Identification of predators of Royal Albatross chicks at Taiaroa Head in February 1994

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CONTENTS

Executive Summary

INVESTIGATION OVERVIEW:

Four Albatross chicks that died at Taiaroa Head between 12 and 20 February 1994 were examined for sign of predation. Distributions of intercanine distances of stoats *(Mustela erminea),* ferrets *(M. furo)* and feral cats *(Felis catus)* were measured. Distances between puncture holes on chicks (identified from the underside of the skin) were then matched with these predator tooth measurements in order to identify the predator responsible.

CONCLUSIONS AND RECOMMENDATIONS:

Analysis of clusters of these puncture holes is confused by bites overlying one another, so only outlying pairs (>21 mm from the nearest neighbours or large flesh wounds) can be used. Matching of parallel rips on the bill of chicks also allowed better discrimination of potential predators.

Sign left is consistent with a stoat (or stoats) having killed all four Albatross chicks at Taiaroa Head in February 1994. Two chicks were very likely killed by a stoat, while it is possible, but unlikely, that a ferret killed or scavenged the two other chicks. Circumstantial evidence is entirely consistent with the culprit being the male stoat trapped on 27 February 1994, but this is not proven.

Identification of the predators responsible was made more difficult by:

(i) loss of a hair from the bill of a killed chick;

(ii) only having the head of one of the chicks (the remaining parts of the carcase was used for baiting traps);

(iii) the fly-blown and decayed nature of the chicks;

(iv) the crowded and overlaid nature of most bite marks.

Future predation events are likely to occur.

We recommend that:

(1) a careful search of the site is made to secure predator hair samples (it is clear that a chick fought back and plucked a hair from its attacker);

(2) the carcase is immediately retrieved and chilled or frozen;

(3) the whole carcase is retrieved;

(4) photographs are taken of dead chicks in their original position and/or any other features that appear to be part of the predation events;

(5) a computer model is now developed to compare observed bite mark distributions against those expected for when a stoat, ferret or cat has inflicted the wounds;

(6) a more detailed research project is commissioned (involving filming of the biting behaviour of the predators) to test the assumptions made in identification of predators from sign.

Our trialing of different methods leads to our recommending the following interim protocols to identify predators (until the more detailed research recommended above is available) by chick necropsy:

(a) skin the chicks and identify and map all puncture wounds by viewing from the underside of the skin;

(b) identify any "outlying" pairs of puncture holes as those >21 mm from their nearest neighbours or gaping wounds (which might otherwise have obscured or removed the evidence of a puncture hole). Consult Table 3 for each such outlying pair to determine the most likely predator responsible (as done in Table 6 for this study).

(c) Compare all matchings of parallel marks on the bill between 4 mm (the smallest stoat intercanine distance) and 21 mm (the largest cat intercanine distance) with the likely culprit (as in Table 5).

1. Introduction

Four of 10 Royal Albatross *(Diomedea epomophora)* chicks present at Taiaroa Head Nature Reserve, Otago Peninsula were killed by predators in February 1994. Trapping was immediately intensified to stop the predation in the reserve following the first deaths (McKinlay 1994). A stoat was caught 15 days after the start of predation. Could this have been the predator responsible?

The recent experience at Taiaroa Head highlighted the need to develop the best possible diagnostic clues from the chick carcases to identify the predator responsible for killing them. If such diagnostic clues exist, they would help target the predators killing other wildlife species around the country, and therefore assist the quest for better targeted, more efficient, and cheaper predator control. Such a method would also have assisted a decision in the present emergency about when to discontinue intensive trapping and predator shooting efforts that were expensive and disruptive of normal work routines.

The three mammalian predators that are present on the Otago Peninsula are stoats *(Mustela erminea),* ferrets *(M. furo)* and feral cats *(Felis catus)* (Ratz *et al.* 1992, Fechney *et al.* 1993). The intensive killtrapping within the reserve yielded one male stoat on 27 February, one female ferret on 3 March and one male stoat on 6 March during the present emergency (McKinlay 1994).

2. Aims

The Science and Research Division, Department of Conservation requested us to

1. determine the predator species that killed four Royal Albatross chicks from Taiaroa Head;

2. describe the evidence and method used to determine the predator responsible;

3. evaluated the evidence, if any, that the individual stoat trapped at Taiaroa Head on 27 February was or was not the predator responsible for killing the chicks.

3. Methods

3.1. INVESTIGATION OF BITE MARKS

Carcases of the four chick found dead between 12 and 20 February 1994 were first examined whole and markings on the bill and on the body were recorded. All four were skinned. Skins were sketched to show holes and wounds, and the positions of puncture holes was mapped by viewing from the underside of the skin.

The markings on the bill of the chick were analysed separately in two ways because the marks were very distinct and distances easily measured. Distances between all possible pairings of holes were measured on either side of the bill, and then across the length of the bill. Photographs were taken of both sides of the bills and from above. Parallel rip marks were highlighted on a copy of these photographs to demonstrate that they potentially belong together.

Electronic callipers were used to measure all possible distances between the puncture holes in the body of the chick that were at least 4 mm apart (the minimum intercanine distance for stoats) and up to 21 mm apart (the maximum intercanine distance for cats). No distinction was made between the upper and lower jaw intercanine distances because the holes made by each jaw are impossible to distinguish on the carcass.

The puncture holes on the body that lie beyond 21 mm (the greatest intercanine distance of cats, the biggest predator) from the nearest cluster were sometimes in pairs. These pairs were assumed to belong together as there were no other holes close by and have been called "outliers".

3.2. PREDATOR DENTITION MEASURES

Intercanine distances for each predator species were measured from skulls held in the Zoology Department, University of Otago. These animals were collected from throughout the Otago region by the predator/prey research team investigating protection of hoiho *(Megadyptes antipodes)* and for mitigation of bovine tuberculosis in farm stock. There are no published data on growth of the inter-canine distances, so we can not directly filter out young animals from their teeth measurements. Accordingly we have indirectly filtered them by not measuring teeth of individuals that had been caught during the time of dispersal of independent young of the year up until the predation outbreak studied here. The first predation event occurred at Taiaroa Head on 12 February. Accordingly, stoats caught between mid January and 12 February were excluded and ferrets caught between mid December and 12 February were excluded (King 1990). All cats were included because young can be found throughout the year (King 1990).

3.3. COMPARISONS OF MEASUREMENTS ON CHICKS AND PREDATORS

Means, standard deviations and ranges of the measurements of the predator intercanine distances were calculated to compare with distances measured between puncture holes in the skin of chicks. Each distance between all potential pairs of holes was assigned a likelihood of belonging to the normal distribution of intercanine distance for a cat, ferret or stoat (Appendix 1). The species with the highest probability was given a score of 1, and the other two species were assigned a zero. Scores for all potential pairing of bites were summed and converted into percentages. This gives a probability of a series of pairs of puncture holes to be attributed to each predator species.

4. Results

4.1. ALBATROSS CHICK NECROPSIES

CHICK 1:

Date of death: 12.2.1994

Identification: L/B/T; under WBG

Weight before necropsy: 316g

Condition: The chick was fly-blown. Both eyes were gone and the left eyesocket was brown. The right eye socket and surrounding tissue was eaten away. A big bruise was found halfway down the neck. Several puncture holes were identified around the eyes and on the neck and throat.

A wound by the right wing was surrounded by puncture holes and a further two puncture holes were found by the left shoulder blade. A wound was found on the ventral side of the body by the left leg and another one on the dorsal side near the right leg. The whole body was skinned and a large number of puncture holes were found.

CHICK 2:

Date of death: 20.2.1994

Identification: unknown

Condition: This chick was the last one killed. The body was used as bait during the trapping and therefore no information was collected on the weight, wounds and general condition of the body. However, puncture on the head and marks on the bill were examined.

CHICK 3:

Date of death: 18.2.1994

Identification: BO- WBY, Garage-flat

Condition: The body of the chick was fly-blown. The skull was smashed and half eaten. The bill had marks on it and the back of the head, below the left eye and the throat had puncture wounds. There was a large wound by the right shoulder blade, bruising on the back-bone there, and a general loss of feathers in this area. Four puncture wounds were found during preliminary examination.

When the chick was discovered, it had a single hair in its bill. This hair was later described as gold with a black tip. Unfortunately this evidence blew away in the wind when it was removed from the bill (P. Lyver, pers. comm.).

CHICK 4:

Date of death: 19.2.1994

Identification: Rob's patch

Condition: When the chick was discovered dead, the adult was near the nest and had blood on its breast feathers. The chick lay in the nest, with its head stretched out of the nest. Regurgitations were found and were thought to have originated from the chick. The ventral side of the bird was red with blood, as was the nest.

This chick was the largest of the four. The bill of the chick had obvious marks on and the neck had been chewed leaving a large wound with clear puncture holes. Puncture holes were particularly numerous on the head. Internal bleeding was extensive.

4.2. ANALYSIS OF INTERCANINE DISTANCES

Intercanine distances of the three predator species were on average about 31.1% greater for upper jaws than lower jaws, and on average 23.4% greater for males cf females of the same species (Fig. 1). The presence of many comparatively short intercanine distances of young cats means that it will effectively be impossible to categorically separate cat from ferret bite marks using intercanine distances (Fig. 2, Table 1 and 2).

If bites from upper and lower canines are equally represented by holes on the carcasses, 10% of stoat bites will be indistinguishable from those of ferrets; 70% of cat bites will be indistinguishable from ferrets; and 16% and 98% ferret bites cannot be distinguished from stoats or cats respectively (Table 2).

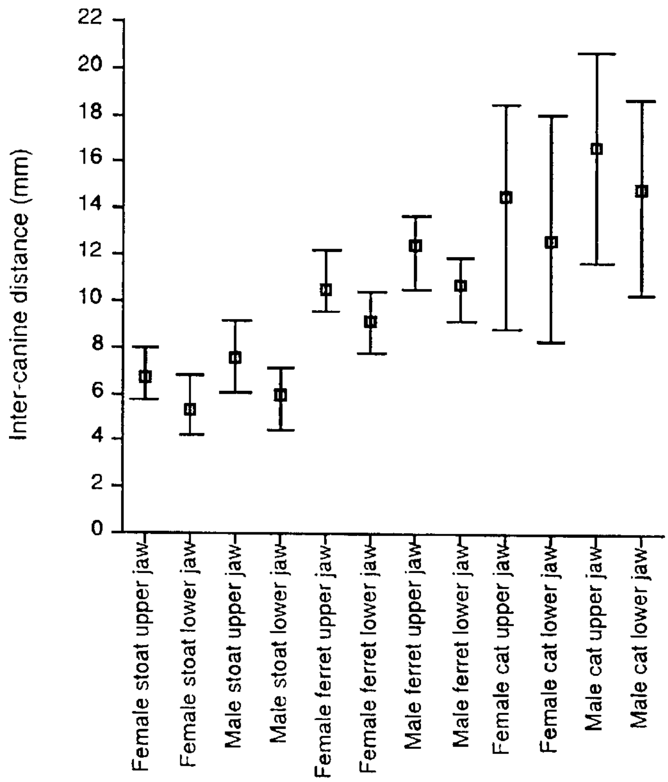

Fig. 1: The mean and range of intercanine distances of upper and lower jaws of male and female stoats, ferrets and cats.

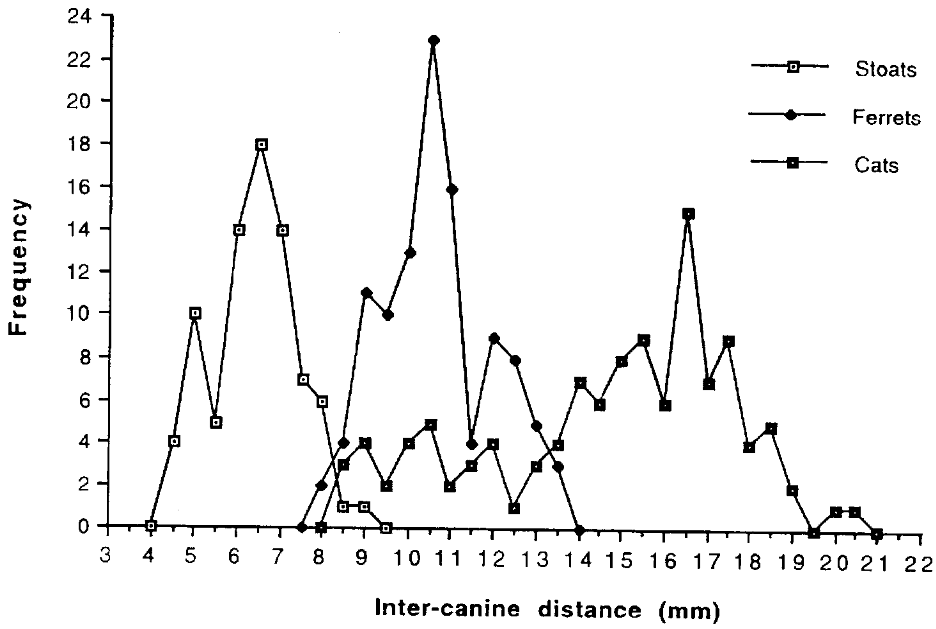

Fig 2: Frequency distribution of intercanine distances of stoats, ferrets and cats (sexes and upper/lower jaws combined)

These data were used to calculate the probability that an observed bite distance was made by a stoat, ferret or cat by (i) converting the frequency distributions of intercanine distances in Fig. 2 to proportions (to allow for differing numbers of each predator sampled), (ii) summing the proportions for each interval of inter-canine distance, and (iii) calculating the proportion of the sum calculated in (ii) above that was made up of stoat, ferret or cat (Table 3).

These proportions will estimate the probability that the bite was made by each species provided (a) all sizes of each predator are equally likely to have bitten the chicks, and (b) our estimated inter-canine distance frequencies represent those present in the population. This latter assumption is dependant on all sizes of a species being about equally trappable.

Table 1: Intercanine distances of the three predator species. Upper and lower jaws are combined. A mixture of ages of animals is included (see text for selection criteria).

	n	Mean (mm)	Standard deviation	Range
Stoat	80	6.43	1.026	4.35 - 9.04
Ferret	108	10.69	1.318	7.83 - 13.63
Cat	116	14.69	2.910	8.29 - 20.64

Table 2: The overlap of intercanine distances of the three predator species (sexes and upper/lower jaws are combined). For example 10% of stoats have intercanine distances that overlap with those of ferrets.

	% overlap with other predators		
Predator	**Stoat**	**Ferret**	**Cat**
Stoat	x	10%	2.5%
Ferret	16%	x	98%
Cat	6%	70%	x

4.3. ANALYSIS OF BITES ON THE BILL

4.3.1. Measurements of all possible distances between markings on the bill.

Only three of the four dead chicks showed markings on the bill. The appendices and Table 4 have the details of the measurements and analysis.

The majority of the marks on the bill of chick no. 2 matched cat distances, thus making a cat the more likely source of these marks (Table 4). 40.6% of the marks on the bill of chick no. 3 matched stoat distances but marks on the bill of chick no. 4 matched stoat and ferret distances equally well.

These scores in themselves have little discriminating power, and any of the three predators could have inflicted the bites.

4.3.2. Measurements between parallel rip marks on the bill.

When only parallel rips were matched (Table 5) a more consistent indication of potential predators responsible in the three chicks with bill marks was obtained.

Table 3: The probability that an outlying bite mark of a given intercanine distance was inflicted by a stoat, ferret or cat.

Distance (mm)	Likelihood stoat	Likelihood ferret	Likelihood cat
4.5	1	0	0
5	1	0	0
5.5	1	0	0
6	1	0	0
6.5	1	0	0
7	1	0	0
7.5	1	0	0
8	0.802	0.198	0
8.5	0.165	0.490	0.345
9	0.084	0.683	0.233
9.5	0	0.842	0.158
10	0	0.776	0.224
10.5	0	0.830	0.170
11	0	0.895	0.105
11.5	0	0.587	0.413
12	0	0.706	0.294
12.5	0	0.895	0.105
13	0	0.640	0.360
13.5	0	0.444	0.556
14	0	0	1
14.5	0	0	1
15	0	0	1
15.5	0	0	1
16	0	0	1
16.5	0	0	1
17	0	0	1
17.5	0	0	1
18	0	0	1
18.5	0	0	1
19	0	0	1
19.5	0	0	1
20	0	0	1
20.5	0	0	1
21	0	0	1

The majority had a distance that matches the intercanine distance of stoats. Only a few could be attributed to ferrets or cats. None of the pairings for chick no. 4 were made by cats (Table 5).

Table 4: Scores of predator responsible from all possible pairing of distances between bite marks on the bill. Likelihood scores assume a normal distribution (see Appendix 1).

Chick 2:

		Number of puncture pairs matching		
	n *	**Stoat**	**Ferret**	**Cat**
Left side	81	28	23	30
Right side	46	13	8	25
Cross-over	121	26	45	50
Total	**248**	**67**	**76**	**105**
Overall proportion		27.0%	30.7%	42.3%

Chick 3:

		Number of puncture pairs matching		
	n *	**Stoat**	**Ferret**	**Cat**
Left side	17	9	3	5
Right side	28	11	10	7
Cross-over	46	17	17	12
Total	**91**	**37**	**30**	**24**
Overall proportion		40.6%	33.0%	26.4%

Chick 4:

		Number of puncture pairs matching		
	n *	**Stoat**	**Ferret**	**Cat**
Left side	17	14	3	0
Right side	13	8	5	0
Cross-over	42	11	25	6
Total	**72**	**33**	**33**	**6**
Overall proportion		45.8%	45.8%	8.4%

* n is the number of distances measured between all possible pairings of marks on the bill.

Table 5: Scores of predator responsible from all possible pairing of parallel rip marks on the bill. Likelihood scores assume a normal distribution (see Appendix 1).

Chick 2:				
		Number of parallel rip marks matching:		
	n *	**Stoat**	**Ferret**	**Cat**
Left side	7	5	2	0
Right side	7	5		
Cross-over	1	0	1	0
Total	**15**	**10**	**4**	
Overall proportion		66.7%	26.7%	10.6%

Chick 3:				
		Number of parallel rip marks matching:		
	n *	**Stoat**	**Ferret**	**Cat**
Left side	4	3	1	0
Right side	7	5	0	2
Cross-over	3	2	0	
Total	**14**	**10**	**1**	**3**
Overall proportion		71.4%	7.1%	21.5%

Chick 4:				
		Number of parallel rip marks matching:		
	n *	**Stoat**	**Ferret**	**Cat**
Left side	7	4	3	0
Right side	7	4	3	0
Cross-over	7	7	0	0
Total	**21**	**15**	**6**	**0**
Overall proportion		71.4%	28.6%	0%

* n is the number of distances measured between all possible pairings of parallel rip marks.

4.4. PUNCTURE HOLES ON THE BODY

The puncture holes on the body that lie beyond 21 mm from the nearest cluster were often in pairs termed "outliers". More detail about the position of these measurements and holes on the body of the albatross chicks is presented in Appendices 2 to 5. Two outliers were found on the two chicks. Both could definitely be matched with the intercanine distance of a stoat (Table 6).

Large clusters of bite marks on the body have been mapped (see appendices), but are largely uninterpretable because bites overlie one another.

Table 6: Summary of the distances between outlying pairs of puncture holes on Albatross chicks and their match to inter-canine distances of predators (from Table 1). Probabilities for each predator are taken from Table 3.

Chick no.	No. of outlying pairs	Code*	Position	Distance apart (mm)	Probability for each predator Stoat	Ferret	Cat
1	1	SR	body	6.06	1.00	0	0
3	1	no map	neck	5.39	1.00	0	0

* for the code of the outliers refer to Appendices 2 - 5. The neck of chick 3 was not mapped but these two outlier puncture holes were the only ones found in the region.

5. Discussion

5.1. SIGNS LEFT ON THE BODY

In addition to chew marks, flesh had also been removed from areas of chicks where they were fly-blown. The combination of these two factors made any analysis of the carcases very difficult. Puncture holes could only be found where the skin had been left intact and the carcases had not reached an advanced stage of decay. More rapid recovery and immediate freezing of the carcass is recommended would make the necropsy work easier, and the evidence of predation clearer.

Simple comparison of distances between all puncture holes will be biased toward cat intercanine distances. If all possible measurements are taken of all pairings of holes up to 21 mm spacings, then by chance alone there would be disproportionately more measurements of the longer distances that match cats. A coefficient would need to correct for such a bias. Attempts to calculate such a coefficient by computer simulation were made by Dr David Fletcher (Mathematics and Statistics Dept., University of Otago) for this contract analysis. However, computational time increased geometrically with increased number of puncture holes present so continuing with this first approach proved unworkable.

A subsequent model and analysis should now be developed where observed and expected "nearest neighbour distances" between puncture holes will be used to see if the predators responsible can be distinguished. Such a computer model could determine the expected distribution of nearest neighbour distances by simulating the bite positions of a notional stoat, ferret or cat. We recommend that DoC commissions the preparation of such a model because it has potential to assist several mainland bird conservation projects as well as further Taiaroa Head predator control efforts. The main advantage of such a method is that it potentially can determine the "signature" of the predator even when most of the bites overlie one another. In this, and other cases, few outliers will be available.

In the absence of the more detailed method, analysis of the puncture holes has been restricted to the marks on the bill and outliers from clusters of puncture holes on the body. The more certain pairing of such marks makes them more reliable as potential signatures of predator identity.

5.2. EVIDENCE OF PREDATORS INVOLVED

The analysis of parallel marks on the bill (Table 5) provided the least confused interpretation because the bill was less affected by decomposition and the marks were clearer than on the body. No inferences whatever should be taken from Table 4 because of the crowded nature of the bill marks, the bias referred to above and the lack of information used by matching parallel marks. However, even using parallel marks of the bill may be difficult to interpret because the bill is a very narrow structure and the orientation of the predator head as it bit is unknown. The parallel bill marks suggest that stoats were the most likely culprits, and in one case it is virtually certain that it was not a cat (Table 5).

Chicks 1 and 3 were the only chicks with outliers and all of them would have been inflicted by stoats alone (Table 6). This evidence suggests that a stoat or stoats killed these two chicks. No other predators are even potentially implicated. Evidence for the chicks 2 and 4 is less conclusive. It is possible that any of the three species was involved, but most likely that it was one or more stoats.

The observed pattern of a sudden predation outbreak followed by ongoing losses of chicks on consecutive nights is quite typical of the pattern of predation of hoiho chicks lost to stoats in the Catlins (Ratz *et al.* 1992), and for hoiho chick losses on Otago Peninsula (J.T. Darby, pers. comm in Ratz *et al.* 1992). It is likely that an individual (sometimes termed "rogue") predator "locks onto" the chicks as targets after having killed its first one. If so, all the albatross chicks killed at Taiaroa Head during this emergency are most likely to have been killed by the same predator. This further suggests that a stoat was responsible for killing chicks 2 and 4, as well as the two (chicks 1 and 3) for which there is unequivocal evidence that stoats were the culprits.

One of the nests where a chick was killed had clear sign of a tunnel through long grass reaching the edge of the nest (H. Moller, pers. obs.). This sign could not have been left by a cat. Stoats move throughout long-grass areas, whereas ferrets tend to be restricted more to tracks through it (H. Ratz, unpubl. obs.). A single long hair was seen briefly by Phil Lyver (pers. comm.) in the bill of a dead chick and described as "gold with a black tip". Unfortunately it blew out of his fingers as it was being retrieved. At the time it was inferred that it was most likely to have come from a ferret (they have long coarse guard hairs with black ends over much of their body). However, it is also possible that it was a hair plucked out of the black tail tip of a stoat. The detailed analysis of the bites presented here suggests that the latter interpretation is the most likely.

5.3. WAS THE STOAT TRAPPED RESPONSIBLE?

A stoat trapped on 27 February 1994 had very uneven wear on its teeth. One canine on the upper jaw was only about 2/3 of the usual length. However, the fleshy (and in some cases decayed) nature of the chicks made it impossible to determine whether bite holes were uneven in length.

Only circumstantial evidence implicated this particular stoat because no further chick losses occurred after it had been killed, and no other stoats were trapped before then in the reserve area. However this does not prove this stoat to be the one that killed the Albatross chicks.

6. Conclusions and Recommendations

All the sign left is consistent with a stoat or stoats having killed four Albatross chicks at Taiaroa Head in February 1994. Two chicks were very likely killed by a stoat, while it is possible but unlikely that a ferret killed or scavenged the two other chicks, or that a cat scavenged one of them. The simplest and most likely interpretation is that a stoat or stoats killed and ate all the chicks.

Circumstantial evidence is entirely consistent with the culprit being the male stoat trapped on 27 February 1994, but this is not proven.

Identification of the predators responsible was made more difficult by:

(i) loss of a hair from the bill of a killed chick;

(ii) only having the head of one of the chicks (the remaining parts of the carcase was used for baiting traps);

(iii) the fly-blown and decayed nature of the chicks;

(iv) the crowded and overlaid nature of most bite marks.

Future predation events are likely to occur. We recommend that:

(1) a careful search of the site is made to secure predator hair samples (it is clear that a chick fought back and plucked a hair from its attacker);

(2) the carcase is immediately retrieved and chilled or frozen;

(3) the whole carcase is retrieved;

(4) photographs are taken of dead chicks in their original position and/or any other features that appear to be part of the events for future reference;

(5) a computer model is now developed to compare observed bite mark distributions against those expected for when a stoat, ferret or cat has inflicted the wounds;

(6) a more detailed research project is commissioned (involving filming of the biting behaviour of the predators) to test the assumptions made in identification of predators from sign.

Our trialing of different methods leads to our recommending the following interim protocols to identify predators (until the more detailed research recommended above is available) by chick necropsy:

(a) skin the chicks and identify and map all puncture wounds by viewing from the underside of the skin;

(b) identify any "outlying" pairs of puncture holes as those >21 mm from their nearest neighbours or gaping wounds (which might otherwise have obscured or removed a puncture hole). Consult Table 3 for each such outlying pair to determine the most likely predator responsible (as done in Table 6 for this study).

(c) Compare all matchings of parallel marks on the bill between 4 mm (the smallest stoat intercanine distance) and 21 mm (the largest cat intercanine distance) with the likely culprit (as in Table 5).

7. Acknowledgements

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Appendix 1:
Likelihood that spacings between puncture wounds were made by a stoat, ferret or cat. This assumes a normal distribution of inter-canine distances. The scores form the basis of Table 4 and 5.

Distance (mm)	Likelihood stoat (from normal distr.)	Likelihood ferret (from) normal distr.)	Likelihood cat (from) normal distr.)	score for stoats	score for ferrets	score for cats
4.0	0.015	0.000	0.000	1	0	0
4.1	0.020	0.000	0.000	1	0	0
4.2	0.025	0.000	0.000	1	0	0
4.3	0.032	0.000	0.000	1	0	0
4.4	0.040	0.000	0.000	1	0	0
4.5	0.050	0.000	0.000	1	0	0
4.6	0.061	0.000	0.000	1	0	0
4.7	0.074	0.000	0.000	1	0	0
4.8	0.089	0.000	0.001	1	0	0
4.9	0.106	0.000	0.001	1	0	0
5.0	0.124	0.000	0.001	1	0	0
5.1	0.145	0.000	0.001	1	0	0
5.2	0.167	0.000	0.001	1	0	0
5.3	0.190	0.000	0.001	1	0	0
5.4	0.214	0.000	0.001	1	0	0
5.5	0.239	0.000	0.001	1	0	0
5.6	0.265	0.000	0.001	1	0	0
5.7	0.289	0.000	0.001	1	0	0
5.8	0.313	0.000	0.002	1	0	0
5.9	0.335	0.000	0.002	1	0	0
6.0	0.356	0.000	0.002	1	0	0
6.1	0.373	0.000	0.002	1	0	0
6.2	0.387	0.001	0.002	1	0	0
6.3	0.398	0.001	0.003	1	0	0
6.4	0.405	0.001	0.003	1	0	0
6.5	0.407	0.001	0.003	1	0	0
6.6	0.405	0.002	0.003	1	0	0
6.7	0.400	0.002	0.004	1	0	0
6.8	0.390	0.003	0.004	1	0	0
6.9	0.376	0.004	0.004	1	0	0
7.0	0.359	0.004	0.005	1	0	0
7.1	0.340	0.006	0.005	1	0	0
7.2	0.318	0.007	0.006	1	0	0
7.3	0.294	0.008	0.006	1	0	0
7.4	0.270	0.010	0.007	1	0	0
7.5	0.244	0.013	0.007	1	0	0
7.6	0.219	0.015	0.008	1	0	0
7.7	0.195	0.019	0.009	1	0	0

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