CHAPTER 3: EVALUATION OF METHODS

INTRODUCTION

Incidental sampling

In order for a study to be scientifically valid, "the selection and appropriate use of sampling methods that yield unbiased estimates of behavior are critical" (Mann 1999:103). However, ethological studies often involve opportunistic recording of events, which may preclude quantitative evaluation. Such *ad libitum* sampling has inherent biases and assumptions, as outlined by Altmann (1974) and Mann (1999). Informal recording of events, such as during incidental observations, have an unknown dependency on the behaviour in question, as session onsets are not systematic. Events that are easily recognisable or visible may be recorded more frequently (Altmann 1974), with an under-representation of events that do not attract the observer's attention to the same degree.

In marine ecology, manipulative experiments are not often feasible and research is expensive (Bowen 1997). *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). Despite such sampling being fraught with bias, it has heuristic value in planning systematic sampling and can be used as illustrative material (Altmann 1974).

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). Information regarding spatial, temporal and environmental parameters may still be accurately recorded for each event. However, since sampling effort is unquantified, rates, frequencies and proportions cannot be accurately calculated (Mann 1999).

Predation by pinnipeds is most often recorded on an *ad libitum* basis. Hofmeyr & Bester (1993) interviewed observers who had incidentally recorded king penguins falling prey to Antarctic fur seals. Records of Cape fur seals preying on penguins (Cooper 1974; Rebelo 1984) and other seabirds (Shaughnessy 1978; Marks *et al.* 1997; Navarro 2000) use opportunistic sightings as the method of observation. Other incidental records of pinniped predation include: leopard seals preying on Adélie penguins (Rogers & Bryden 1995); Weddell seals feeding on gentoo penguins (Cobley & Bell 1998); Hooker's sea lion (*Phocarctos hookeri*) preying on fur seals (Robinson *et al.* 1999). Cetaceans (notably Killer whales *Orcinus orca*) and their interaction with seabirds (king penguins, African penguins and Cape cormorants) were also recorded opportunistically (Condy *et al.* 1978; Randall & Randall 1990; Williams *et al.* 1990).

Scan sampling

The systematic recording of events, as with scan sampling, permits the calculation of rates and proportions, because observer effort can be quantified. Session onsets are predetermined and independent of behaviour. Data are recorded from a subgroup of the population in question, rather than a focal individual. Each member in this group is observed in turn for the same length of time, and the current activity of each noted (Altmann 1974). The behavioural categories are chosen such that they are easily and rapidly distinguishable. Kovacs & Innes (1990) made use of this form of sampling in investigating the level of disturbance caused by tourists when visiting a harp seal (*Phoca groenlandica*) herd.

Continuous observations

If behavioural events are sufficiently "attention-attracting" (Altmann 1974:247), such that every event will be recorded, and if these events do not occur too frequently to record, all occurrences of some behaviours may be recorded during continuous observations. Such a sampling technique provides information regarding the rate of occurrence of the behaviour in question (Altmann 1974). This method was employed by Penney & Lowry (1967) while investigating leopard seal predation on Adélie penguins, as well as by Bonner & Hunter (1982) in their study of Antarctic fur seals preying on macaroni penguins.

In this chapter, eight years of incidental observations of seal-seabird predation are compared with the results from six months' intensive systematic observations as well as incidental observations, in order to investigate the differences between these methods.

METHODS

Historical incidentals

Opportunistic observations of seal-seabird predation in the vicinity of Ichaboe Island were carried out by Mr. P.A. Bartlett between October 1991 and October 1999. The date, time, direction and estimated distance of the predation from the island, environmental parameters, seal age and sex, bird species and age, and the duration of the predatory event were recorded whenever possible. Indicators of predatory activity, identified at the start of the study, were used as cues to alert the observer to a predatory event (see *Predation cues*, Chapter 2). Any other relevant behavioural data were also noted.

These incidental observations (historical incidentals) were used to plan a systematic sampling method, which was carried out from November 1999 to May 2000.

Scan sampling

The method of scan sampling used in this study is an adaptation of the 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). Due to the difficulty in identifying individual seals, the focal animal approach could not be strictly carried out. A subgroup of the seal population was therefore observed, specifically those involved in preying on birds. Therefore, behavioural criteria (i.e. predation) determined the focal individual; samples of animals and behaviour are therefore not independent. Furthermore, the same individual seal may have been responsible for more than one predatory event; such events would not have been independent. If no predation occurs during a particular scan, no focal animal was identified. This method may thus be more aptly described as “focal event sampling”.

The beginning and end of interactions were discernible, with behavioural categories easily distinguishable. The start of a predation was identified when cues such as a seal attacking a bird, kelp gulls scooping, the formation of a gannet cloud or a seal thrashing prey were observed. When the kelp gulls settle on the water to scavenge the bird carcass, or when a gannet cloud disperses, this was taken as the end of the seal-seabird predatory interaction.

Focal event sampling involved scanning the coastal waters around the island for predation cues from an elevated observation hut (9 m a.s.l.) with 7 x 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 mist or fog. When the visibility was less than *c.* 500 m, no scans were done, and as soon as the mist or fog cleared, scans continued as usual. It was assumed that every predatory event occurring at the time of a scan would be noticed.

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-month fieldwork period, a total of 4 129 scans (which is equivalent to 137.63 hours of observation) were done over 86 days. An average of 48.6 (SD = 10) scans were carried out per day.

Continuous observations and project incidentals

In addition to the focal event sampling, 162.5 hours of continuous observations were done throughout the same season during 107 sessions over 57 days. These observations were usually carried out from the observation hut for periods lasting between 15 minutes and five hours (mean = 1.5 hours), searching in all directions for predation cues. It is assumed that all predatory events will be observed during continuous observations, even if they occur simultaneously and that those events occurring in the "summit shadow" (see Figure 1.1) are negligible due to the surf in this area.

Continuous observation periods were not decided upon before the study, and were prompted by predatory activity on four occasions. Focal event sampling continued as described above throughout these observation periods, where these ran concurrently. Apart from scanning and continuous observations, predations were also noted opportunistically (project incidentals) in the same manner as they had been over the previous eight years. Continuous observations and project incidentals were carried out from November 1999 to May 2000.

When observational methods ran concurrently, a predatory event would be recorded for only one method. Focal event sampling as a method of observation took preference, followed by continuous observations and then the incidental sightings. Therefore, if a particular predatory event was observed during a continuous observation period, as well as during a scan, the method would be recorded as focal event sampling rather than continuous observation. Also, if an individual predation lasted long enough to span two scans, it was recorded only for the first scan in which it was seen. It was assumed that all predatory interactions in the vicinity of the island (in a 1 km radius) would be noted during focal event sampling and continuous observations, both of which took place from the elevated observation hut.

The predation cues identified by P.A. Bartlett (pers. comm.) were used as indicators of predatory events, and the same information recorded for each event as listed previously (see *Historical incidentals* above).

Proportion of predations represented in incidental records

Between November 1999 and May 2000, when incidental observations of seal-seabird predation were complemented by systematic observations, it is assumed that the proportion of predations noted was greater than in years when all observations were incidental. During this period of intensive observations (denoted “project”), records were kept of those predations that were noted incidentally, regardless of whether or not the same predation event was noted during systematic observations. In this way, it was possible to calculate the proportion of predations noted incidentally (PI), and those that would have been missed, had no systematic observations been carried out. The sum of predatory events noted incidentally (TI, excluding the project records; i.e. October 1991 to October 1999, and June 2000 to May 2001), multiplied by PI, give adjusted values of predation, which are believed to be more realistic. The total number of predations for this ten-year period equals the sum of the adjusted values and the project records.

Statistical analysis

Frequency distributions were compared using non-parametric tests. 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. The Kolmogorov-Smirnov Test was performed to compare two groups, and the p-values used to give insight into the relationship. In the case of categorical variables, the Pearson Chi-square Test was used (Sokal & Rohlf 1998).

During continuous observations, few gannet and penguin predations were noted (see Table 3.1). These are excluded from the results due to their small sample sizes. The graphic representation of the results were simplified by grouping classes and using percentage instead of frequency distributions. For example, in Figure 3.2, predatory events that occurred between 06:00 and 08:59 were grouped in a class labelled 07:30, those between 9:00 and 11:59 were grouped and labelled 10:30, and so forth. However, the analyses were carried out on the original (ungrouped) data. Individual predatory events were assumed to be independent. Predatory events where only the carcass of the bird was found, were excluded from the calculations on the diurnal and spatial distribution of predation, because the exact time and location of predation could not be established.

RESULTS

Predations noted per method

A total of 2774 seal-seabird predatory interactions were observed between October 1991 and May 2000 (Table 3.1).

Table 3.1. Numbers (with percentage of total in parentheses) of different bird species preyed upon by seals at Ichaboe Island, as recorded using different methods of observation (see text for details).

Method of observation	Cormorants	Gannets	Penguins	Unknown	Total
Historical incidentals	1033 (41.8)	882 (35.7)	523 (21.2)	33 (1.3)	2471
Project incidentals	79 (62.2)	15 (11.8)	13 (10.2)	20 (15.7)	127
Focal event sampling	64 (51.2)	32 (25.6)	7 (5.6)	22 (17.6)	125
Continuous observations	41 (80.4)	3 (5.9)	1 (2.0)	6 (11.8)	51

There is a significant difference between bird species preyed upon as observed by each method (Pearson Chi-Square, $X^2 = 99.96$; d.f. = 6; $p < 0.0001$).

Where focal event sampling and continuous observations ran simultaneously, 28 predations were noted during the continuous observations that would have been missed had only focal event sampling been used as a method of observation. Predations were noted in 3% of scans and in 23% of continuous observation sessions.

Predation cues

The first predation cue to attract the attention of the observer differed with each method (Pearson Chi-square, $X^2 = 113.5$; d.f. = 12; $p < 0.0001$). Seals attacking and thrashing birds were noted as a first cue the most often during continuous observations. While kelp gulls swooping was an important cue to predatory activity regardless of the method of observation, carcasses were only seen as a first cue during incidental observations (Figure 3.1).

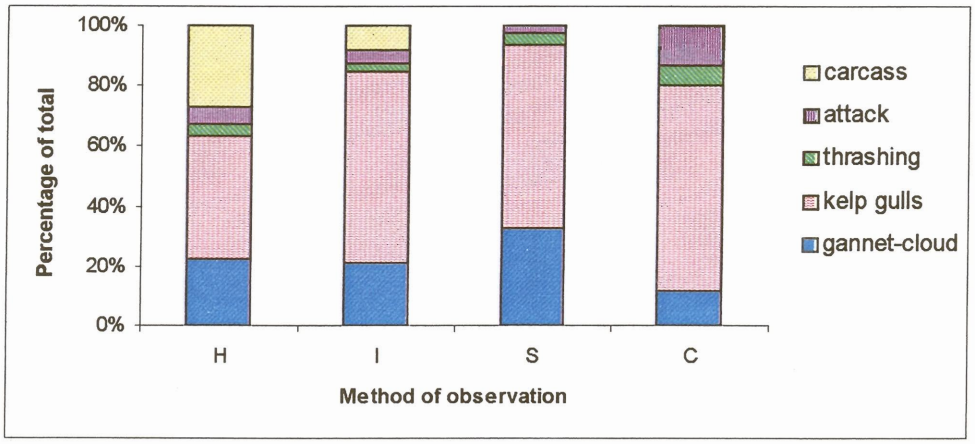

Figure 3.1. The number of predations (as a percentage of the total) associated with specific cues as noted during different methods of observation. Observation methods: **H** – historical incidentals; **I** – project incidentals; **S** – focal event sampling; **C** – continuous observations.

Diurnal differences

The time of day that birds were seen to be preyed upon during each of the observational methods, differed significantly for cormorants (Kruskal-Wallis ANOVA, H (3, n = 1177) = 16.49; p = 0.0009). However, the difference between historical incidentals, project incidentals and focal event sampling was not significant for gannet (Kruskal-Wallis ANOVA, H (2, n = 923) = 0.65; p = 0.72) and penguin (Kruskal-Wallis ANOVA, H (2, n = 538) = 1.01; p = 0.60) predations (Figure 3.2).

The majority of cormorant predations occurred in the morning as observed during historical incidental observations, while during focal event sampling more cormorants were preyed upon in the afternoon (Kolmogorov-Smirnov; $p < 0.001$) (Figure 3.2a). Gannet predations occurred throughout the day as observed through focal event sampling; incidental observations of these peak just after midday (Figure 3.2b). In contrast, the majority of penguin predation occurred after 15:00 for each method used (Figure 3.2c).

Environmental conditions

Environmental conditions, particularly wind speed as measured using the Beaufort Scale (hereafter denoted BS), differed significantly for each method of observation in the case of cormorant predations (Kruskal-Wallis ANOVA, $H(3, n = 1217) = 16.56$; $p = 0.0009$); no significant difference was seen in the case of gannet (Kruskal-Wallis ANOVA, $H(2, n = 921) = 0.78$; $p = 0.68$) and penguin (Kolmogorov-Smirnov; p = n.s.) predations (Figure 3.3).

Cormorants were seen to be preyed upon in conditions of both low (BS 3) and high (BS 7) wind speeds, except as observed during historical incidentals where 96.5% of cormorant predations occurred at wind speeds of less than 21 knots (BS 5); historical incidentals and focal event sampling differ significantly in this respect (Kolmogorov-Smirnov; $p < 0.01$) (Figure 3.3a). Gannet predations occurred at wind speeds of up to 47 knots (BS 9) (Figure 3.3b), while over 80% of penguin predations took place at wind speeds of 21 knots or less, regardless of observational method (Figure 3.3c).

Spatial differences

The distance from the island that predations were observed during each observational method, differs significantly with respect to cormorants (Kruskal-Wallis

ANOVA, $H(3, n = 1185) = 85.65$; $p < 0.0001$), gannets (Kruskal-Wallis ANOVA, $H(2, n = 904) = 13.44$; $p = 0.0012$), as well as penguins (Kruskal-Wallis ANOVA, $H(1, n = 528) = 7.62$; $p = 0.0058$) (Figure 3.4).

With few exceptions, cormorant predations were observed closer than 600 m from the island (Figure 3.4a). During historical incidentals, almost 90% of these were closer than 200 m, while during focal event sampling cormorant predations were seen up to 400 m distant (Kolmogorov-Smirnov; $p < 0.001$). Whereas during project incidentals almost 40% of gannet predations occurred further than 600 m from the island, both historical incidentals and focal event sampling have less than 20% of observed gannet predations in this distance class (Figure 3.4b). Penguin predations were noted closer to the island during historical incidentals than in the course of project incidentals or focal event sampling (Figure 3.4c).

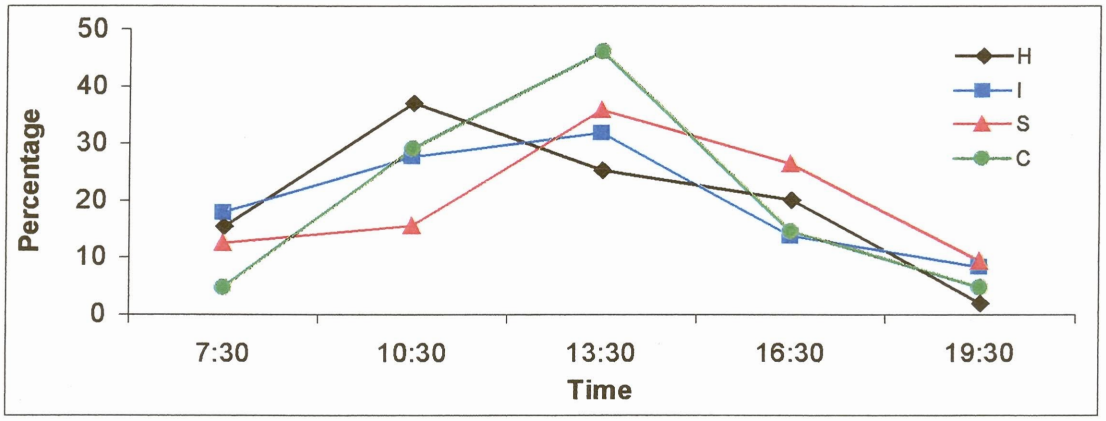

Figure 3.2a

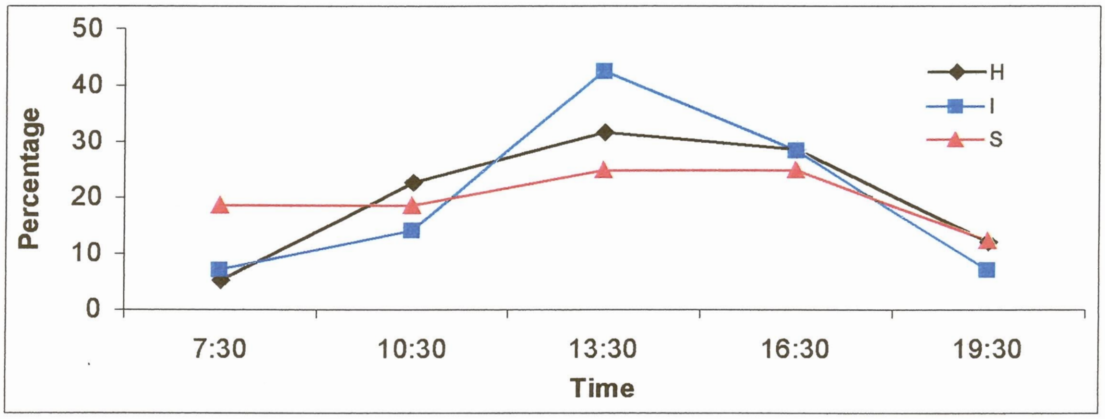

Figure 3.2b

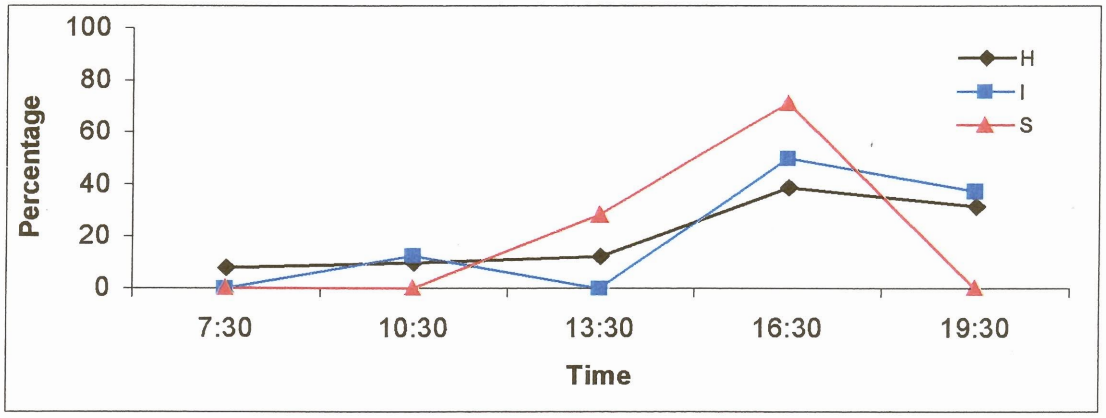

Figure 3.2c

Figure 3.2. Percentage distributions of the number of birds preyed upon by seals throughout the day, as noted during different methods of observation. Bird species: **a** – cormorants; **b** – gannets; **c** – penguins. Observation methods: **H** – historical incidentals; **I** – project incidentals; **S** – focal event sampling; **C** – continuous observations.

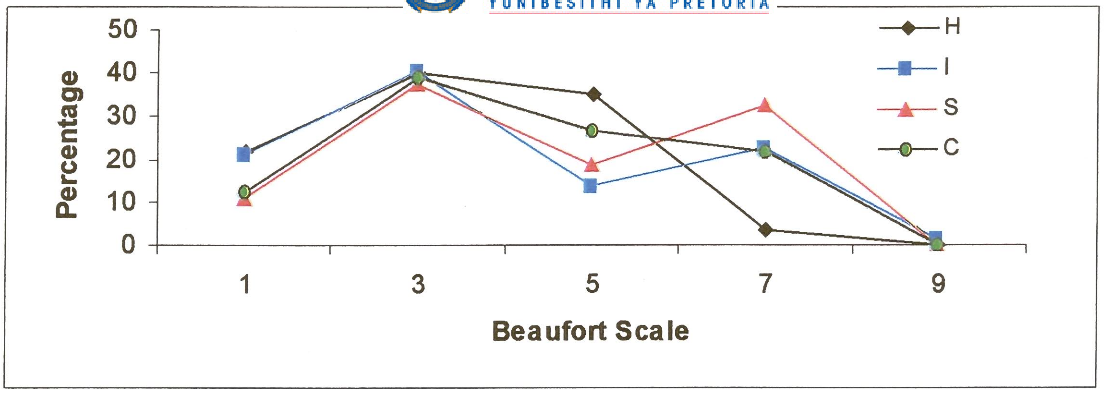

Figure 3.3a

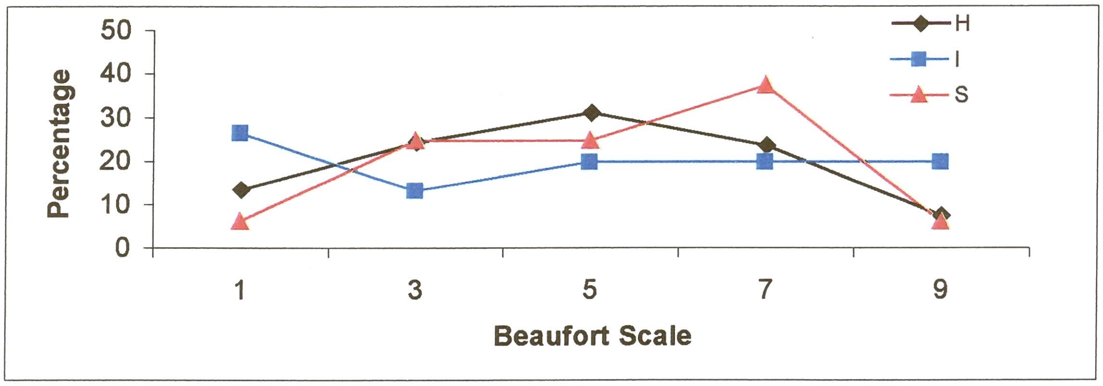

Figure 3.3b

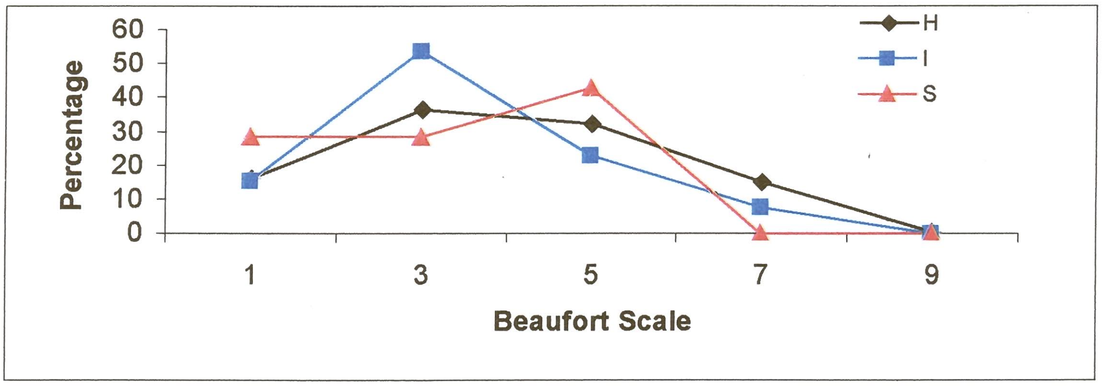

Figure 3.3c

Figure 3.3. Percentage distributions of the number of birds preyed upon by seals during different environmental conditions, as noted during each method of observation. Bird species: **a** – cormorants; **b** – gannets; **c** – penguins. Observation methods: **H** – historical incidentals; **I** – project incidentals; **S** – focal event sampling; **C** – continuous observations.

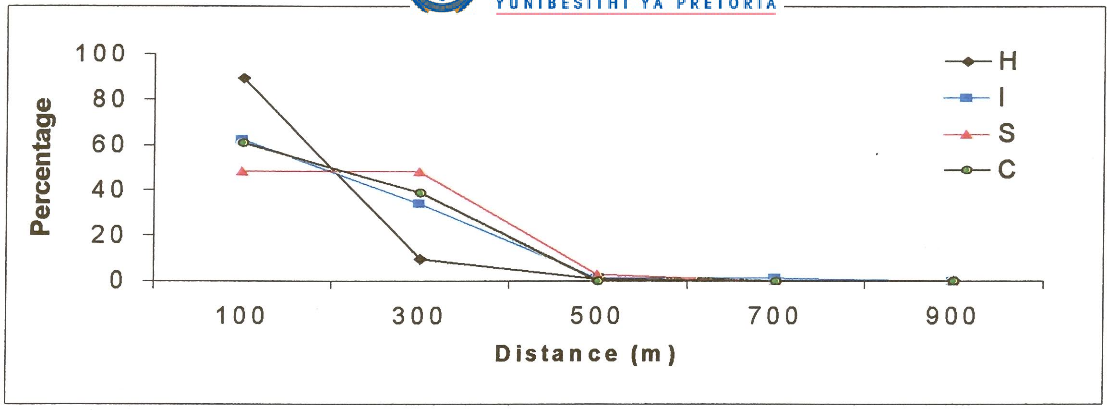

Figure 3.4a

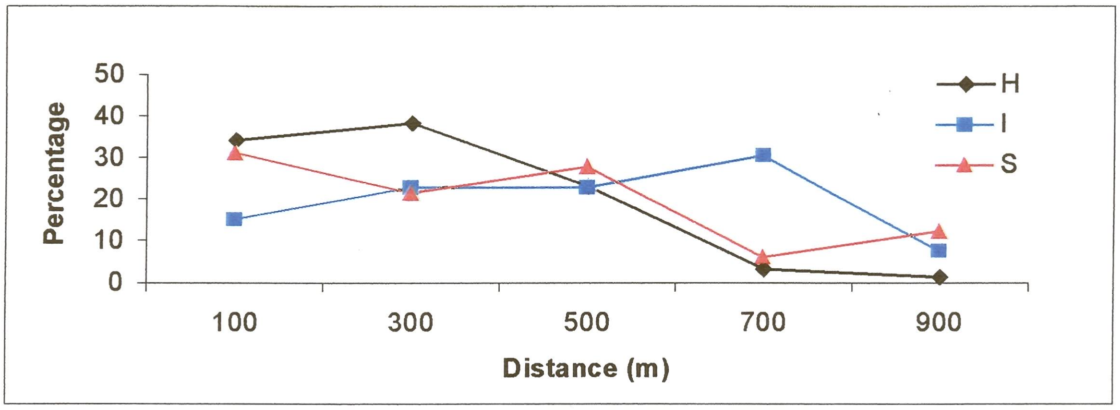

Figure 3.4b

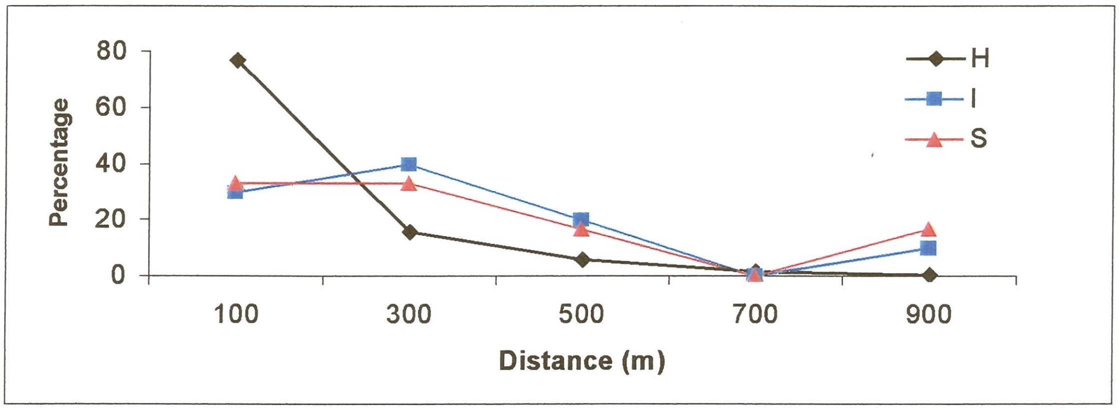

Figure 3.4c

Figure 3.4. Percentage distributions of the number of birds preyed upon by seals at different distances from the island, as noted during each method of observation. Bird species: **a** – cormorants; **b** – gannets; **c** – penguins. Observation methods: **H** – historical incidentals; **I** – project incidentals; **S** – focal event sampling; **C** – continuous observations.

Figure 3.5 is a graphic representation of the spatial distribution of seal-seabird predations around Ichaboe Island, as seen during each method of observation.

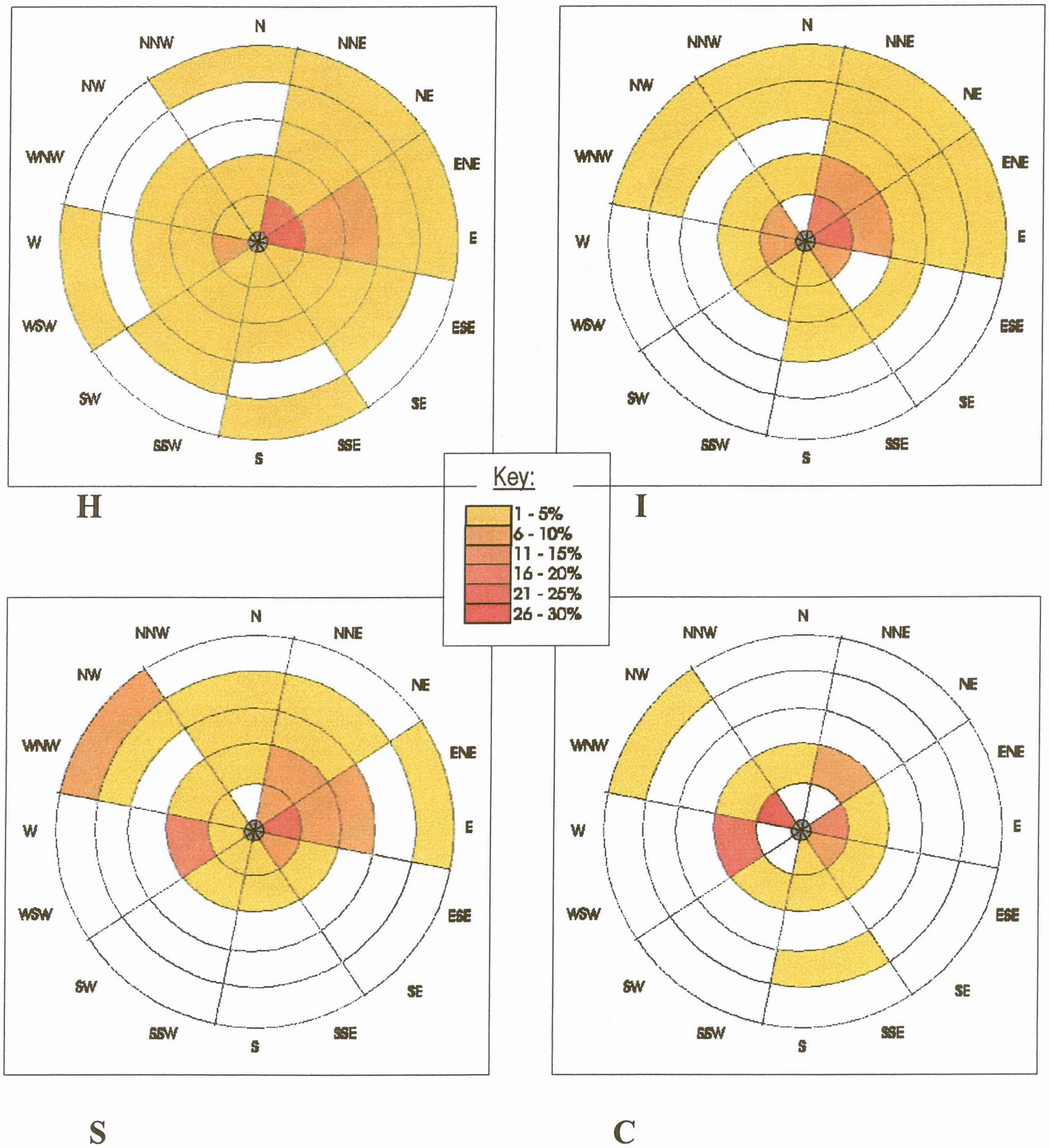

Figure 3.5. Plots of the spatial distribution of the number of predations noted, as a percentage of the total, by each observational method. The dark centre circle in each graph represents the island; the concentric rings represent distances at 200m intervals from the island. Observation methods: **H** – historical incidentals; **I** – project incidentals; **S** – focal event sampling; **C** – continuous observations.

Proportion of predations represented in incidental records

Incidental observations of predation events, when compared with records of events that were recorded systematically, underestimate by up to 36% the number of birds taken by seals in a season (Table 3.2).

Table 3.2. The number of seal-seabird predations noted (N) during incidental observations and missed (M) by this method (but noted during systematic observations) between November 1999 and May 2000 at Ichaboe Island, and the calculated values for PI. Pr – total number of predations noted during this period.

Bird species	N	M	Total (Pr)	PI
Cormorants	136	48	184	0.74
Gannets	32	18	50	0.64
Penguins	16	5	21	0.76

The number of predations for the ten-year period increases from 2989 to 3995, when adjusted for events not recorded during incidental observations (Table 3.3).

Table 3.3. Calculation of the adjusted values of predation for the ten-year period under discussion. TI – sum of all incidental observations excluding project records; PI – proportion of predations represented in incidental records; Pr – predatory events noted between November 1999 and May 2000.

	TI	PI	TI / PI	Pr	(TI/ PI) + Pr = Total
Cormorants	1122	0.74	1518	184	1702
Gannets	975	0.64	1523	50	1573
Penguins	532	0.76	698	21	719

DISCUSSION

Bird species preyed upon

The ratio of bird species preyed upon differs with respect to the method of observation; this may be due to the large annual variation in predatory activity (see Chapter 4). Moreover, if there are individual seals targeting specific prey species, this will further affect the species and numbers of birds preyed upon per annum. Because the methods did not all run concurrently, these cannot be compared adequately. However, regardless of the method of observation, cormorant predations were the most numerous, followed by gannets and then penguins, which reflect the abundance (or availability) of each species on the island (see Chapter 5).

The difference between bird species preyed upon as noted during each method of observation may reflect annual variation. Furthermore, cormorants (especially fledglings) may be taken by seals opportunistically (as opposed to being targeted) more often than the other species; such predation is bound to be variable.

Continuous observations versus focal event sampling

Because all predations within a given time will be noted during continuous observations, it is reliable as a measure of predation rate per hour. In contrast, focal event sampling cannot be used for calculating rates, but rather has value in investigating diurnal, seasonal and environmental influences on predation. In any case, predation rate cannot safely be extrapolated temporally, due to seasonal and annual variation, and the differences between prey species (see Chapter 4).

While the DDU focal event sampling systematically sampled diurnal and seasonal ranges, which other methods of observation lack, it nevertheless misses some predation. This method is complemented by continuous observations, which have poor diurnal or seasonal representation, but which noted all predatory activity during the observation period. A combination of these methods may therefore be best in investigating this behaviour.

Predation cues

Predation cues differ between methods due to the differences in bird species preyed upon as noted during each observational method. The presence of kelp gulls serve to confirm predatory activity, and formed the most important first cue for each method (Figure 3.1). These birds are observant, recognising a potential source of food and competing with other gulls for it. Kelp gulls scavenging bird carcasses that had been preyed upon by seals, alert the observer to these. Therefore, watching kelp gull behaviour may be easier and more reliable than looking for predatory activity (such as an attack or thrashing). Likewise, gannet clouds are an important cue – mostly associated with a gannet predation (see *Predation cues*, Chapter 2) – that contributed over 20% of first cues for each method except continuous observations. This may be due to the small number of gannet predations noted during continuous observations; moreover, cues such as an attack or thrashing would be noticed before a gannet cloud forms. Indeed, these cues (attack and thrashing) were more prevalent during continuous observations. Such cues, of short duration, are more likely to be missed during other methods of observation. Also, no carcasses were noted as a first cue during continuous observations; this is because other predation cues were noted before the seal left the carcass. In contrast, carcasses adrift were important as first cues for incidental observations (both historical and project). Due to the opportunistic nature of these observations, it is likely that predations will be missed, especially if occurring often throughout the day. As a result, it is more convenient and more reliable to count and identify carcasses in the absence of systematic observations. Besides, carcasses of birds that have been preyed upon by seals may remain visible long after the predation (and associated cues) have ended; this cue is therefore more likely to be noticed.

The use of specific cues indicating predatory activity proved valuable in this study. One of the main advantages of such a tool is that the attention of the observer is attracted to predatory activity in a number of ways, increasing the likelihood of recording the behaviour in question.

Diurnal differences

Incidental observations are influenced by observer activity and vigilance, which is not constant diurnally or seasonally, and can therefore not be quantified accordingly. For this reason, it is not in itself adequate to assess temporal variation in the behaviour in question. However, the accuracy and value of this method can be evaluated when compared with systematic methods of observation. Such systematic methods can be repeated over seasons and even applied to similar studies for comparison. However, regular, systematic observations (such as focal event sampling) are not always feasible, in the absence of which opportunistic records are still valuable.

When comparing observational methods in terms of diurnal predation trends for each prey species, the overall pattern corresponds between methods, although there are significant differences. Focal event sampling, for instance, is more reliable in terms of observing predatory events throughout the day, specifically early in the morning, as evidenced by observations on gannet predations (Figure 3.2b). Diurnal variation in gannet predations as observed during project incidentals, may be ascribed to a low sample size (n = 15). Penguin predation occurs mostly late afternoon, as shown by each method. This indicates that even incidental observations may reveal trends; penguin predation at this time of day is related to penguin activity (see Chapter 4). Cormorants were preyed upon throughout the day, though the diurnal distribution differs with each method used. These predations are often of short duration, and may be missed during both incidental and focal event sampling methods. Furthermore, the records with a carcass observed as first cue (which was the case only for incidental observations) were excluded from this analysis. Incidental observations would therefore not necessarily reflect the diurnal pattern of cormorant predations; 63.2% of records with carcass observed as a first cue involved cormorants. This explains the significant difference between methods for cormorant predations.

The most reliable method for assessing diurnal patterns is focal event sampling, with which the results from the other methods are compared. Incidental observations may be able to discern diurnal patterns, as indicated by the lack of any significant difference between methods regarding gannet and penguin predations.

Environmental differences

Trends in predation as recorded during incidental observations may be an artefact of observer activity while not necessarily providing information on seal or bird activity; this may explain the differences between incidental and regular sampling with regard to Beaufort Scale. Since focal event sampling was carried out irrespective of environmental conditions, predations were noted at high wind speeds that may have been missed had the observations been incidental. However, this does not seem to be the case for penguin predations, where incidental observations noted a higher percentage of these predations at high wind speeds than focal event sampling (Figure 3.3c).

Gannet clouds are more likely to form in conditions of strong wind (i.e. high BS), and these highly visible cues are most often associated with a gannet predation (see Chapter 2). For this reason incidental observations at high BS may be biased toward gannet predations, while cormorant and penguin predations are possibly under-represented.

For each method of observation, cormorant predations varied with BS, gannets were preyed upon during all conditions (including high BS), while the majority of penguin predations took place at a BS of less than 7. As with diurnal differences, there was a significant difference between methods regarding cormorant predations, but not for gannets and penguins, indicating that environmental patterns in predation may be adequately sampled during incidental observations, but that the accuracy may vary with bird species.

Spatial differences

Focal event sampling and continuous observations were carried out from an elevated observation point, such that these methods should observe predatory activity further from the island, as well as covering a greater area (343°). Furthermore, cues that are of short duration or not as easily visible will be noted more often and at greater distances during these systematic sampling methods than during incidental observations.

All cormorant predations were noted less than 600 m from the island; this is reflected in each method. Focal event sampling, however, noted a greater proportion of these between 200 m and 400 m than historical incidentals (see Figure 3.4a); this may be due to the reasons outlined above. As expected, gannet predations (which have more visible cues such as gannet clouds) were noted further from the island than cormorant or penguin predations during historical incidentals. Furthermore, this is the case for both focal event sampling and continuous observations, indicating that gannets are indeed taken at greater distances. Project incidental observations observed a greater percentage of gannet predations further than 600 m than the other methods; this may be ascribed to a small sample size (n = 15). As for penguin predations, focal event sampling and project incidentals have similar percentage distributions (see Figure 3.4c); however, both these had low sample sizes (see Table 3.1). The historical incidental observations of penguin predations may therefore be a more accurate representation of the distance from the island that these birds are preyed upon by seals than the data obtained from systematic observations.

The glare of the sun on the water in the morning or late afternoon may have made identification of prey difficult, or even caused predatory events not to be noticed. However, this is believed to have been a problem only during incidental observations, as polarised eyewear was used during the systematic observations, alleviating the glare and enabling observations.

The paucity of observations further than 400 m and to the southern side (west through south-south-east) of the island during project incidentals, focal event sampling and continuous observations when compared with historical incidentals (see Figure 3.5), may be as a result of seasonal differences in the spatial distribution of predation (see Chapter 4). The majority of predations noted incidentally (this term refers to both historical and project incidentals) were recorded in the north-eastern and eastern sectors, which are easily visible from the settlement, where the observer would be spending the most time. Focal event sampling and continuous observations also recorded larger percentages of predation in these sectors, so this is not simply an artefact of incidental observations. Using these methods, however, a concentration of predation was noted in the western sector (west and west south west) between 200 m and 400 m offshore. This is the same sector where the seal colony is situated (see Figure 1.2); predations in this area are therefore under-represented in incidental observations.

The significant differences between methods concerning the distances that predation was noted from the island for each prey species suggest that the method of observation (especially incidental observations) may have introduced bias in these results.

Evaluation of incidental observations

The comparison of incidental observations with systematic observations of seal-seabird predation has highlighted possible sources of bias in the former. These concern diurnal, environmental and spatial biases that differ per prey species. Despite these, incidental observations may reveal trends in predation that are biologically significant. The value of the historical incidental observations in this study is increased as a result of these having been carried out by the same observer over a long period of time (eight years); short-term incidental observations by different observers might not have revealed biologically significant trends.

The quantification of the proportion of predatory events that are represented in incidental records allows for more realistic values of predation to be calculated for the period when observations were incidental. Though this has revealed that up to a third of predations may be missed during this method, it is nevertheless recommended that incidental observations be carried out in the absence of systematic observations, provided detailed records are kept, because every individual record is valuable in investigating this behaviour.