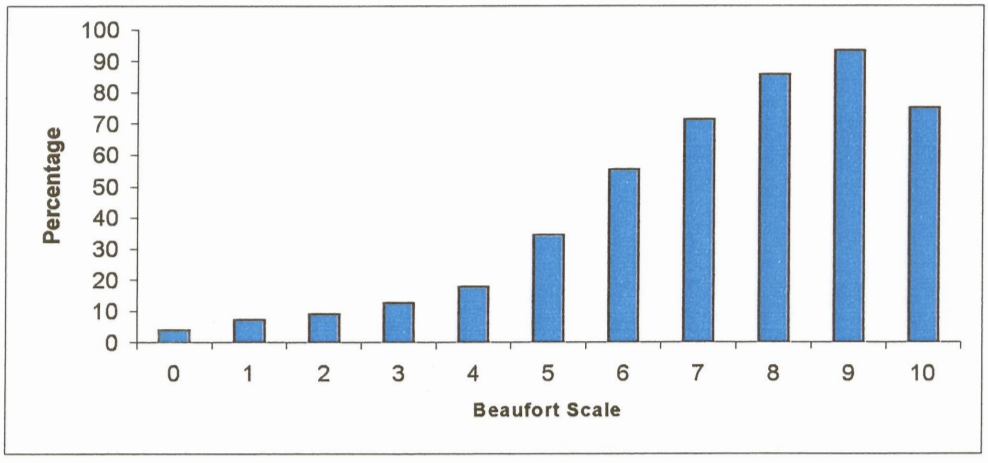

Figure 2.3. Percentage of predations associated with a gannet cloud at different wind speeds (as measured by the Beaufort Scale).

Predation behaviour

No seals were observed to attack a bird on land. On 18 December 1999, an adult penguin with a gash across its neck and shoulder (suspected to be an injury inflicted by a seal) had climbed out onto Little Ichaboe and was preening itself amongst the seals. The bird was ignored, even though it was the pupping season and the seals were more aggressive than usual.

After diving, gannets sit briefly on the water before taking off and joining the birds overhead, to plunge again. Gannets and cormorants often fish together, with the cormorants flying low over the fish shoal, and sitting on the water. When gannet fledglings go out to sea for the first time, they sit on the water singly, whereas fledgling cormorants sit on the water in groups (pers. obs). The phenomenon of seals killing birds without feeding, or only feeding partially on the carcass was observed more often in the case of cormorant predations than of other bird species.

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 (shaken violently from side to side) on the surface, and "degloved" (Marks *et al.* 1997; Figure 2.4) to expose the viscera and breast muscles. Underwater video footage has also revealed that the seal may submerge 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 seem to tolerate one another and do not fight over carcasses. Groups of two or three seals sometimes prey upon birds close to one another.

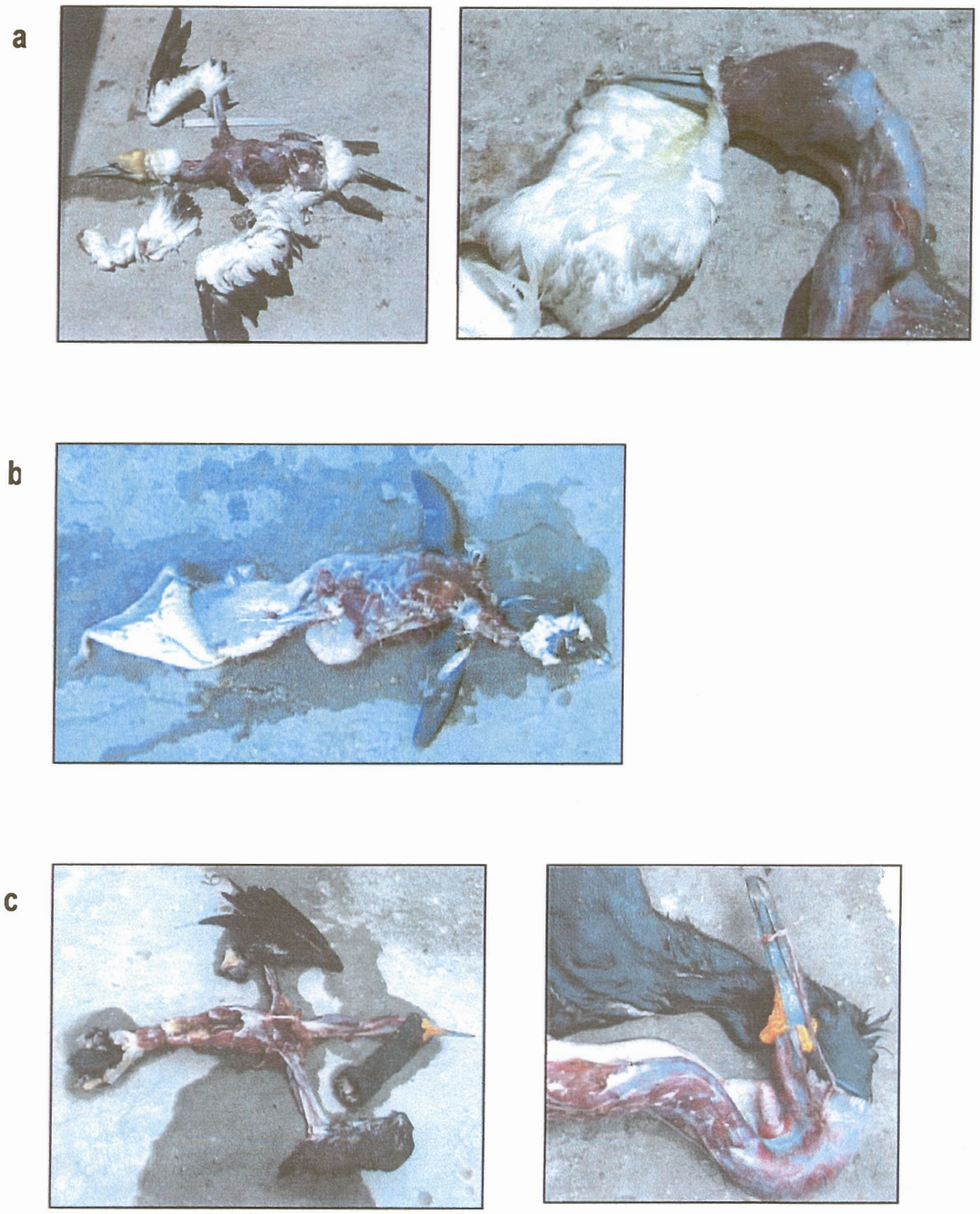

Figure 2.4. Bird carcasses "degloved" by seals: **a** - adult Cape gannets; **b** - adult African penguin; **c** - adult Cape cormorants. The skin has been torn loose and is flung over the head or legs during the seals' thrashing actions, exposing the breast muscles and viscera. This is typical of seal predation.

The age of the seal could be identified in 54% (n = 1497) of the predatory interactions seen. Seals of medium size (subadults) were responsible for 84.8% of these. No adult seals were seen taking cormorants, whereas 77.2% of birds taken by young seals were cormorants. The majority (63.2%) of seals preying on birds were identified as males; all the adult seabird predators were males (Table 2.1).

Table 2.1. Numbers of different bird species killed by seals of different size categories (age categories are in brackets).

Seal sizes	Penguins	Gannets	Cormorants	Total	Percentage male
Large (adult)	35	54	0	91	100
Medium (subadult)	307	390	560	1269	43.58
Small (young)	8	23	105	136	1.46

On 31 July 1997, a young seal attacked and killed an adult White-breasted cormorant; this is the only occasion this bird species was taken by a seal at Ichaboe Island. The seal seemed unsure, and made repeated passes, with the cormorant defending itself by pecking at the seal, but not flying off. The seal attacked from below and pulled the bird under, resurfacing further from the island to thrash the bird. There was not much bird activity on the water at the time.

Seal specialisation

Some individual seals target specific bird species, and may even prefer a specific anatomical portion of these birds. In April and May of 1993, carcasses of at least 13 gannet fledglings and one adult gannet were found with only the viscera

removed. A further three fledglings were found alive with their abdomens ripped open. An adult male seal was believed to be responsible for these, and upon his removal on 2 May 1993 (see Table 2.2), no further gannets were found with such wounds.

"Blunt Flipper", a subadult male seal, was seen taking 230 birds, of which 41 were gannets (93% fledglings), 47 penguins (66% adults) and 142 cormorants (73% fledglings). Of the cormorants, one was identified as a bank cormorant and 103 as Cape cormorants. This seal was active from 25 March 1996 to 02 December 1998. On 25 March 1998, Blunt Flipper killed twenty-one Cape cormorant fledglings within the space of 160 minutes, a predation rate of 7.9 birds.h^{-1}. A mean of 3.4 ± 3.3 (n = 67) birds fell prey to this seal per predation-day. The highest predation rates per hour were invariably when cormorants were preyed upon. On one occasion, Blunt Flipper killed four birds within nine minutes; this converts to a rate of 26.7 birds per hour.

Almost 90% (206 out of 230 birds) of predations by Blunt Flipper occurred less than 200 m from the main island. Cormorant predations occurred at distances of 250 m or less; penguin and gannet predations were seen as far as 700 m distant. The cormorant predations were predominantly to the northeast and east of the island. This seal was observed hunting birds up and down the channel east of Ichaboe, once chasing a group of penguins, and on one occasion seemed to play with a gannet fledgling before killing and eating it. Blunt Flipper preyed on birds throughout the day. The time between successive gannet predations was 37.8 ± 65.0 min (n = 13); for penguins it was 33. 9 ± 32.1 min (n = 18) and for cormorants 26.7 ± 52.3 min (n = 74).

A subadult male seal, referred to as "U", preyed on 60 Cape cormorants, 20 bank cormorants and a further 14 cormorants which were not specifically identified,

between 24 November 1992 and 2 May 1993. "U" caught up to 15 birds a day (5.9 ± 3.8 birds per predation-day; n = 17) of which 95% were taken less than 100 m from the island, within "Bamboo Bay" (see Figure 1.1). This seal preyed on adult cormorants diving for nesting material, and made seven failed predation attempts. Nine birds were killed only and not fed upon; seven of these occurred on the same day. The time between successive predations by this seal was 34.2 ± 21.8 min (mean ± SD; n = 6) for bank cormorants and 26.5 ± 16.9 min (n = 46) for Cape cormorants.

Another subadult male, "Ragged Flipper" (Figure 2.5) preyed on 42 penguins (22 adults and 2 juveniles recognised) and one Cape cormorant between 15 January 1997 and 27 October 1998.

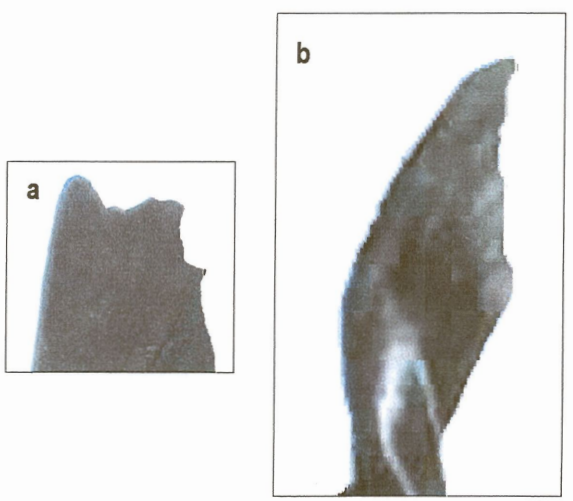

Figure 2.5. Ragged Flipper, a subadult male seal, specialised in taking African penguins and could be identified by the ragged tipped left fore-flipper (**a**). Its right fore-flipper (**b**) was normal.

A maximum of five penguins were seen to be taken by this seal in one day (1.5 ± 1.0 birds per predation-day; n = 29). Forty out of forty-three predations (93%) by Ragged Flipper were between 100 and 200 metres from the island and fairly evenly spaced around the island. 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. The average time between successive predations recorded for Ragged Flipper was 35.6 ± 21.0 min (n = 11).

"Broad Flipper", a large subadult male seal, was seen preying on 33 adult penguins on ten days between 6 January and 26 April 1992, catching up to seven birds on one day (3.3 ± 2.0 birds per predation-day; n = 10). This seal operated only to the east and east north east of the island, with two out of three birds taken less than 100 metres from the shore. Broad Flipper would patrol the route for penguins returning to Jackass Beach (see Figure 1.1), one of the main access points for penguins, catching satiated adults in the late afternoon as they return to the island. The mean time between successive predations by Broad Flipper was 34.1 ± 16.6 min (n = 22), and the rate of predation up to 3.6 birds.h^{-1} (3.1 ± 1.9; n = 5).

The minimum time between successive penguin predations by Broad Flipper was five minutes, by Ragged Flipper ten minutes, and Blunt Flipper fifteen minutes. The minimum time between successive cormorant predations by Blunt Flipper was two minutes and by "U" five minutes.

Among the seals shot were one adult and six subadult males; all were judged in good body condition, though two were noted to have worn canines. Their stomachs contained up to 6kg of bird remains (Table 2.2).

Table 2.2. Seals shot and recovered while preying on birds at Ichaboe Island.

Date shot	Seal	Age	Sex	Stomach contents	Notes
02-May-93	"U"	subadult	male	2.5 kg cormorant remains	
02-May-93		adult	male	few gannet feathers	
19-Aug-97		subadult	male	1.5 kg penguin remains	
20-Aug-97		subadult	male	55 g penguin skin and feathers	
27-Oct-98	Ragged Flipper	subadult	male	550 g penguin skin and feathers	Canines very worn
02-Dec-98	Blunt Flipper	subadult	male	6 kg penguin and gannet remains	Canines very worn
17-Mar-99		subadult	male	1.35 kg penguin remains	

Predation rate and duration

For those cases where a single seal was believed to be responsible for successive predations, the time between these differed significantly per bird species, as did the feeding time and predation rate per day (Table 2.3). The ratio between the average time a seal feeds on each prey species equals 1:0.7:0.5, while that for the time between successive predations (carried out by the same seal) equals 1:0.8:0.5 for penguins, gannets and cormorants respectively.

Table 2.3. Differences between predation rate and duration per prey species. P-values are the results of Kruskal-Wallis ANOVAs. SD = one standard deviation; *n* = sample size.

		Prey species		
		Gannets	Penguins	Cormorants
Time between successive predations (<60 min)	mean	22.82	29.33	13.46
	SD	17.28	15.61	14.09
	n	95	110	227
	$p < 0.0001$			
Duration of predation (min)	mean	7.90	11.7	5.9
	SD	4.41	6.06	2.54
	n	98	6	70
	$p = 0.0004$			
Number of predations per day (by same seal)	mean	3.3	3.2	5.3
	SD	1.9	1.3	3.7
	n	55	61	61
	$p = 0.0004$			

Injured and preyed upon birds

Seals did not consume entire birds. In most cases only the breast muscles and/or viscera were removed by the seal (Figure 2.6), and the carcass was further scavenged by kelp gulls. Some birds were killed but not fed upon by the seal (Figure 2.7). Figure 2.8 shows the breast muscle of a cormorant sliced by a seal, possibly with an

upper canine. Gannets were preyed upon in the same manner as the cormorants, with the seal usually removing the breast muscle and viscera (Figure 2.9). Figure 2.10 shows two penguins that had been preyed upon by the same seal in close succession – one was well-eaten and the other had only part of the breast muscle removed.

Some birds, especially penguins, escaped with injuries of which they may have died later (Figure 2.11). However, many penguins were observed with old, well-healed scars, especially across the chest or lower abdomen (Figure 2.12). 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; these were attributed to seals.

Figure 2.6. Photograph of the carcass of a bank cormorant fledgling, showing the extent to which the breast muscles and viscera were removed by the seal.

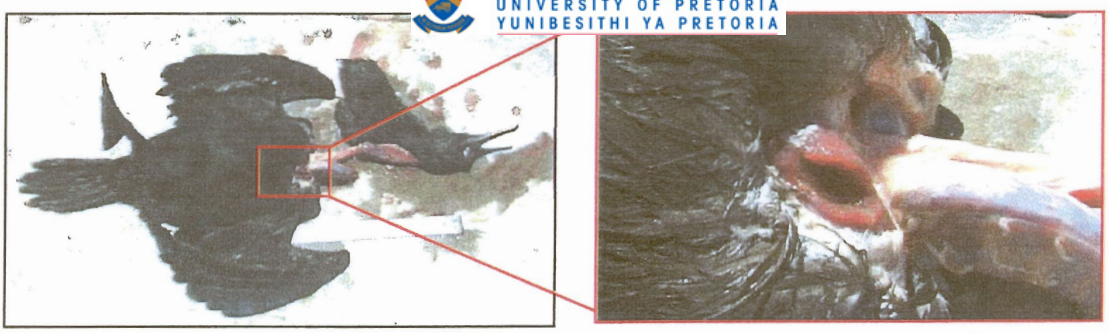

Figure 2.7. Bank cormorant fledgling killed by a seal – note the canine imprint in the breast muscle; this bird was not fed upon.

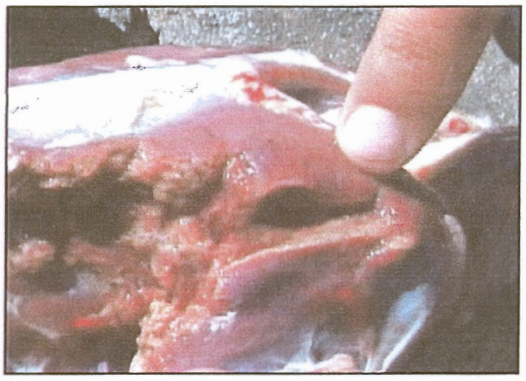

Figure 2.8. Cormorant breast muscle sliced by seal during predation.

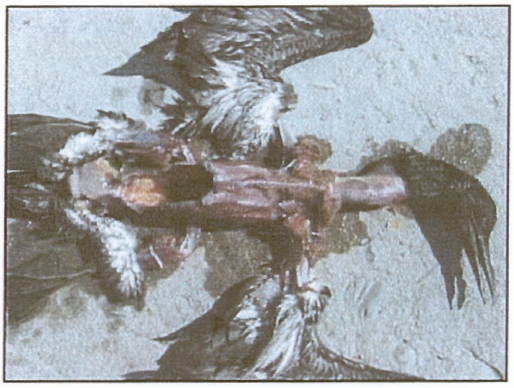

Figure 2.9. Carcass of gannet fledgling showing breast muscles and viscera removed by seal.

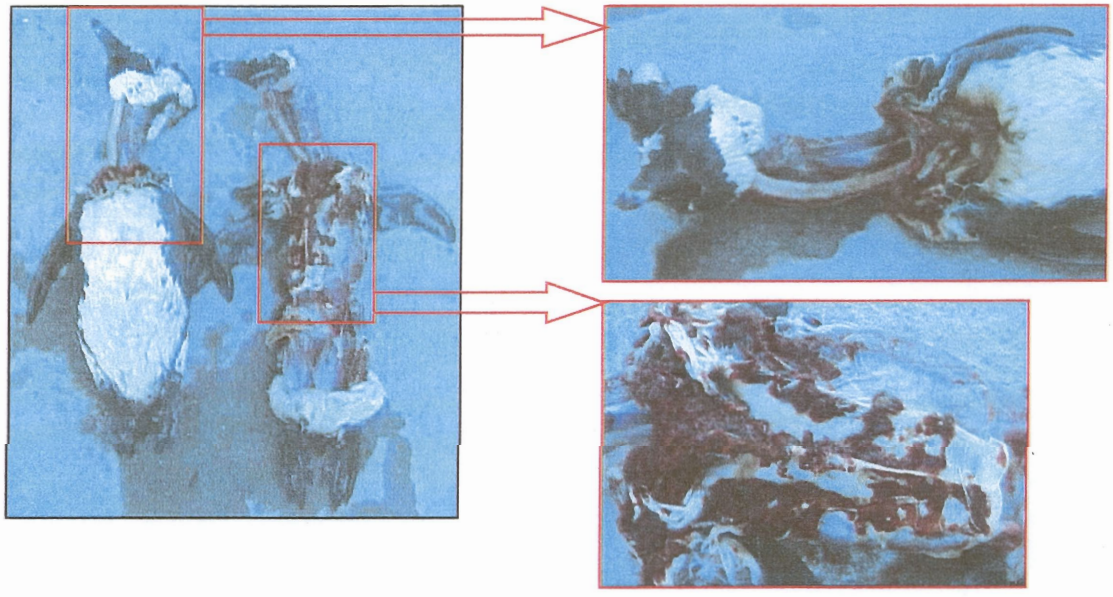

Figure 2.10. Two penguins killed by the same seal in close succession.

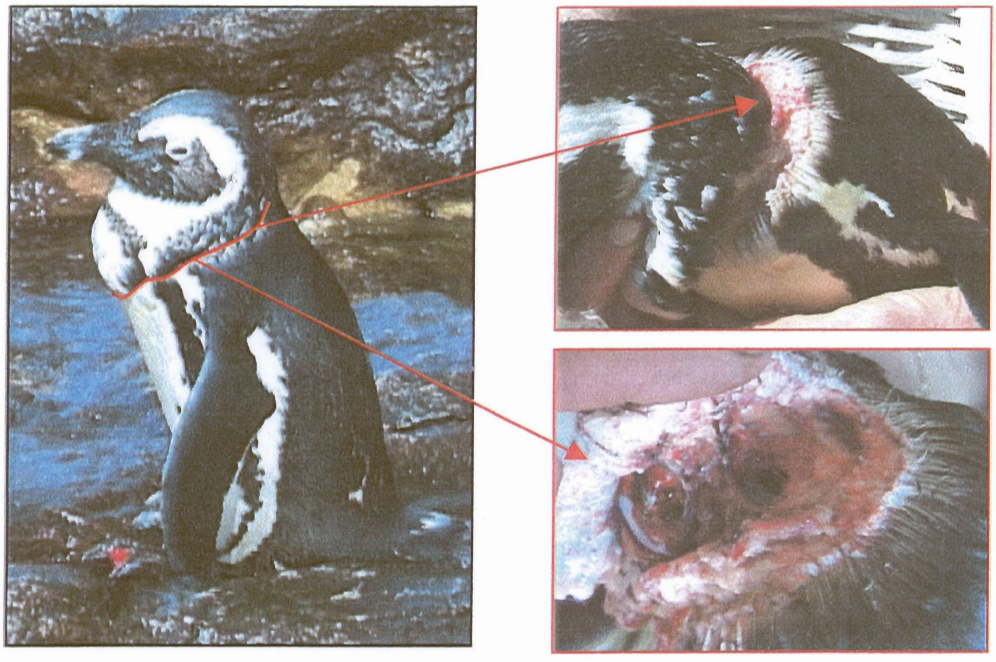

Figure 2.11. Adult penguin with suspected seal-inflicted injuries. The skin and muscles on the neck are ripped through with additional puncture holes in the neck and feet.

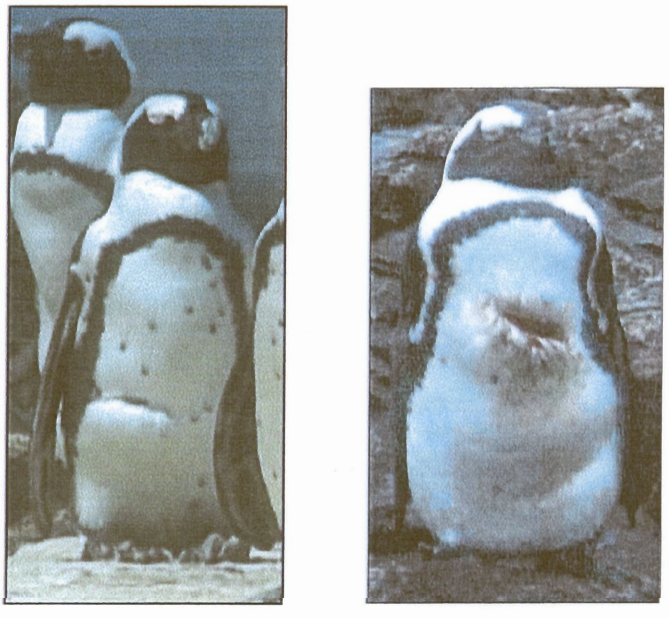

Figure 2.12. Adult penguins with suspected seal-inflicted injuries: **a** – old, well-healed scar; **b** – fresh injury.

DISCUSSION

Seabird predation by seals

While seal predation on penguins is well documented (see Introduction), reports concerning predation on gannets and cormorants are few (Shaughnessy 1978; Marks *et al.* 1997; Navarro 2000). Seal-seabird predation occurs at low levels, with small subgroups, such as subadult males, specialising in this behaviour (Marks *et al.* 1997). The current study supports this statement.

Not all seals at Little Ichaboe prey on seabirds – at least 80% of the predators identified fell in the subadult age-group, and the predators were predominantly male (Table 2.1).

Predation cues

Though the predatory cues identified differed in terms of visibility, i.e. attracting the attention of the observer, they proved a valuable aid in recognising predatory events, especially for opportunistic observations (see Chapter 3). These cues were chosen specifically for their association with predatory events, so that an observer familiar with them will recognise such events and can tell them apart from normal bird or seal fishing activity.

A gannet cloud is conspicuous, especially when comprised of many birds. Because the majority of these clouds are associated with predatory events involving adult gannets, predations on these birds are less likely to be missed than cormorant or penguin predations. Gannet clouds will be discussed in more detail later in this chapter.

Kelp gulls swooping or scavenging was the most important predation cue, although not as visible as a gannet cloud in terms of attracting the observer's

attention. The presence of kelp gulls confirms that there is something for these birds to feed on (such as a bird carcass), whereas gannet clouds sometimes form for reasons other than a predation. Marks *et al.* 1997 also note the presence of kelp gulls at predation events; indeed, for this study, activity by birds or seals in the water that was not attended by kelp gulls confirmed that the activity did not involve seal-seabird predation.

Thrashing is the most important indication of a predation currently taking place. Seals also thrash lobsters and large fish, so this cue is not necessarily indicative of a seal-seabird predation. The prey can be identified when thrashed by the seal, and even at considerable distances it is possible to distinguish between bird species, by the shape, size and colour of the prey. This is why thrashing is important not only as a predatory cue, but also to identify the seal and prey. However, thrashing is often only visible for a short period of time, and in some instances is not seen at all, when the seal feeds on the bird underwater.

Direct evidence of a predatory activity, such as a seal attacking a bird, is important to recognise, as the entire predatory event can be noted, and the duration more accurately recorded. Ideally, every account of such predatory activity should start with the seal attacking the bird, or even with the events leading up to the attack, by observation of the seal and the bird involved. However, due to the short duration of an attack, it is easily missed during incidental observations and even scan sampling, so only continuous observations would reliably record the start of a predation (see Chapter 3).

Though carcasses (usually adrift) are indicative of past predations, and do not necessarily provide data on the behavioural aspects of seal-seabird predation, they were nonetheless an important clue to predatory activity, especially for gannet and

cormorant fledglings. During opportunistic observations not every predatory event would have been noted. In this case, a count of carcasses adrift provides information on the number and species of birds killed; upon inspection, the extent of injuries may be noted and a likely predator implicated. Moreover, on days when predatory activity occurs frequently and close inshore, it was more convenient to count carcasses than do continuous observations (see Chapter 3).

Behaviour

Unlike the incident noted by Rebelo (1984), no seal was observed attacking birds on land. The sea-wall surrounding Ichaboe Island generally serves to exclude seals from the island, though 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 'landing stages' of the penguins, where they congregate on the seaward side of the wall. The possibility of seals taking birds on land is therefore not excluded, though the incident of the injured penguin ashore on Little Ichaboe amongst the seals confirms that seals do not necessarily consider seabirds as prey.

Most observations only start once predation cues are seen, which usually means that the seal has already seized the prey. It is therefore not always possible to determine whether an ambush or active pursuit has preceded the predation, or whether the birds are taken opportunistically as opposed to being targeted. The nature of the attack may, however, be deduced from other behavioural characteristics as seen during continuous observations, as well as other circumstantial evidence. Simultaneous predations prove that more than one seal is involved in preying on birds; this is important when trying to discern whether a single seal is responsible for successive predations. Predations in the same area at regular intervals with no

simultaneous activity noted, may be ascribed to only one seal individual; if in quick succession it may mean that the birds are only killed, and not eaten.

The hesitant behaviour on the part of the young seal that killed the white-breasted cormorant, suggested that the seal was inexperienced, at least in preying on this largest of the cormorants. It is possible that the cormorant did not regard the seal as dangerous, which is why it did not attempt to fly off. The number of white-breasted cormorants at Ichaboe is small (maximum of 11 breeding pairs), so seals would not encounter them as often as the other birds. Therefore, the predation level (one white-breasted cormorant predation noted in nine years) is not surprising.

No failed predation attempts on penguins were witnessed; however, these would not be as obvious as with the other birds. Penguins with suspected seal-inflicted injuries are more prevalent on the island than gannets or cormorants – 60.7% of injured birds were penguins. 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 (see Figures 2.11 and 2.12), hence the larger number of penguins with injuries and scars.

Seabirds generally recognise seals as a threat, and display anti-predator behaviour (Randall & Randall 1990). Penguins change direction and porpoise away from seals, while adult gannets and cormorants are reluctant to dive in the vicinity of seals, and take off from the water if 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 there are higher numbers of fledglings than adults preyed upon in quick succession, often by the same seal.

Surplus killing is defined as the "killing by a predator of prey, without the killing individual or its offspring or members of the same social unit eating anything

from the kill, although there is free access to the carcass and usually the particular prey species would be eaten by that predator" (Kruuk 1972a: 234). Miller, Gunn & Broughton (1985) suggest the term "surplus killing" for cases where the prey is killed but not fed upon, and "excessive killing" if the carcass is partially consumed, both of which occur in excess of the short-term energy requirements of the predator. Specialisation in food selection may be a response to high prey densities, which could lead to surplus killing, often but not necessarily facilitated by unusual environmental conditions (Miller *et al.* 1985). Cape fur seals display selective consumption of seabirds (Cooper 1974; Navarro 2000; this study), and kill birds without feeding (Marks *et al.* 1997; this study). Therefore, seal-seabird predation involves both surplus and excessive killing, especially regarding cormorant and gannet fledglings. These highly vulnerable prey are abundant for a few months and are often killed in quick succession in a clumped distribution with at least some of the prey not having been fed upon. These are restrictions that Miller *et al.* (1985) believes should be applied to surplus killing. The curiosity of gannet and cormorant fledglings indicates that their anti-predator response regarding seals is absent, which may further expose them to surplus killing. However, surplus killing involves the typical prey of the predator (DelGiudice 1998), and is therefore not strictly applicable in this study.

Young seals that are inexperienced seem to prefer to attack cormorants, and are not always successful. On the other hand, experienced seals preying upon 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 fur seals (Marks *et al.* 1997 and references therein) 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. The same was the case for two killer whales *Orcinus orca* "playing" with cormorants and penguins at Mercury Island (Williams, Dyer, Randall & Komen 1990).

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 32 gannets and four cormorants killed in this area may have been taken opportunistically in the same way as pieces of kelp or floating objects are 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 2000:16), later taking them as prey.

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 he 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 ones to deglove Cape cormorant fledglings (R.A. Navarro, pers. comm.). Hiruki, Schwartz & Boveng (1999) noted incidents of leopard seals interacting while hunting, with one seal capturing and releasing fur seal (*A. gazella*) pups to another. 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. Hiruki *et al.* (1999) could not confirm co-operative

hunting but noted that leopard seals tolerated one another while hunting; the same holds true for this study regarding Cape fur seals preying on birds.

Only penguins were seen to be chased by seals. A seal can outswim a satiated penguin whereas gannets and cormorants would take off if pursued. Three out of six observations of this behaviour involved one seal individual, Blunt Flipper. On one occasion, the chase resembled a "cat-and-mouse game"; the seal chasing the 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.

Gannets remain in the water only for a short while after plunge-diving for fish (Duffy, Berruti, Randall & Cooper 1984). When the seal approaches the bird from below, the bird may take off. The high wind speed at which three of the airborne attacks on gannets took place may be when the bird was aware of the seal, and able to take off from the water rapidly, aided by the wind. The seal then carries through the attack despite the bird having taken off.

Gannet and cormorant fledglings are inexperienced in taking off from the water, and are relatively heavy. Together with their inability to recognise seals as danger, and their curiosity (see above), they therefore become easy prey for seals. If these birds happen to be in the area where the seals play in the surf off Little Ichaboe, inquisitive young seals may take these birds as an extension of play behaviour and later learn to become active bird predators.

It cannot be assumed that those birds that were killed only or that managed to escape with injuries were necessarily preyed upon by inexperienced seals. Regular bird predators may also attack and injure birds, or kill them without feeding on the carcass.

Seals may find seabirds easy prey, and some individuals 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 specialise in seabird predation. The local seabird populations may not be able to sustain this added mortality factor (see Chapter 5).

Time between predations

The ratio of the average time between successive predations between the three bird species is equivalent to that of the average time a seal feeds on each species. Therefore, the time between successive predations carried out by the same individual seal may indicate the time spent with each carcass. Gannets and penguins are large and heavy compared with cormorants, and seals spend more time feeding on these birds. In a given period of time a seal can take almost twice as many cormorants as gannets or penguins. In addition, cormorants are far more abundant at Ichaboe and likely to occur in larger groups, whereas gannets and penguins would be encountered singly or in small groups. Thus a greater predation rate for cormorants would be expected. Moreover, inexperienced seals may take cormorants rather than the larger gannets and penguins.

The results report the time between successive predations by the same seal individual, and the number of birds taken by the same seal in one day. Hence, these results pertain only to those seals that are exploiting this food resource on a regular basis. These seals are therefore not taking birds opportunistically, but repetitively and deliberately. If it were only play behaviour, the birds would not be consumed, but possibly only injured or killed. Though not all bird carcasses could be inspected, the

time lapse between the subsequent predations by these specialist seals suggests that the birds were fed upon. However, the majority of successive predations could not be attributed to any particular seal due to the difficulty in identifying individuals. The results reported here therefore represent a biased portion of the data (in only involving specialist seals and not those preying on birds opportunistically), and cannot be extrapolated to population level.

Age and sex of seal

It is difficult to identify the sex of a seal while it is preying on a bird, though seals often roll and put a fore-flipper in the air, or hang upside down in the water with the hind flippers visible after the predation. As the head and neck of the seal may be visible during the thrashing action, the age of the seal can often be estimated by judging the size of the seal's neck and flippers against the size of the bird carcass. Although adult and subadult males can be easily identified, adult and subadult females would be classed as "subadult" only – for this reason female seals cannot be ruled out as bird predators, though no females were positively identified. On the other hand, a seal perhaps needs to be large, with well-developed neck muscles in order to succeed in thrashing a bird. Harcourt (1993) suggests that adult male southern sea lions (*Otaria byronia*) are able to exploit a food source (South American fur seals, *A. australis*) that the smaller females are unable to exploit. Due to the marked sexual dimorphism of the Cape fur seal (Shaughnessy 1979), the females reach maturity before the males. Therefore, when females are physically large enough to prey on a penguin or gannet, they are involved in reproduction and may be pregnant or suckling their pups, which may explain why subadult seals appeared to be the most regular bird predators. However, if birds were a good source of food, female seals with pups

ashore would be seen preying upon seabirds more often; though due to the difficulty in identifying female seals from a distance, this cannot be ruled out. Young 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, Bester & Oosthuizen 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. Other studies on seal-seabird predation also found the predators to be predominantly male (Bonner & Hunter 1982; Hofmeyr & Bester 1993; Rebelo 1984; Shaughnessy 1978; Williams 1988). A review by Riedman (1990) suggests that predation on birds (or other pinnipeds) are restricted to adult or subadult male pinnipeds, with the exception of leopard seals.

Seal specialisation

Navarro (2000) described the behaviour of a bull seal observed at Malgas Island in 1988 that killed at least 61 gannet fledglings using the same technique, a single abdominal bite. This is remarkably similar to the behaviour of the bull observed in April 1993 at Ichaboe. This is an indication of specialised behaviour, with the seal showing 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.

Specialisation and individual preferences for specific prey were shown for leopard seals by Hiruki *et al.* (1999). Other authors (Bonner & Hunter 1982; Cobley

& Bell 1998; Cooper 1974; Hofmeyr & Bester 1993; Penney & Lowry 1967; Walker *et al.* 1998; Williams 1988) also ascribe seal-seabird predation to a few individuals whose techniques or preferences may differ (Cooper 1974; Bonner & Hunter 1982; Rogers & Bryden 1995).

The predatory behaviour of individual seals did not conform to the overall pattern of predation at Ichaboe Island. The predations carried out by seals that were individually recognisable were generally recorded close to the island, but this does not necessarily imply that these seals operated only in close proximity to the island. Most observations were island-based; it became increasingly difficult to identify seals at farther 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 each individual seal. Nevertheless, Broad Flipper appeared to prey only on penguins, Ragged Flipper on penguins and one cormorant, Blunt Flipper on gannets, penguins and cormorants, and "U" on cormorants only.

Though these four seals represent a small sample of the seals that prey on birds at Ichaboe, they offer insights into individual seal preferences and behaviours concerning seabird predation. Blunt Flipper was observed taking the most birds, notably juvenile cormorants between March and June, juvenile gannets mainly from March to April and penguins year-round. Therefore this seal took birds in accordance with their abundance (see Chapter 1). In contrast to this, Broad Flipper preyed on adult penguins during a time when cormorant and gannet fledglings, which may be relatively easier to catch, were abundant. Ragged Flipper, on the other hand, took penguins over a wider range spatially and temporally, while "U" was seen preying mainly on adult cormorants from November to January. Broad Flipper and "U" seemed to specialise more, each exploiting a particular niche - Broad Flipper

ambushing satiated penguins in the late afternoon as they return to the island, and "U" preying on adult cormorants diving for nesting material within a small area called Bamboo Bay. Four very different strategies of predation are evident, indicating that this is not a common, stereotyped behaviour, but rather that individuals develop their own preferences and techniques.

For an hourly predation rate of over 20 birds, it is assumed that the birds were killed only, and not fed upon; this is the case for 15 cormorants preyed upon by Blunt Flipper. With such times as two to five minutes between successive predations by the same seal, it is assumed that the seal did not feed on the carcass, or ate very little. Such surplus killing and wastage from a carcass is not a common occurrence (Kruuk 1972b), and it seems that this behaviour is restricted to only a few individual seals. However, persistent over-predation could severely impact local seabird populations (see Chapter 5) and necessitate the removal of the particular seal individual responsible.

Gannet clouds

When gannets are hovering together in a group over something in the water, they are usually fishing, and individuals can be seen plunge-diving into the water, surfacing a short while later. Such a group may be a cue to fishing activity to other birds, which fly out from the island and join those in the group. Flying out (from the island) to hover over a seal preying on a bird is energetically costly for the gannets (Adams & Klages 1999), and seems to serve no purpose. However, a gannet cloud may serve as a visual cue to the presence of food to other gannets, similar to Black-browed Albatrosses in mixed-species feeding flocks (Silverman & Veit 2001).

If a seal attacks a gannet that has just surfaced after diving, and a few other gannets in the vicinity take flight, these birds hovering over the predation site may be a signal to other birds that there are fish. Other birds, gannets in particular, may fly towards the area to join in potential fishing, and in so doing attract the attention of still more birds. Individual birds may choose to remain within the cloud for a short while before flying off again, while the presence of the group of gannets in the air serves to continually attract more birds. The gannets may be reluctant to dive into the water due to the presence of the seal feeding on a bird; this behaviour may serve to further confirm predatory activity. When the seal no longer thrashes the carcass, the gannet cloud disperses.

When predation occurs regularly throughout the day, gannets may spend a large proportion of their time flying out to join gannet clouds to investigate the activity on the water, and return to the island a short while later. This may be repeated with every predation event, causing the gannets to expend energy unnecessarily and without gain.

While the majority of gannet clouds were associated with predations involving adult gannets at Ichaboe Island, they have been noted to form over juvenile gannet predations at Malgas Island (M.A. Meÿer, pers. comm.). It is interesting to note, however, that gannet clouds have also been seen to form over a person on the water (surfing, paddling, or in a dinghy) as well as over a person on the island (pers. obs). This behaviour may therefore also be associated with investigating anything unusual.

Injured birds

Gannets or cormorants that are injured may be unable to fly or swim back to the island, so the number of injured birds of these species is possibly under-represented.

On the other hand, penguins are still able to swim ashore provided their flippers are not too damaged, which may be why penguins with fresh or old injuries on the ventral body surface are common.

Though sharks and killer whales (*Orcinus orca*) have historically been noted or implicated as predators of the African penguin (Randall, Randall & Compagno 1988; Randall & Randall 1990), very few of these predators have been observed offshore at Ichaboe Island since 1991 (P.A. Bartlett, pers. comm.). These are therefore not responsible for the injuries seen on penguins at Ichaboe.

According to Randall *et al.* (1988), penguins often suffer broken bones when attacked by a seal. This was not the case in the current study, where birds preyed upon by seals hardly ever had broken bones. Cooper (1974) noted that seals usually removed the viscera of penguins they prey on. In the current study, this was more often the case with cormorants and gannets.

Kelp gulls find it difficult to penetrate the feathers and skin of an entire bird carcass that is adrift, but readily scavenge bird carcasses where the breast muscles and viscera are exposed. It is therefore not always certain which anatomical portion of a carcass had been consumed by a seal if the carcass was collected some time after the bird was preyed upon, as kelp gulls may have scavenged a considerable portion of the bird.

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