Trail-camera monitoring of White-capped Albatross (*Thalassarche steadi*) on Disappointment Island: 2018, 2022 and 2023 breeding seasons

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Cover photo: Nesting White-capped Albatrosses above Castaway Bay, Disappointment Island, 14 February 2023, Trail Camera D3 (*Photo credit : Graeme Elliott /Kath Walker*)

Summary

- This report details the findings of an analysis of images from a series of trail cameras put out to monitor fledgling survival and aspects of nesting phenology of White-capped Albatross *Thalassarche steadi* breeding above Castaways Bay on Disappointment Island (Auckland Island archipelago). The cameras were put out in mid-January 2018 (three sites and six cameras), mid-February 2022 (10 sites and cameras) and mid-February 2023 (the same 10 sites but with differing viewpoints). In all cases, the cameras were expected to run for up to a year but most failed before that, either outright from the start, or later through marked shifts in their fields of view, including falling over, or because of battery failure.
- The proportion of chicks that fledged, as a percentage of the number observed initially from the post-hatch stage onwards was 25%–30% in the 2018 breeding season and 47%–53% in 2022, the variation depending on assumptions made about the fate of late-stage chicks present when the cameras monitoring them failed. None of the cameras functioned for long enough to estimate survival for 2023. The maximum it could have been was 68%, based on the number of chicks still alive when the cameras began failing between early March and early June.
- Fledging occurred over a 47-day period in 2018 (mean fledging date: 3/08/2018, N = 5) and a 39-day period in 2022 (mean fledging date: 30/07/2022, N = 21). Of those pairs that were successful in 2022, and which were seen back at the colony at the start of the 2023 season, 71%–78% did not renest that season.
- The fledging period, from hatching to fledging, was reasonably accurately determined in one chick to be 166 days, 31% longer than in the similar-sized Shy Albatross *Thalassarche cauta* in Australia. The brood-guard stage for this chick lasted ca. 20–23 days. The estimated post-guard stage across all fledglings was 156 ± 10 days (range 143–179 days, N = 26).
- Observed deaths or disappearances of monitored chicks was 42% in 2018, 4% in 2022, and 26% in 2023. There are large uncertainties in these and other figures because of camera failures, differences in start dates, and the difficulty of seeing precisely what was happening at nests obscured by vegetation. In all but two occasions, both involving the late loss of a chick, adults continued to visit the nests intermittently, on average being recorded on 29% of days up to six weeks later.
- Several recommendations are made, the key ones being
  - the need to review set-up protocols if objectives change
  - the necessity of having more complete metadata about each site, including which nests, active or not, are present in the camera's field of view
  - orienting cameras to look down on occupied nests, rather than facing upwards
  - the merit of photographing each site separately, from the same position and height as the trail camera at that site, and,
  - ensuring that if cameras are changed midway through the season, their replacements cover the same field of view.

Introduction

The White-capped Albatross *Thalassarche steadi* is an endemic New Zealand species that nests almost exclusively on the Auckland Islands, mainly on Disappointment Island, where >94 % of the global population breeds. Although subject to regular population monitoring, mostly through aerial photographic surveys (see Baker *et al*. 2023 for a synopsis), the species' breeding biology and phenology are poorly known. Even basic details such as the degree of synchrony in egg-laying, the durations of the incubation and nestling periods, or nesting success are either uncertain or unknown (Sagar 2013). It is considered to be a facultative biennial breeder, with 48%–67% of successful pairs apparently not breeding the following year (Thompson *et al*., 2009), a factor that complicates using annual breeding numbers to estimate the whole breeding population.

White-capped Albatross is classed by the New Zealand Department of Conservation as At Risk–Declining (Robertson *et al.* 2021). It is the most frequently recorded albatross species taken as bycatch by commercial fisheries in New Zealand's Exclusive Economic Zone, with an estimated >2,000 individuals being caught each year (Edwards *et al* 2023). Globally, direct and cryptic mortality may account for many as 6,850–7,050 birds annually (Baker *et al*. 2007). Most of this mortality is additive to natural causes of death. With such levels of additional mortality, therefore, it is imperative to establish not only the overall size and trend of the breeding population, but also its productivity, how it varies across breeding seasons, and what factors may be causing the variations.

To this end, therefore, a series of trail cameras, each intended to run for a year, were set up at White-capped Albatross nests on Disappointment Island to monitor nest survival and provide measures of productivity over successive years (Rexer-Huber et al. 2018, 2019, Parker et al. 2022, Elliott *et al*. 2023). Six cameras were set up in pairs in mid-January 2018 (the cameras in each pair had slightly different fields of view and together covered 26 unique, active nests). Two cameras, from different pairs, failed 10–11 weeks after deployment, before any chicks had fledged. The remaining four cameras covered 17 nests, from which five chicks fledged, a success rate of 29% (Rexer-Huber et al. 2019). Overall nesting success is likely to have been even lower because failures during incubation would not have been recorded. Because of this probably anomalously low success rate, ten cameras were set up in mid-February 2022 to monitor a larger sample of active nests (61). From eight of these cameras 22 chicks clearly fledged from 33 nests still visible through to mid-August 2022, three others most likely fledged, and six nests failed; the fate of the other two nests was not reported. This gave a chick survival rate from hatching to fledging of 66–76 % (Elliott et al. 2023). Again, overall nesting success would almost certainly have been lower because nest monitoring only started late in the incubation/early hatching period.

These initial results provided widely different measures of fledging success, perhaps not representative of the larger White-capped Albatross population or for those seasons (see discussions in Rexer-Huber *et al*. 2019; Elliott *et al*. 2023). But there are also some finer details, such as the timing and causes of failure, the patterns of attendance by adults at both active and inactive nests (including ones that have recently failed), and the relationship between breeding success (or failure) in one season and whether the birds return to breed the next, that might be extractable from an in-depth analysis of the imagery. Accordingly, the present study set out to re-examine the imagery and answer some additional questions.

1. What is the pattern of daily attendance at active nests and how does it change through the chick-rearing period?
2. Is it possible to determine the causes of breeding failure, if only broadly?
3. What is the fate of dead chicks? Are they scavenged and by what species?
4. Assuming that pairs return to the same nest site the following season, what proportion of pairs that successfully fledged a chick the previous season then re-nest? What proportion renest following failure?
5. If a previously successful pair re-occupy their nest but do not breed the following season (always assuming that it is the same pair, or at least one bird is), for how long into the breeding season do they continue to occupy that site?
6. For how long do members of a breeding pair continue to attend a nest (if at all) after it has failed? Does this vary with the time of the failure in the nesting cycle? What is the pattern of that attendance?
7. How long, and with what pattern of attendance, do birds occupying an empty nest continue to attend that nest (remembering that some of these nests may have failed before the cameras were set up and started in Jan 2018, Feb 2022 and Feb 2023)
8. How long is the transition period between the end of brood-guard stage, when a chick is left alone for the first time, often only an hour or two, and the post-guard stage proper, taken to be the day when the chick is left alone for a whole day or more?

By convention, the breeding seasons of species such as the White-capped Albatross, which lay eggs in the austral summer but fledge chicks the following austral winter, are referred to by the year in which the chicks fledged (*i.e.,* 2018 for the nesting season 2017–2018; 2022 for the 2021–2022 season; etc.)

Study area

Lying 6.5 km west of Auckland Island, Disappointment Island (-50.608°, 165.972°) is a rugged 318- m high, 2.96 km^2 island (3D surface area is considerably larger but unknown). The main body of the island is surrounded by steep cliffs, with few places suitable for landing. The cameras were set up on a 0.15 ha plot on the south-east facing slope above Castaways Bay, the main landing point. The vegetation in this area comprised lush *Poa foliosa* grassland interspersed with clumps of megaherbs (*e.g.*, *Anisotome latifolia*, *Stilbocarpa polaris*). Walker *et al*. (2020) provide more detail on the island's overall vegetation. In most places it is dense and tall, frequently as high or higher than the nesting albatrosses, often obscuring them from full view.

Methods

Camera deployment

2018

Six Swift 3C trail cameras (model 3.0C), mounted on waratahs, were deployed in January 2018 in three sets of pairs to monitor chick survival, hatching and fledging dates, and when adults returned to the colony the following season (Rexer-Huber et al. 2019). The fields of view of each camera in a pair overlapped slightly but only one of any duplicated nests was assessed. All 26 nests selected for monitoring by the field team were attended by banded breeding birds, either incubation eggs or brooding just-hatched chicks (Rexer-Huber et al. 2019). Very few bands were seen in the subsequent imagery, however, either because the birds were sitting or, when standing, intervening vegetation obscured their legs. Even when bands were seen, it was usually impossible to read the numbers because of low image resolution and the distance of the birds from the camera.

The cameras were programmed to take hourly images from just before dawn to just after dark. Within each pair one camera started at 05h45 and ending at 19h45, while the other started at 06h15 and ended at 20h15. The exception was camera 1A, which maintained its schedule for 42 days, then suddenly switched to ending each day at 21h15 until it failed on 7/04/2028.

The cameras were expected to remain active for about a year. These cameras were retrieved in early February 2019 (Rexer-Huber *et al*. 2019). All six camera mounts remained upright, but the cameras themselves showed substantial weathering. Condensation and algal growth inside the lens affected three cameras, while two had corroded battery-memory card compartments. The two latter cameras, 1A and 2A, failed in early April after 73 and 78 days, respectively, while the other four cameras ran for 172–294 days (average 249 days). Only cameras 3A and 3B ran for long enough to record the return of birds to the colonies at the start of the 2019 breeding season (Rexer-Huber *et al*. 2019).

2022

In mid-January 2022, 10 Swift Enduro cameras (model 3.5C) were installed on waratahs placed at seven sites in the Castaways Bay colony. Cameras were positioned so as to ensure no overlap between their fields of view, which were photographed as supporting metadata from above the trail cameras. A total of 61 known-active nests were marked later on these photographs to assist with image analysis and nest monitoring (Parker *et al*. 2022). Except for camera D1, all these marked site photographs were included with the 2022 image sets.

By monitoring more nests than in 2018, the 2022 trail camera study had the same aims as for the pilot: to measure chick survival and fledging success and provide better data on phenology—mean fledging dates; for how long the colony was empty; and the dates of first return the next season (Parker *et al*. 2022). Except for D7, the cameras were programmed to take images hourly from 08h00 to 16h00. The reduced frequency was intended to extend the battery-life of the cameras so that they would last a whole year, unlike in 2018 season, when the camera batteries lasted no more than 294 days. Camera D7 took images hourly each day, starting initially at 00h31 but experiencing substantial drift throughout the 351-day period of use, gaining 1 sec every ca. 12 days. There was no noticeable time drift in the other cameras.

2023

Following the retrieval in mid-February 2023 of the 10 cameras put out a year earlier, 10 new Swift Enduro cameras (model 4.0PC-R) were installed at approximately the same sites but with their fields of view altered to maximise the number of active nests monitored by each camera (Elliott et al. 2023). Unfortunately, the shift in viewpoint resulted in the loss from view of five active nests, while bringing in to view new nests, the prior history of which was unknown.

The time stamp on the Camera D10a images started on 13/03/2023. This must have been a set-up error because the field programme ended on 15/02/2023. A check on the weather conditions recorded on the other images (cloudy or sunshine; low mist; temperature) confirmed the mistake in the settings, so the date of the first image file was reset to show the start as 13/02/2023, 28 days earlier (the time the images were taken each day was not affected). The dates on all subsequent images were readjusted accordingly. It was not possible to change the dates burnt on to the images themselves. Future researchers working on the D10a image set will need to be aware of the error.

When the SD cards in 2023 trail-camera sets were collected on 18–21 January 2024, only that for camera D3 had a prolonged set of images (and they were all blurred and therefore unusable, with the camera failing on 19 November 2023). All the other SD cards failed between early April and early June 2023, before any chicks had fledged. (Camera D1 failed at the outset.) A total of 57 nests were identified initially as being potentially active, although 10 later turned out to be empty or occupied but the contents unknown.

Image Processing

Nests selected for monitoring were either those marked by the survey team on a series of synoptic images showing the field of view from above the camera (February 2022 images only, continued through to the start of the 2023 breeding season), or those nests obviously occupied at the start of an image series (January 2018). Some nests that were occupied only during the 2023 season were added. The temptation to scroll ahead through the images to see if an occupied nest was truly active (*i.e.,* containing an egg or chick before selecting it), was resisted so as to avoid a 'survivorship bias'.

Images for each colony were processed sequentially at hourly intervals each day using IrfanView 4.72 (64 bit), enabling rapid cycling through a series of images. The positions of the nests selected for monitoring at the start of each series, were marked out using the screen annotation programme Ink2Go 1.7.21. This allows one to write on top of an active application and save the overlay for future use on the same image set. Observations started with the first image of the day, the time depending on the set. The state of each nest in this image and the presence of any birds at it was noted and then updated if a higher-order features was seen later in the day. The order of increasing importance for the nest state was NC < NA < E < C < PG < F < D < 0 (Table 1), while for the presence of adults at the nest it was 0 < 1 < 2.

It was seldom possible to tell what was beneath a sitting bird as they rarely stood up. On occasions, what appeared to be a chick's head was seen, peeking from beneath the sitting adult, and was recorded as such (code C). There is considerable uncertainty in these cases, however, because the level of discernible detail was low, even when magnified. Chicks often only became apparent when they were several days old, partly because recently hatched chicks were tightly brooded but also because it was seldom possible to see into the nest on occasions when birds stood up. On a few occasions, later corrected after close review, an adult's webbed feet were mistakenly identified as an egg or chick.

Table 1. Codes used when analysing the state of White-capped Albatross nests on Disappointment Island during the 2018, 2022 and 2023 breeding seasons

Code	Explanation
NC	Not checked, either because the nest was no longer visible or it had failed
NA	Nest checked but the contents not seen, either because an adult was sitting on the nest, covering the contents, or because the nest was shielded by vegetation
E	Egg seen to be present
C	Small chick present, still being brooded by an adult
PG	Chick present but not being brooded by an adult, although an adult could still be sitting alongside the nest and chick (post-guard stage)
F	Chick fledged or assumed to have fledged, being fully feathered and having moved out of the camera's field of view
D	Chick dead, confirmed either by the presence of a carcass or the absence of the chick from a nest where it was clearly visible earlier
0	Obviously empty nest

The occupancy of both failed and apparently empty nests was also monitored to give some idea of when in the nesting season, and for how long, individual and pairs of birds continued to attend such 'empty' nests. This is relevant to the larger question of the nature of birds attending empty nests well into the breeding season: whether they are failed breeders, still physiologically stimulated to breed; birds that may be skipping a breeding season, for whatever reason (*e.g.*, if they had successfully fledged a chick the previous season); or birds preparing to breed for the first time.

Data analysis

The data were entered into Excel spreadsheets, as requested, and submitted to the Department of Conservation for eventual more detailed analysis of chick survival once data from several years have been retrieved (e.g., Thompson 2025). In the meantime, a more basic approach to estimating survival during the observation period was tried, albeit one that involves some assumptions.

For the three breeding seasons where observations were made throughout the chick-rearing period (perhaps excluding a week or more at the start in 2022 and 2023), the number of days that each nest was known to be active—containing either an egg, brooded chick, post-guard chick, or fledgling/near-fledging—was calculated from the first day of observation in each season: 19/01/2018 (when active breeders were either sitting on eggs or brooding small chick), 16/02/2022 (when the active nests apparently mostly had chicks in the late brood-guard stage), and 12-13/02/2023 (likewise containing chicks in the late brood-guard stage).

It was not necessary to see the contents on each date, only to have at least one confirmed sighting throughout the overall observation period, and sufficient evidence subsequently to suggest that the nest remained active (*e.g.*, adult still sitting, or attending the nest appearing to feed or groom a chick). In reality, on almost every occasion, confirmed sightings—E, C, PG—were made intermittently throughout these observation periods, but not necessarily on every day (i.e., there were often many intervening days when either an adult was sitting but the contents could not be seen, or no adult was present, but the contents could still not be seen: 'NA' was the assigned notation on these occasions). The logical assumption is that if there was a confirmed sighting on one day, then the nest must have been active on all previous days.

There were four possible outcomes to the sequence of observations for each nest:

- the breeding attempt clearly failed (i.e., a broken egg or dead chick was observed, or a nest that contained a chick at one time was clearly empty soon after, with no evidence of any subsequent activity, or a scavenger/predator—Northern Giant Petrel *Macronectes halli,* or Subantarctic Skua *Stercorarius antarcticus*—was present at a nest known to be active up to that point)
- the fate of a nest was inconclusive, in that a chick was seen up to some point, even if intermittently, but not subsequently (this excludes chicks in nests that failed, or obviously fledged or were almost certain to have done so)
- observations were truncated because the camera failed or its field of view shifted, meaning that no further observations could be made on that nest or its contents
- chick observed to have fledged or almost certainly did so, based on full plumage development and time.

Nests that clearly failed are integral to calculating survivorship (or, conversely, mortality). For these nests, time-to-failure is simply the number of days from the start of observation to the date of failure.

For nests where the outcome is inconclusive (no fledged chick seen but no obvious failure either), it is almost certain that the nest failed at some point, but when? For these nests, the time-to-failure was estimated as the number of days between the start date and the last day on which the chick was seen, *plus a number of additional days based on the frequency of positive sightings in the previous 10 days*. The chance of not seeing the chick for k days is $(1-\hat{p})^k$, where $\hat{p}$ is daily detection probability, here based on the preceding 10 days (i.e., if the chick was seen on seven of the previous 10 days, $\hat{p} = 0.7$). With $(1-\hat{p})^k = 0.3^k$, and setting $0.3^k \leq (1-\alpha)$, where α is the desired confidence level, provided that $(1-\hat{p}) \neq 0$, the number of **subsequent** days of observation required without the chick being seen (k) before it can be assumed, with α level of probability, that a chick has died can be calculated as:

$$k \geq \ln(1-\alpha)/\ln(1-\hat{p})$$

This value, k, was calculated for each inconclusive sighting, with $\alpha = 0.95$, and added to the number of days between the start date and the last day on which the chick was seen. Beyond this extended date, the nest is assumed to have failed with 5% uncertainty. It is possible to account for uncertainty in the estimate of p by using priors and Bayesian statistics but, for simplicity, the frequentist approach was used. This is a key assumption.

The result is similar to a Kaplan-Meier (K-M) non-parametric survival analysis, differing here primarily in assigning the truncated ('censored') data to precise dates as calculated above. In a K-M analysis, censored data are assigned to the preceding timed event, often at set intervals (Kaplan & Meier 1958). In the present analysis, for nests known to be active up to when a camera failed, or where the chick appeared to wander off long before they seemed ready to fledge ('gone walkabout'), their observations were truncated at that point. From then on, they did not contribute to the number of nests on which survival probabilities were calculated. Conversely, nests from which a chick fledged remained in the population throughout.

Survival probability was then calculated as the proportion of nests confirmed to be active on any date over the total number of nests *known to have been active up to that point*. If there were no truncations, then this would simply be the initial number of active nests under observation (19 in 2018, 45 in 2022, 47 in 2023). But because a number of nests fell out of the analyses over time due to camera failures, the total number of nests under observation dropped after each truncated episode.

Overall, the study covered 16,347 nest-days (number of nests multiplied by the number of days on which each was observed, excluding days following a chick's death or fledging). All measures of variation around averages derived from these figures are presented as ± 1 standard deviation.

Results and Discussion

A synopsis of all cameras, their operational periods, numbers of nests observed and the number of nests the bowls of which could be clearly seen are given in Annex 1 (Table A-1). Summaries of the numbers of daily records from each camera and nest for each nest-tag category obtained from the trail-camera imagery at White-capped Albatross nests on Disappointment Island for 2018, 2022 and 2023 are given in Annex 1 (Tables A2–A5).

2018

A preliminary assessment of breeding success for the 2018 season has already been published, with only five chicks fledging from 17 out of an initial 26 monitored nests (29% fledged: Rexer-Huber *et al*. 2019). Camera failure accounted for the other nests. No metadata accompanied the 2018 image sets to show which nests were monitored in the earlier analysis, or which marked birds were present at which nests.

For the present study, 43 nests where albatrosses were present initially were marked and their fate followed. Only 19 of these later proved to be active (*i.e.,* an egg or chick was seen at some stage, even if only once). Given that the field team in 2018 focused on nests that were known to be active when the cameras were set up, and presuming that all 26 of the nests assessed by Rexer-Huber *et al*. (2019) were among the 43 nests monitored in this study, then six nests could have failed before they could be confirmed as active.

Five of the 19 active nests monitored in this study each produced a fledged chick, the same finding as Rexer-Huber *et al*. (2019). These chicks fledged between 12/07/2018 and 27/08/2028, with a mean fledging date of 3/08/2018, similar to that reported by Rexer-Huber *et al*. (2019) except their mean fledging date was a week earlier. A sixth chick may also have fledged as it was alive, healthy and well-feathered in mid-July when the camera failed, around the time the first chicks at other nests were seen to fledge. This gives a success rate in the post hatch-to-fledging period of 25%–30%, depending on whether the sixth chick is excluded or included.

The overall nesting period, from egg hatching to the chick fledging, was documented for nest 1B-2. It had an egg on 24/01/2018. On 27/01/2018, the adult was seen hunched over the nest bowl, with white fragments of what seemed to be eggshell, together with what seemed to be a recently hatched chick. The adult appeared to have been assisting the chick to emerge from the egg (the resolution of the image and the dull early morning light made it impossible to be more precise, even when the image was enhanced). The chick was briefly glimpsed later that day and confirmed the next (28/01/2018), when it was seen twice. It was seen briefly on 17 of the next 18 days while being brooded by an adult, before being left by itself for 1–2 hours a day until 20/02/2018, when it was left alone for almost the whole day. During this period, a parent bird returning to feed and brood the chick twice, each time for less than an hour. This pattern of chick being alone for much of the day, broken by brief periods when the adult returned to brood the chick or sit alongside it, continued until 24/02/2018. From then on, the chick was left unattended, marking the post-guard stage. It fledged on 12/07/2018, 166 days after it hatched on 27/01/2018. The corresponding brood-guard stage lasted ca. 20 days, followed by a ca. 3–5-day transition from the brood-guard to the post-guard stage.

Eight chicks died or disappeared, all of them before mid-March, 60 days after the cameras were set up. One nest, 2B-1, clearly failed before hatching. An egg being incubated was seen with a hole in it when the sitting bird left the nest on at 11h15 on 13/02/2018. The hole was larger one hour later when a bird with the numeric band number '269', either the same bird as earlier or its partner, was back on the nest at 12h15. This bird continued to occupy the nest for the next two hours, after which it was not clearly seen again. The egg remained in the nest until 09h15–10h15 the next day, gradually disintegrating in a way that suggested it was being picked apart. It had disappeared entirely by 10h15. In the following week, covering 101 hourly records, an adult was present at the nest on 23 occasions, either sitting (12) or standing (11). All the records of a bird standing on the nest were of an unmarked individual. Given that all the obvious nests in these images were occupied by marked birds (Rexer-Huber *et al*. 2019), the presence of one or more unmarked birds at this now-empty nest implies that presumed non-breeding, 'floating' individuals will readily attempt to occupy such nests. No interactions were seen to suggest the breeding pair tried to defend this failed nest against intruders. The fate of the other six chicks is unknown. All were alive when two cameras failed in early April 2018. The pattern of chick survival in 2018 is shown in Fig.1.

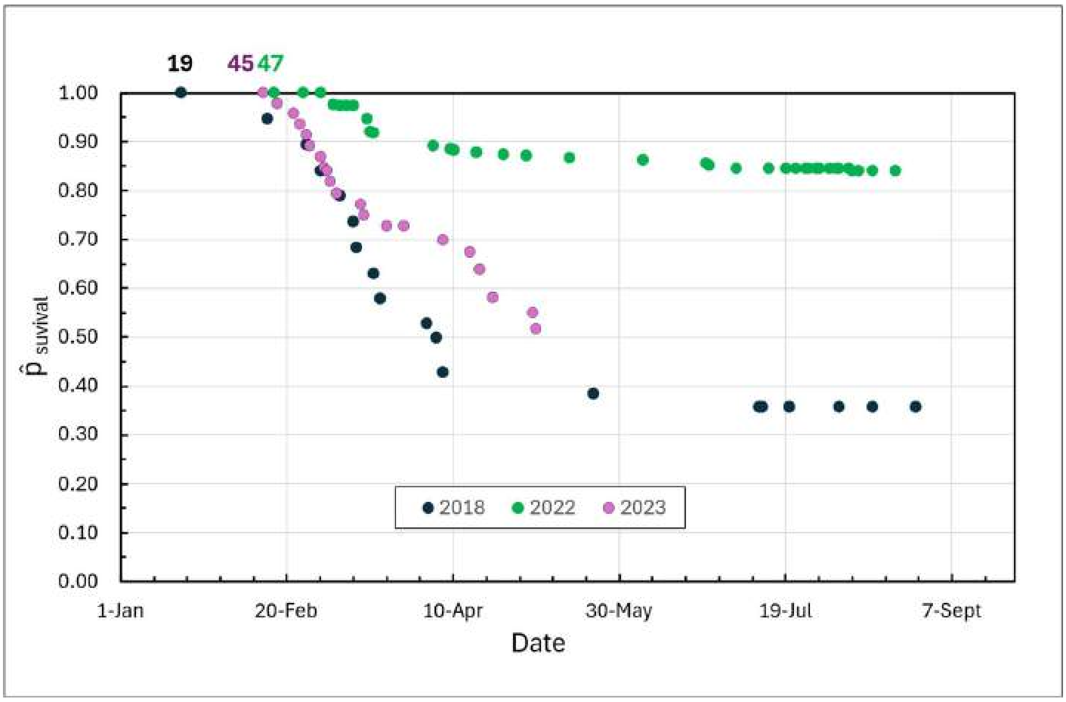

Figure 1. Estimated survival of White-capped Albatross nests starting with an egg or chick during three seasons: 2018, 2022 and 2023. See text for details of how survival was calculated. The last three truncated data points for 2023, have been omitted, otherwise the picture would misleadingly imply a zero probability of survival at that stage. All the 2023 cameras stopped functioning on or before 8 June 2023, when 33 chicks may still have been alive, including those lost from view earlier because of camera failures or shifts in camera fields of view.

Only three of the six cameras functioned beyond early October 2018, the last of which, camera 3B, failed on 9 November. No returning birds were seen in camera 1B images up to when it failed on 19/10/2018. Two birds were seen on 29/09/2018 in camera 3A images, one of which was present at nest 3A-2 for much of the day. In the early evening it was joined by another bird and the two engaged in *Bill Aligning*, an assumed pair-bonding display in the closely related Shy Albatross *Thalassarche cauta* (Johnstone *et al*. 1975, cited by Marchant & Higgins 1990). Although this nest was occupied intermittently—present on 33% of 57 daily occurrences up to 16/03/2018, when it was last seen at the nest—there was no evidence of breeding during 2018 (*i.e.,* no period of prolonged occupancy indicating incubation or brooding, at least after 19/01/2018 when observations started; the nest could have failed before then).

The first birds returning at the start of the 2019 breeding season on camera 3B, were seen on 30/09/2018 at nests 3B-3 and 3B-4. Both nests were then occupied intermittently up to 18/10/2018, when they were joined by their partners. From 20/10/2018, nest 3B-3 was occupied continuously until the camera failed on 9/11/2018 (21-day period) with two birds present on 50% of the days. Nest 3B-4 was occupied continuously from 22/10/2018 until the camera failed, with two birds being present on 53% of the 19 days in that period. Neither nest was active in 2018, at least not after 19/01/2018, but were occupied intermittently up to 6/04/2018 (7-week period): nest 3B-3, 26% occupancy (10% with two birds present); 3B-4, 30% occupancy (4% with two birds present).

Only two nests monitored via camera 3B were clearly active in 2018, at least after 19/01/2018, when the cameras were activated. A chick fledged from nest 3B-2 on 20/07/2018. Both adults returned to the colony and their nest on 8/11/2018, 111 days later. The camera failed the next day, but given the late return of this pair, it is debateable if they nested again in 2019.

Nest 3B-5 failed, with the post-guard stage chick dying on 22/05/2018, following a day of snow and sub-zero temperatures. Based on the pattern of occupancy at this nest, the chick was 118 days into its post-guard stage, but was only clearly identified for the first time on 12/02/2018, 19 days after the first occasion when there was no adult at the nest. A bird was seen briefly at this site on 18/10/2018, at 13h15, 150 days after the nest failed. The site then remained unoccupied for the next 20 days until 6/11/2018, when it was briefly visited at 18h15, the last visit seen before the camera failed two days later. Following its 2018 nest failure, and given the late return at the start of the 2019 season, it is also doubtful that this pair bred in 2019.

Across all monitored nests, the average return date at the start of the 2019 breeding season was 14/10/2018. The average interval between the return of the first bird and its partner was 11.2 ± 6.5 days (range 0–18 days, N = 10).

2022

An initial assessment of fledging success for the 2022 season has also been published previously, with 22 chicks certainly having fledged from 33 nests visible throughout the season (out of 61 nests selected for monitoring: Elliott *et al*. 2023). A further three chicks probably fledged, as they were close to doing so before being lost from view when camera D7 tipped over in early July 2022. Six nests failed. Camera failure, either from the start (camera D10) or through slippage within the first couple of months (cameras D2 and D3), meant the fate of the remaining nests was unknown (Elliott *et al*. 2023).

Nine of the 10 image sets were accompanied by a synoptic image on which were marked those nesting birds that the field team considered suitable for monitoring at that site, all apparently with an egg or chick. The exception was camera D1, for which there was no synoptic image, although six nests in it were monitored. In the present study, 51 nests were marked for monitoring, of which 45 proved to be active nests (chick present on at least one occasion). Some of the nests marked on the synoptic images were unsuitable for monitoring because of parallax errors arising from photographing the birds from above the trail cameras, rather than directly in line with them.

Overall, 21 out of 45 active nests observed from the outset produced a fledgling, giving a success rate in the post hatch-to-fledging period of 47%. This estimated success rate is likely to be slightly inflated, however, because the cameras were place out almost a month later in 2022 than in 2018, with the cameras starting on 16/02/2022. All 45 active nests had chicks in the latter stages of being brooded (the first post-guard stage chicks were seen only a few days later, on 19/02/2022). Thus, any chick deaths occurring soon after hatching and through much of the brood-guard stage would have gone undetected. Moreover, several cameras were affected by slippage, so observations at these nests were incomplete and therefore truncated in the analysis of survival (Fig. 1).

Fledging occurred over a five-week period, 14/07/2022–21/08/2022, with a mean fledging date of 30/07/2022. This was just four days earlier than in 2018, which extended over a broadly similar spread of fledging dates, albeit with a much smaller sample size.

Three chicks, not included in the above numbers, may have fledged. One chick occupied nest D2-1, the only nest in the image at the time. The chick was fully feathered and looked healthy when it left the nest on 17/06/2022. Back-calculating from when it was first seen being brooded as a large downy chick, and when it transitioned to the post-guard stage it was estimated to have been ca. 139 days old when it left the nest, possibly too early to have fledged then but probably old enough to survive through to fledging sometime later. Two other chicks, in nests D7-1 and D7-4, left their nests on 25/06/2022 and 26/06/2022, respectively. At that time, they were estimated to be ca.149 and ca.146 days old, respectively. Their nests remained empty until the camera tilted over, putting all its monitored nests permanently out of view (at which time there was one PG chick still in its nest). If these three additional chicks did fledge successfully, then at least 24 chicks will have fledged from 45 monitored nests (53% fledging success).

Only two obvious failures were recorded in 2022, both involving the death or disappearance of the chick. A post-guard stage chick at nest D3-3 died in mid-March 2022. It was a small downy chick ca. 21 days into the post-guard stage. It was seen at 14h00 on 16/03/2022 but looked lifeless. A Northern Giant Petrel was seen at the nest at 15h00, but had gone by 16h00, leaving only clumps of white down strewn over the surrounding area. Five visits, presumably by the parent birds, were observed over the following 32 days. There was no evidence of renesting in 2023 because camera D3 failed on 15/09/2022.

A post-guard stage chick at nest D7-3 disappeared sometime between 4/03/2022 and 9/03/2022, also while just at the small downy stage of development. The chick was present on 3/03/2022 when the camera's field-of-view shifted sharply overnight, resulting in the loss of view of the nest. When the camera's field of view shifted back overnight on 9/03/2022, the following day revealed an empty nest. Other failures could have gone unrecorded because the view of many nests, being monitored initially, were lost through shifts in the cameras' fields-of-view.

2023

The mean date of first return of adult albatrosses to their presumed nest sites at the start of the 2023 breeding season was 26/10/2022 (range 20/09/2022–25/11/2022, N = 36), almost two weeks later than at the start of the 2019 season. As then, the usual pattern of return was for one bird to return ahead of the other. The average interval between the return of the first bird and its partner across all categories of returnees was 24.5 ± 19.4 days (range 0–79 days, N = 28). These figures are substantially greater than in 2019. They exclude a brief, < 1 hour visit by an adult to nest site D6-3 on 7/09/2022, a presence that was unusually early. Occupancy of the site was not sustained and may have been coincidental. (The sporadic presence of a bird at a site does not necessarily mean that it is one of the site's normal occupants.) The next visit was on 9/10/2022 but the site was not truly reoccupied until 28/11/2022, where the bird there was joined three days later by its presumed partner. This pair apparently lost their chick sometime in March 2022 (a post-guard chick was seen 21–22 February 2022 but not again; sustained observations were compromised by shifts in the camera's field of view).

Of the 22 pairs that successfully fledged a chick in 2022, four nested again in 2023, 10 did not (no sustained occupancy of the nest site through to mid-February 2023), while the outcome for the remaining eight could not be fully resolved because cameras D9 and D8 failed in late October and early December 2022, respectively (Table 2).

The four pairs nesting at the same sites in 2023 from where chicks successfully fledged in 2022 are presumed to be the same birds, but without being banded or individually distinguishable in some other way this remains an assumption. If true, then 71% of pairs (10/14) that had been successful in 2022 did not renest in 2023. In addition, none of the four successful pairs at site D8 in 2022— D8-2, D8-4, D8-7, and D8-8— showed any signs of breeding in 2023. All returned late (two in early November, the other two in late November); three were alone throughout, up to when the camera failed on 4/12/2022. Nest-site attendance was sporadic (average duration of continuous daily presence 4 ± 3.6 days, range 1–9 days). If these four successful pairs in 2022 are included, then 78% of successful pairs in 2022 (14/18), did not renest the following season. This is higher than the 48%–67% reported by Thompson *et al*. (2009)

Copulation was observed at six nests between 5/11/2022 and 11/12/2022. The earliest observed copulating pair (D5b-6) were seen with an egg on 3/12/22, and with a tiny chick, assumed to have just recently hatched, on 14/01/2023. Assuming that the egg was laid two days after last copulation (following Abbot *et al*. 2006), this gives a maximum incubation period of 70 days. Likewise, pair D6b-5, seen copulating on 17/11/2022 and with a just-hatched chick on 30/01/2023. Assuming the egg was also laid two days after copulation, this gives an incubation period of ca. 71 days.

The orientation of the replacement cameras put out in mid-February 2023 differed from those used before the cameras were serviced, to increase the number of visible active nests (*i.e.,* those with chicks: Elliott *et al*. 2023). This was further complicated by having different camera number x site combinations to those used before (Table 3).

Table 2. Nest re-occupancy and renesting histories in the 2023 breeding season of White-capped Albatross pairs that fledged chicks successfully in 2022 as recorded on static cameras.

Pair no. (camera-nest)	Fledging date 2022	Nesting activity 2023
D2-1	17/06/2022	**Nested**: sitting on egg 1/12/2022
D4-1	10/08/2022	Present but did not nest 2023
D4-2	4/08/2022	Present but did not nest 2023
D4-3	14/07/2022	**Nested**: sitting on egg 14/01/2023
D4-4	10/08/2022	Present but did not nest 2023
D4-5	3/08/2022	Intermittently present, not nesting, 2023
D4-6	14/08/2022	Present but did not nest 2023
D4-7	4/08/2022	**Nested**: small chick seen 9/02/2023
D5-1	28/07/2022	Present but did not nest 2023
D5-2	10/08/2022	Present but did not nest 2023
D5-3	22/07/2022*	Present but did not nest 2023
D5-4	22/07/2022*	**Nested**: sitting on egg 10/01/2022
D6-1	22/07/2022*	Present but did not nest 2023
D6-2	22/07/2022*	Present but did not nest 2023
D8-2	21/08/2022	Camera D8 failed on 4/12/2022, so whether any of these pairs nested again is uncertain. Up to when the camera failed, none of them were apparently nesting in 2023, and they probably did not (see text for more)
D8-4	1/08/2022	
D8-7	7/08/2022	
D8-8	29/07/2022	
D9-2	28/07/2022	Camera tilted forward on 22/10/2022; views of nests and birds lost. At that point, only one bird had returned, to D9-5. Its fate and that of the others is unknown
D9-3	25/07/2022	
D9-4	19/07/2022	
D9-5	19/07/2022	

* These dates are correct. It is perhaps just coincidence that the chicks apparently all fledged (or left their nests, not to be seen again) on the same day

Table 3. Apparent broad correspondence between the cameras put out in mid-February 2022 and retrieved in February 2023 (suffix 'b'), and those that replaced them, put out 1-3 days later, after servicing (suffix 'a'). The geographic coordinates are those of the new placements (Graeme Elliott, personal communication, 14/06/2025).

Before	After	Site coordinates (Feb 2023)	Status when taken up in mid-February 2023
D1b	D2a*	-50.60499, 165.98930	Operating but tipped over 1/03/2022; nothing useful after this
D2b	D9a	-50.60514, 165.98851	Operating but gradually slipped forward; nothing useful after 1/01/2023
D3b	D6a*	-50.60499, 165.98930	Camera slipped sideways in Feb-March 2022, before failing 1/05/2022. No later imagery
D4b	D10a	-50.60510, 165.98877	Operating; three active nests (egg or chick), all visible in the replacement, D10a, FOV.
D5b	D8a	-50.60505, 165.98868	Operating; one recently failed nest (chick lost)
D7b	D4a	-50.60525, 165.98882	Operating; two nests with chicks (just visible in replacement D4a)
D8b	D3a	-50.60516, 165.98883	Camera failed 4/12/2022
D9b	D7a	-50.60533, 165.98877	Camera fell over 22/10/2022
D6b			Operating; one nest with a chick 1/02/2023. Unclear which camera replaced D6b; FOV unresolved
D10b			FOV unknown; camera D10b failed at the start
	D1a	-50.60530, 165.98903	FOV unknown: camera D1a failed at the start
	D5a	-50.60535, 165.98906	Unclear which camera D5a replaced: FOV downslope from D9b and D7a

* Cameras D2a and D6a were placed at the same location but faced different directions

The fields of view (FOV) of the cameras present before servicing, and those that replaced them, are compared in Annex 2. Camera D10b failed at the outset, so its FOV is unknown relative to that which replaced it. Camera D1a likewise failed at the start, so its FOV is also unknown. Camera 5a's FOV—its equivalent among the 2022 image sets unknown—is down slope from both D9b and D7a, considered an equivalent pair (Annex 2). Finally, camera D6b, set up in 2022, does not have any obvious equivalent among the 2023 replacement cameras (Annex 2).

These changes made it difficult to track the fate of birds known to be nesting when the cameras were taken in for servicing. The nests that have been identified as active before the cameras were removed for servicing, and what are taken to be the same nests seen on the replacement cameras (with different numbers) are shown in Table 4. Three nests active at site D5b had no obvious counterparts at D8a, its replacement. The chick visible at site D6b could not be found again because its replacement was not identified.

Table 4. Active nests and their status before the mid-February removal of the cameras for servicing and replacement, and the corresponding nest numbers and subsequent fates, if known, among the 2023 (after servicing) image sets. BG = chick at brood-guard stage; PG = chick at post-guard stage, generally alone; FOV = camera field of view.

Nest (before)	Status in mid-February, before replacement	Nest (after)	Subsequent fate
D2b-1	Sitting tight; egg seen 7/12/22. Only nest visible in D2b image set	D9a-1	BG chick to 21/02/23, then PG chick present to 15/04/23 (disappeared midday); camera failed 8/06/23.
D4b-3	Sitting tight; egg seen 14/01/23. Adult sitting tight to 12/02/23	D10a-6	Adult continued sitting to 21/02/23 when nest shown to be empty
D4b-7	Chick being brooded 10/02/23. Adult sitting tight through to 12/02/23	D10a-3	PG chick present at least to 19/04/23; camera failed 21/04/23
D4b-8	Adult sitting tight through to 12/02/23, brooding chick.	D10a-5	PG chick present to 21/04/23, when camera failed
D5b-4	Sitting on an egg 10/01/23 but later views sporadic due to shifting FOVs	D8a-?	Exact equivalence unknown; D8a views are further upslope
D5b-6	Brooding chick up to 26/01/23 but nest empty 30/01/23 (*i.e.*, failed). Adult(s) remained at nest for next 10/13 days.	D8a-?	Exact equivalence unknown; D8a views are further upslope
D5b-7	Adult sitting tight throughout. No sign of egg or chick, but likely to have been present, given the adult's behaviour	D8a-?	Exact equivalence unknown: D8a views are further upslope
D6b-5	Chick being brooded 1/02/23; later views lost because shifting FOVs	?	Unclear which camera replaced D6b
D7b-1	Unclear. Adult on nest when seen but views sporadic due to shifting FOVs	D4a-1	Apparently not nesting; adult presence sporadic beyond 16/02/23
D7b-3	Chick being brooded 12/02/23. Pair had failed the previous season (2022)	D4a-3	PG chick present when camera failed 7/04/23
D7b-4	Chick being brooded 12/02/23	D4a-4	PG chick present when camera failed 7/04/23

Given the aim of measuring survival to fledging in the 2023 chick cohort, most of which had only recently hatched, the decision to alter the field of view of the cameras retrieved for servicing and then put out again a few days later may have seemed logical. Nevertheless, it disrupted the sequence of observations of nests that had been monitored from the beginning of the 2023 nesting season, starting in October 2022, making it difficult to track their fate. As it was, with the exception of camera 3a, all the replacement cameras failed at some point before any chicks fledged in the 2023 season. These breakdowns ranged from D1a, failing at the outset, to cameras D5a and D9a, which failed on 8/06/2023. Camera D3a continued operating through to 19/11/2023, although a major shift in viewpoint on 4/03/2023 resulted in the loss from view of all nests but one, an empty nest. This nest had failed earlier with the overnight disappearance of a brooded chick on 22/02/2023. From early September 2023 all images from D3a were blurred.

Of 57 nests marked for monitoring at the start of the image series, 47 later proved to be active (chick seen). Of these nests, 12 (26%) failed, with the chick being seen dead or simply disappearing, often overnight. The remaining chicks, 32 (68%) were alive when their cameras failed; the fate of three others (6%) was unknown, as no nest were visible after 8 June 2023 (Table 5). The pattern of survivorship was similar to that recorded in the smaller 2018 cohort, despite the cameras being started nearly a month later (Fig.1).

Table 5. Details of the fates of active nests seen in the fields of view of the replacement cameras put out in mid-February 2023. Camera failure included major shifts in the field of view resulting in monitored nests being lost from sight. D = death or disappearance of chick; NA = bird sitting tight (incubating or brooding), nest content not known; C = brooded chick; PG = post-guard stage chick; UK = unknown (chicks seen early on but not later so their fate was unknown; they probably failed).

Camera	Monitored nests (N)	Active nests (N)	Nest state when last seen (number of nests)	Date camera failed	Notes
D1a	–	–	–	13/02/23	No images
D2a	5	2	PG (2)	4/05/23	
D3a	5	4	D (2), PG (2)	3/03/23	See text for details
D4a	6	5	D (1), PG (4)	7/04/23	
D5a	6	5	D (1), PG (4)	8/06/23	
D6a	6	6	PG (5), UK(1)	13/05/23	
D7a	10	8	D (1), PG (5), UK(2)	20/05/23	Camera shift 15/02
D8a	6	6	D (2), PG (4)	18/04/23	
D9a	6	5	D (4), PG (1)	8/06/23	
D10a	7	6	D (1), PG (5)	21/04/23	

Patterns of nest attendance

The patterns of attendance of adult White-capped Albatross at nests depended on where in the nesting cycle a pair was. Documenting this obviously depended on when trail-camera observations started. In 2018, this was in mid-January, when most birds on nests were either in the late stage of incubation or were brooding recently hatched chicks. Occupancy was correspondingly high initially, gradually falling off from early February onwards as chicks were increasingly left alone while the adults went off to forage (Fig. 2).

In contrast, in both 2022 and 2023, observations only began in mid-February, when adults were either brooding or guarding large downy chicks, or were already beginning to leave their chicks so that they could go off to forage and provision them. Adult presence at these nests, while high initially, fell off rapidly as more chicks were left unattended (Figs. 3–4). Given that the cameras were positioned to overlook active nests (Graeme Elliott, email 14/06/2025; Kalinka Rexer-Huber, email 16/06/2025), there were relative few nests that were obviously empty from the beginning (none in 2022), but were still being attended by one or two adults (Figs. 2, 4). Adults were still recorded at these nests. In 2018, occupancy by at least one, sometimes two, adults declined from ca. 40% during late January, to ca. 11% until mid-February. Birds were almost entirely absent from these three nests from late-February onwards (Fig. 2). Whether any of them had been active before observations started is not known.

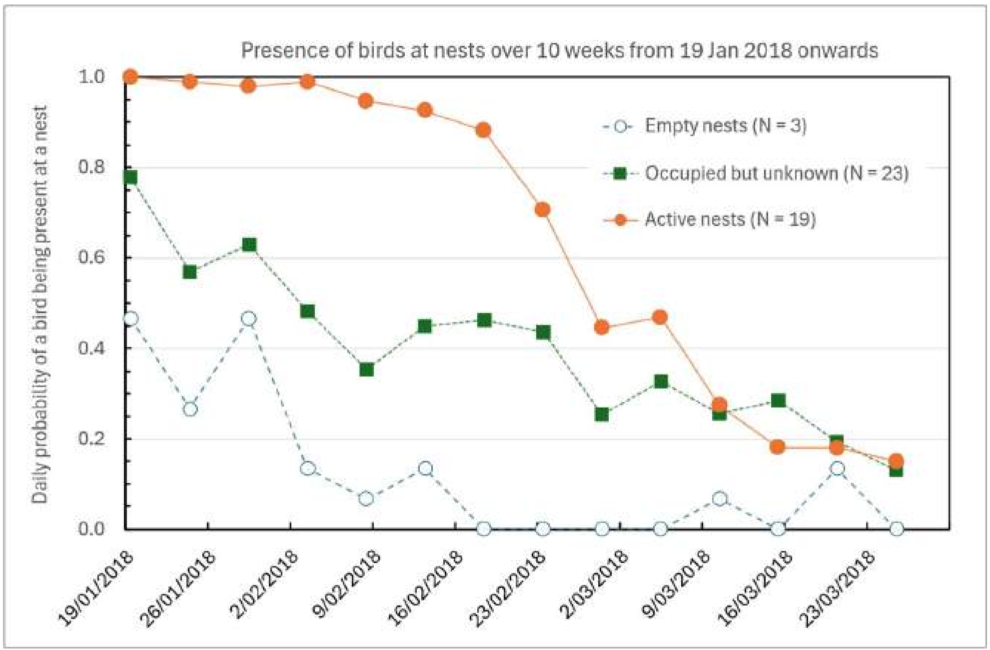

Figure 2. Daily probabilities of White-capped Albatrosses present at nests during the first 10 weeks following the start of hourly trail-camera observations on 19 January 2018. The active nests at the start had birds incubating an egg or brooding a recently hatched chick.

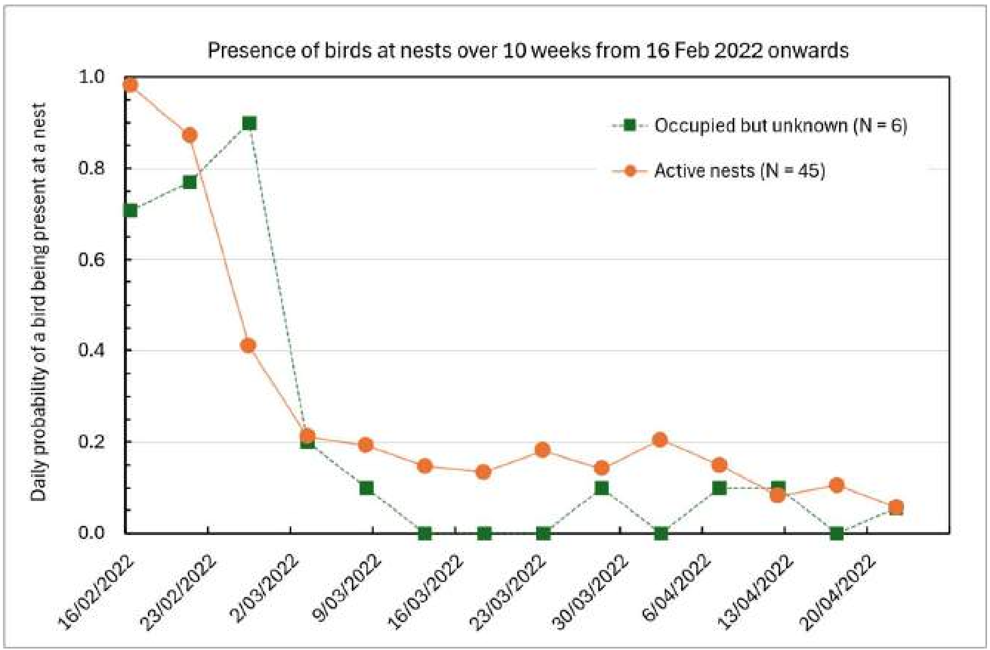

Figure 3. Daily probabilities of White-capped Albatrosses present at nests during the first 10 weeks following the start of hourly trail-camera observations on 16 February 2022. The contents of ca. 26% of the observed nests were never seen. They may have included birds attending empty nests, for whatever reason.

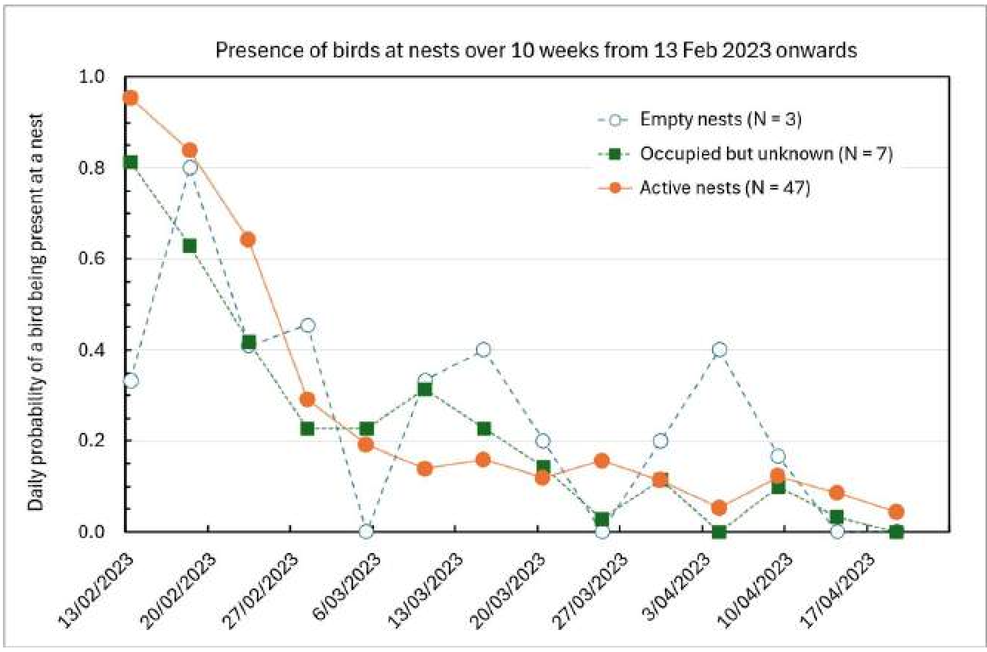

Figure 4. Daily probabilities of White-capped Albatrosses present at nests during the first 10 weeks following the start of hourly trail-camera observations on 13 February 2023. The contents of ca. 12% of the observed nests were never seen. They may have included other birds attending empty nests, for whatever reason.

In 2023, three of the nests being monitored from mid-February onwards were also clearly empty at the start. Even then, they were attended by an adult bird, sometimes two, on 32% of days for up to four weeks following camera deployment, although the pattern was erratic. As in 2018, this no doubt reflects the small sample size. Attendance dropped off sharply after early March (Fig. 4). Again, the overall breeding status of the birds attending these empty nests is not known. They could have lost an egg or young chick before observations started, or they could have either been birds that had bred the previous season and were skipping the current one but still occupying their site, or were incipient breeders, preparing to nest in the coming season(s). There were no comparable data for 2022 because no obviously empty nests were seen then from the outset.

In all three seasons there were many occupied nests where the contents were never seen, ranging from 50% of observed nests in 2018 to 14% in 2023. In all three years, their patterns of occupancy broadly mirrored those of birds at active nests, albeit with more variable probabilities of daily occurrence (Figs. 2–4). No doubt this reflected the mixed status of the attending birds, with some probably occupying empty nests (some of which could have failed earlier in the breeding season), while others may have been incubating an egg or brooding a small chick. Aside from instances where the view of an occupied nest was lost because of shifts in the camera's field of view, these latter nests probably failed at some point, given that if any of them had been successful, a well-developed chick would have eventually become visible.

Across the three seasons, 18 nest failures were seen directly. These included two instances of egg loss, both apparently due to breakage; nine chicks died in their nests, one being scavenged soon after by a Northern Giant Petrel, and another by a Subantarctic Skua. Seven chicks simply disappeared from their nests, six of them within an hour, the seventh sometime during a five-day period when the view of the nest was lost because of a shift in the camera's field of view. (These disappearances exclude any chicks that had fledged or were close to fledging.) The reasons for the deaths and disappearances are not known. Birds dying in the nest simply curled up and died (one was seen hanging over the edge of its nest, beneath a temporary brooding adult, apparently distressed, before dying). The chicks that disappeared must have been taken by a predator but by which species is unclear. In these instances, the whole chick disappeared, with nothing left behind, in contrast to when a chick died *in situ*, with the carcass being dismembered later, leaving bits of it lying around.

On all but two occasions, the death or disappearance of a chick was followed by a period in which one or both adults returned to the nest intermittently, although usually only for an hour or so at a time. On average, over the 12–45 days following nest failure (average 30 days, the variation depending on how long the nest was still in view), an adult was recorded on 29% of the days (range 10%–79%, N=16). In the two cases where no adults were recorded visiting a failed nest in the month following a chick dying in the nest, the two chicks were ca. 2.5–3 months old, older than the downy chicks dying earlier (feathers on the older chick had already begun to appear). Of course, given that images were taken hourly, there was much opportunity for an adult to visit the nest briefly then leave before the next image was taken. This caveat applies to all estimates of occupancy.

Fledging

Over the two seasons 2018 and 2022, 26–29 chicks fledged, depending on whether two well-developed chicks that left their nests in late June eventually fledged, and another apparently on the cusp of fledging did so soon after the camera monitoring it failed. Determining precise fledgling dates was often not possible because of the tendency of some chicks to wander outside the limited close-up fields of view of the cameras, even though they were judged to still be some days away from fledging proper. These were all assumed to have fledged at some point. Other chicks, close to fledging, moved around considerably, sometimes occupying the nest of an apparently already fledged individual.

The fledging period was reasonably accurately determined for nest 1B-2. The adult was clearly incubating an egg on 24/01/2018. The egg apparently hatched on 27/01/2018. The brood-guard phase lasted ca. 20–23 days, before the chick fledged on 12/07/2018, a 166-day fledging period (chick development is shown in Annex 3). This lengthy fledging period does not seem to be exceptional, based on the duration of other recorded post-guard durations. In 2018 and 2022, the mean post-guard phase, measured from the end of the brood-guard phase to apparent fledging was 157 ± 14 days (range 143–179 days, N = 28). Many fewer brood-guard stage durations were determined (mean 24 ± 9 days, range 12–33 days, N = 7). The overall chick-rearing period therefore averaged ca. 180 days.

White-capped versus Shy Albatross comparison

The breeding biology of the White-capped Albatross is much less well known than that of the closely related, same-sized Shy Albatross *Thalassarch cauta*. That species breeds on three small islands—Albatross, Mewstone and Pedra Blanca—located off Tasmania, Australia (Johnstone *et al*. 1975; Double *et al*. 2003; Hedd & Gales 2001, 2005; Hedd *et al*. 2001, 2002). Shy Albatross begin egg laying in late August (Hedd & Gales 2005), in contrast to early November in the White-capped Albatross, around two-and-a-half months later (White-capped Albatross were observed mating 5/11/2022–11/12/2002, implying eggs laid soon after). Shy Albatross eggs hatch between late-November and mid-December, with chicks fledging from late-March through April (Hedd & Gales 2005). Conversely, the first-observed White-capped Albatross chick, apparently just-hatched, was only recorded in mid-January. A few may have hatched earlier than that but, from the behaviour of the adults at the nests, all appeared still to be incubating. Two White-capped Albatross pairs that were seen copulating on 5/11/2022 and 17/11/2022, were followed by sightings of just-hatched chicks on 14/01/2023 and 30/01/2023, respectively, suggesting an incubation period of ca. 70–71 days. This is within the range reported for Shy Albatross: 68–75 days, average 72 days (Robertson & van Tets (1982, citing unpublished data from N Brothers and CJJ Robertson); and, separately, 73 days (N = 62) (Hedd & Gales 2005). White-capped Albatross chicks fledge 3–4 months later than in the Shy Albatross, from mid-July through to the end of August (earliest and latest recorded dates being 11 July and 26 August, N = 26). Mean fledging date was 30 July, more or less the same as the median date (29 July), with half of all chicks fledging between 21 July and 9 August.

Estimates for the duration of the fledging period in the two species differ greatly. On Albatross Island, Tasmania, Shy Albatross fledge on average at 127 ± 7 days (range 112–136 days; male chicks fledge 10 days later than female chicks, 128 ± 4 days versus 118 ± 8 days, respectively: Hedd *et al*. 2002). In marked contrast, the fledging period for White-capped Albatross is much longer. It was determined reasonably precisely at 166 days for one chick (nest 1B-2 in 2018), a value that is towards the lower bound of an average 180 days, estimated by combining the average duration of the post-guard stage for 28 pairs in 2018 and 2022 (156.7 ± 13.8 days, range 143–179 days), with the average brood-guard duration of a much smaller and more uncertain sample of seven nests: 23.9 ± 9.2 days, range 12–33 days. (Uncertainty stemmed from inexactness in determining just when an egg had hatched, and when the brood-guard stage ended and the post-guard phase began.) Nonetheless, even if only approximately correct, the fledging period for the White-capped Albatross is ca. 42% longer than in the Shy Albatross, a substantial difference.

The reason(s) for this disparity probably reflects a combination of differences in chick-provisioning rate, meal size and quality, and the contrasting climate conditions under which chicks of the two species are raised. Fish predominate in Shy Albatross chicks' diets, along with cephalopods, tunicates and crustaceans (Green 1974, Hedd & Gales 2001). On average, meals are generally small and delivered frequently, every 1.8 ± 0.6 days during the early chick-rearing period, when adults forage within less than 90 km of Albatross Island (Brothers *et al*. 1998; Hedd & Gales 2001; Hedd *et al*. 2001). In contrast, nothing detailed is known about White-capped Albatross diet although the species reportedly eats mainly fish, squid, krill, salps and fish discards from fishing vessels (Sagar 2013). This is broadly similar to the Shy Albatross's diet, albeit taken mainly from different parts of the southern ocean, and perhaps varying nutritionally. Adults tracked from the Auckland Islands during the chick-rearing stage fed mainly between the Auckland Islands and southern New Zealand, at an average distance of 250 ± 214 km from their colony, with some even foraging as far as the waters off south-east Australia (Thompson & Sagar 2006, 2008; Thompson *et al*., 2009). Overall, chick-rearing White-capped Albatrosses apparently travel further and for longer periods than Shy Albatross (Thompson & Sagar 2006), likely leading to chicks being fed less frequently. The interval between successive visits recorded at 35 nests in 2018 and 2022, truncated at 7 days (the maximum interval recorded for Shy Albatross by Hedd *et al*. 2001) averaged 3.2 ± 2.1 days (N = 84), almost twice as long as that reported for Shy Albatross. Less frequent meals, unless offset by larger meal sizes and/or higher food quality, will result in slower chick growth and a longer fledging period.

The Auckland Islands are also colder than Tasmania. No weather data are available for either Disappointment Island or Albatross Island, but some multi-year climate data series are available from nearby weather stations (Enderby Island, -50.4933, 166.2957, 24 km ENE of Disappointment Island for the period 1995-2025 https://data.niwa.co.nz/products/climate-station-statistics?filter:agentno=7340; and Cape Grim, -40.6831, 144.6899, 43 km due south of Albatross Island, for the years 1985–2023, https://www.bom.gov.au/climate/averages/tables/cw_091245.shtml). On average, mean monthly temperatures at Enderby Island are 3.6–5.4 °C lower than those at Cape Grim, and even colder, 4.3–9.3 °C lower, when wind chill is considered. Such temperatures and linked heat losses are also likely to affect chick growth rates.

Conclusion

The use of time-lapse photography to monitor the presence and activities of birds at nests, especially in remote locations where regular access is almost impossible, is clearly a major advance in studying the biology of species breeding in such areas (Black 2018, De Pascalis *et al*. 2018, Edney & Wood 2021). Apart from estimating breeding productivity, suitably positioned and programmed cameras have also been used to measure details such as the frequency and duration of foraging trips, nest attendance, timing of changeovers, division of labour between parents, and the incidence and nature of predation (De Pascalis *et al*. 2018). Not all these were possible in this study.

The cameras on Disappointment Island were originally installed to monitor the fate of nests, chick hatching and fledging dates, and the return dates of White-capped Albatrosses to their colony (Rexer-Huber *et al*. 2018). Given a known number of active nests in each camera's field of view it seems relatively simple to review the imagery a year later to see how many chicks fledged and when. It was immaterial that the nests themselves were not always visible, often obscured by intervening vegetation, because chicks near fledging were sufficiently large and conspicuous to be seen regardless of their surroundings (except when they moved early out of the camera's field of view).

In some sense it also does not matter that nest monitoring began part way through the breeding season, towards the end of incubation and the start of the brood-guard stage of chick development, provided that 'productivity' is then understood to be the chick survival rate from hatching to fledging. But overall this measure of productivity is incomplete and biased, unless there are additional data on how many nests, occupied earlier in the season, failed before observations started, and what proportion of these represent all active nests in the area that season. Such data were not available here. Moreover, in this study, the comparability of 'productivity' estimates between seasons was limited by unavoidable differences in when each set of seasonal observations started: mid-January in 2018 and mid-February in 2022 and 2023.

The proportion of continuously monitored nests in the present study that fledged chicks was 25%–30% in 2018, similar to that reported by Rexer-Huber *et al*. (2019; 29%). Chick survival recorded during the 2022 post–hatch-to-fledging period, 47%–53% (depending on assumptions about the fate of three large chicks still alive when two cameras failed), was less than the 66% reported by Elliott *et al*. (2023) for the same period, although higher than in 2018. The difference between the two estimates for 2022 may be due to differences in the number of active nests examined: 45 in this study compared with 33 nests monitored by Elliott *et al*. (2023). Small sample size is almost unavoidable when using cameras with limited fields of view covering scattered nesting individuals. The limitations that this imposes on the generality of any conclusions should be considered when framing the questions such studies are intended to answer.

The initial small sample sizes were further reduced by camera failures, either outright, such as cameras D10b in February 2022 and D1a in February 2023, or later, either when camera fields of view changed or drained batteries led to breakdown. One camera, D1b (2022), fell over. Others shifted back and forth, or tilted on their axes (3B in 2018, almost all the cameras set in February 2022, and cameras D5a, D7a, D9a and D10a, set in February 2023). The worst examples were cameras D5b–D8b, all of which shifted positions substantially 29–44 times between February 2022 and when they were retrieved a year later. These frequent shifts resulted in both temporary and permanent loss of view of nests being monitored. It is mystifying why the incidence of camera shifts increased noticeably from 2018 to 2023, despite efforts to secure them better and to shore up the waratahs on which they were fixed (Elliott *et al*. 2023).

Battery failure was a particular feature of the cameras set up in February 2023, eight of which failed early, after running for only 85 ± 23 days on average (range 54–116 days), with the battery-level indicators showing depleted batteries. Moisture build-up was another prominent defect, intermittent in some cameras but more persistent in others: 1A and 2A (2018), and D3a and D10a (2023) are examples. Assuming that the O-rings are intact and fitted properly, then condensation must be due to moist air trapped inside the camera body when it is closed up. The feasibility of including a sachet of desiccant to overcome this problem should be investigated, as well as sealing the outside joints with silicon, as is being done on Campbell Island (Johannes Fischer, pers. comm., email 27/01/2026).

Over time, the objectives of the trail camera monitoring programme have been expanded, with the expectation that the data could be used to produce "statistically robust daily survival rates" (Parker *et al*. 2024), as has been done for Salvin's Albatrosses (Thompson 2025, but note that even in that study, robust estimates were only obtained for all years combined). Whether this is achievable for White-capped Albatross is yet to be seen, although the pattern of survival shown in Fig. 1 provides a proxy for the more precise measures derived by Thompson (2025).

Apart from only intermittent observations of most nest contents, along with many camera failures and shifts in fields of view, there are some systemic drawbacks. These include challenging terrain and vegetation, small sample sizes, potential selection and survivorship biases through choosing to focus only on nests containing an egg or chick, and unavoidable varying start dates each season, affecting the age of chicks monitored.

Quantifying uncertainties arising from unclear sightings of nests, their contents, fates and associated timing of events, along with identifying and measuring those covariates that may influence these, is also problematic at present. The contents of almost a quarter (24%) of all 151 nests monitored from the start of the three seasons were never seen, so it is uncertain if they were empty or contained eggs or chicks that failed at some point. Some inferences could be made from changes in bird behaviour, especially occupancy, but that was changing across all nests anyway as the season progressed.

Nest contents were not visible in 53% of all 16,347 observed nest-days. This again illustrates the difficulty of monitoring the details of what is happening at these nests. Of course, for survival analysis, an observation of an egg or chick on a given date automatically means that the nest and its contents must have survived to that date, so a lack of observations up to then is largely immaterial. Any projections made beyond that must necessarily be shrouded in uncertainty, however, if the past incidence of clear views is used to predict later outcomes, as was done in the survival analysis shown in Fig. 1.

Recommendations

1. Any change to or expansion of objectives should entail a review of the set-up protocols, such as necessity and frequency with which nests and their contents be clearly seen, and what biases might arise from choosing where to position cameras and what nests to monitor.

2. To be fully meaningful, trail camera analyses need to be complemented with ancillary data, rather than relying simply on what can be seen in the images alone. Information on which nests in the cameras' fields of view were occupied and active, and what their contents were when the cameras were set up, should be an integral part of the meta-data for an image data set (assuming that such data are collected at the time). This should also include details on which nests were occupied by birds with readable numeric bands (birds with bands could often be seen but their numbers were seldom readable). Obviously, such data are necessarily separate from the trail-camera imagery, which is only retrieved later, but they should be incorporated later into the image meta-data once the image sets are recovered.

3. It would be particularly useful to have a marked-up image taken with an ordinary digital camera, identifying not only individual nests intended for monitoring but also their contents. This has been done since 2022, but apart from circling nests intended for later monitoring, no other information on these nests was available. Synoptic images should be taken in line with the trail camera, not from above, as was the case for the synoptic images accompanying the post-2022 image sets. Such views often differed from the in-line view (a parallax-vision problem). What was seen in the field was not necessarily what was visible in the images.

4. Ideally, cameras should be set up so that their fields of view look downslope. Fields of view looking upslope, or even on the level, where there is dense vegetation cover, make it difficult, sometimes impossible, to see what is happening at a nest.

5. All vegetation able to blow in front of camera lenses should be removed far enough back that it will not regrow before the camera is next serviced (alternatively, place the camera elsewhere). Wind-blown grass obscures the view.

6. When cameras are removed for servicing, even if just to change their batteries and SD cards, care should be taken that they are put back at the same height and pointing in the same direction as before (ideally focused on the same identifiable focal point in view as before). This would avoid the possibility that the field of view, and therefore the nests being monitored, change mid-way through the observation period (as happened in early 2023, resulting in the loss of view of some nests being monitored up to that point).

7. It would help to anticipate the seasonal changes in the angle and direction of the sun, so as to avoid or minimise direct sun glare, especially at dawn and dusk.

8. Persistent fogging suggest excess residual moisture inside the camera housing, something that could be reduced, if space allows, by including a sachet of silica gel or other desiccant. These are available in several sizes from a range of suppliers (*e.g.*, https://www.alchemypp.com/product/appsorb-packets-bags). Sealing the cameras with silicon would also help, to prevent moisture entering the camera, especially if there are doubts about the integrity and tightness of fit of the O-rings.

9. The list of codes used for assessing nesting success and survival currently only cover nest contents and whether they can be seen or not. Using trail cameras solely to monitor nest contents is not employing them to their full potential. Other aspects of the birds' behaviour can be seen daily and even hourly: presence of adults; interactions between birds, especially pairs; copulation; nest maintenance, chick feeding, etc. Some thought should be given as to how such phenomena can be incorporated (coded), so that the return on the time and expense of putting out the trail cameras and analysing the resulting images is maximised.

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Annex 1 (Tables)

Table A-1. Synopsis of all cameras, by year of establishment, together with their operational periods, numbers of nests observed and the number of nests for which the nest bowls could be clearly seen.

2018 Camera	Start date	End date	Duration (days)	Nests surveyed 2018	Nests surveyed 2019	Nest bowls visible
1A	19/01/2018	7/04/2018	79	10	0	0
1B	19/01/2018	19/10/2018	274	4	0	1
2A	19/01/2018	2/04/2018	74	5	0	2
2B	19/01/2018	11/07/2018	174	6	0	2
3A	19/01/2018	3/10/2018	258	7	1	3
3B	19/01/2018	9/11/2018	295	11	13	1

2022 Camera	Start date	End date	Duration (days)	Nests surveyed 2022	Nests surveyed 2023	Nest bowls visible
D1	16/02/2022	11/03/2022	24	7	0	7
D2	16/02/2022	8/02/2023	269	7	1	2
D3	16/02/2022	1/05/2022	75	4	0	3
D4	16/02/2022	12/02/2023	362	7	8	5
D5	16/02/2022	12/02/2023	362	4	7	4
D6	16/02/2022	12/02/2023	362	3	5	3
D7	16/02/2022	12/02/2023	362	6	7	2
D8	16/02/2022	3/12/2022	262	6	3	3
D9	16/02/2022	21/10/2022	248	8	3	2
D10	No images					

2023 Camera	Start date	End date	Duration (days)	Nests surveyed 2022	Nests active at end	Nest bowls visible
D1a	No images					
D2a	15/02/2023	4/05/2023	78	5	2	0
D3a	13/02/2023	19/11/2023	279	5	2*	5
D4a	13/02/2023	7/04/2023	53	6	4	4
D5a	13/02/2023	8/06/2023	115	6	4	2
D6a	15/02/2023	13/05/2023	87	6	5	2
D7a	13/02/2023	20/05/2023	96	10	4	3
D8a	13/02/2023	18/04/2023	64	6	4	5
D9a	13/02/2023	8/06/2023	115	6	1	3
D10a	13/02/2023	21/04/2023	67	7	5	2
*	Occupied nests not visible after 4/03/2023 due to camera slippage					

Table A-2. Summary of numbers of daily records from each nest for each nest-tag category obtained from trail-camera imagery at White-capped Albatross nests on Disappointment Island for the period 19/01/2018–14/09/2018. See Table 1 (main text) for nest-tag details.

Camera-Nest	NA	0	E	C	PG	F	D	Total
1A-1	79	0	0	0	0	0	0	79
1A-2	79	0	0	0	0	0	0	79
1A-3	35	0	0	0	44	0	0	79
1A-4	79	0	0	0	0	0	0	79
1A-5	79	0	0	0	0	0	0	79
1A-6	79	0	0	0	0	0	0	79
1A-7	79	0	0	0	0	0	0	79
1A-8	79	0	0	0	0	0	0	79
1A-9	62	0	0	0	17	0	0	79
1A-10	31	0	0	0	48	0	0	79
1B-1	35	0	0	13	159	1	0	208
1B-2	8	0	1	23	142	1	0	175
1B-3	184	0	0	3	31	1	0	219
1B-4	231	0	0	3	5	0	0	239
2A-1	25	0	0	13	36	0	0	74
2A-2	60	0	0	0	14	0	0	74
2A-3	43	0	0	2	29	0	0	74
2A-4	50	0	0	1	21	0	0	72
2A-5	71	0	0	0	0	0	0	71
2B-1	23	0	2	0	0	0	1	26
2B-2	28	0	0	13	133	0	0	174
2B-3	23	0	0	15	14	0	1	53
2B-4	174	0	0	0	0	0	0	174
2B-5	174	0	0	0	0	0	0	174
2B-6	174	0	0	0	0	0	0	174
3A-1	40	0	0	0	154	1	0	195
3A-2	196	0	0	0	0	0	0	196
3A-3	28	0	0	4	9	0	1	42
3A-4	196	0	0	0	0	0	0	196
3A-5	196	0	0	0	0	0	0	196
3A-6	50	0	0	1	4	0	0	55
3A-7	197	0	0	0	0	0	0	197
3B-1	3	235	0	0	0	0	0	238
3B-2	37	0	0	1	143	1	0	182
3B-3	238	0	0	0	0	0	0	238
3B-4	238	0	0	0	0	0	0	238
3B-5	60	0	0	0	62	0	1	123
3B-6	238	0	0	0	0	0	0	238
3B-7	238	0	0	0	0	0	0	238
3B-8	238	0	0	0	0	0	0	238
3B-9	233	5	0	0	0	0	0	238
3B-10	3	235	0	0	0	0	0	238
3B-11	238	0	0	0	0	0	0	238
Totals	**4651**	**475**	**3**	**92**	**1065**	**5**	**4**	**6295**

Table A-3. Summary of numbers of daily records from each nest for each nest-tag category obtained from trail-camera imagery at White-capped Albatross nests on Disappointment Island for the period 16/02/2022–14/09/2022. See Table 1 (main text) for nest-tag details.

Camera-Nest	NA	0	E	C	PG	F	D	Total
D1-1	5	0	0	5	3	0	0	13
D1-2	6	0	0	7	0	0	0	13
D1-3	4	0	0	5	4	0	0	13
D1-4	5	0	0	3	16	0	0	24
D1-5	1	0	0	2	19	0	0	22
D1-6	9	0	0	7	3	0	0	19
D1-7	14	0	0	5	0	0	0	19
D2-1	1	0	0	6	114	1	0	122
D2-2	47	0	0	0	5	0	0	52
D2-3	3	0	0	7	54	0	0	64
D2-4	26	0	0	2	24	0	0	52
D2-5	13	0	0	0	40	0	0	53
D2-6	3	0	0	0	5	0	0	8
D2-7	8	0	0	0	0	0	0	8
D3-1	12	0	0	1	62	0	0	75
D3-2	75	0	0	0	0	0	0	75
D3-3	5	0	0	2	21	0	1	29
D3-4	1	0	0	0	0	0	0	1
D4-1	4	1	0	4	166	1	0	176
D4-2	1	1	0	6	161	1	0	170
D4-3	0	18	0	4	141	1	0	164
D4-4	13	1	0	0	159	1	0	174
D4-5	10	2	0	0	155	1	0	168
D4-6	13	2	0	1	161	1	0	178
D4-7	3	15	0	0	150	1	0	169
D5-1	4	0	0	4	154	1	0	163
D5-2	1	0	0	7	166	1	0	175
D5-3	5	0	0	9	142	1	0	157
D5-4	2	0	0	5	146	1	0	154
D6-1	3	0	0	0	153	1	0	157
D6-2	0	0	0	4	153	1	0	158
D6-3	17	0	0	0	2	0	0	19
D7-1	0	8	0	4	122	0	0	134
D7-2	4	0	0	0	134	0	0	138
D7-3	11	0	0	4	2	0	1	18
D7-4	7	7	0	2	112	0	0	128
D7-5	4	0	0	0	7	0	0	11
D7-6	5	0	0	0	4	0	0	9

Table A-3 (continued)

Camera-Nest	NA	0	E	C	PG	F	D	Total
D8-1	9	0	0	0	110	0	0	119
D8-2	10	1	0	3	155	1	0	170
D8-3	0	0	0	0	1	0	0	1
D8-4	2	11	0	6	118	1	0	138
D8-5	26	0	0	0	84	0	0	110
D8-6	110	0	0	0	0	0	0	110
D8-7	3	8	0	5	157	1	0	174
D8-8	15	1	0	1	147	1	0	165
D9-1	0	0	0	6	23	0	0	29
D9-2	0	0	0	9	153	1	0	163
D9-3	21	0	0	0	138	1	0	160
D9-4	13	0	0	0	140	1	0	154
D9-5	10	0	0	1	142	1	0	154
Totals	**564**	**76**	**0**	**137**	**4128**	**22**	**2**	**4929**

Table A-4. Summary of numbers of daily records from each nest for each nest-tag category obtained from trail-camera imagery at White-capped Albatross nests on Disappointment Island for the period 15/09/2022–12/02/2023. See Table 1 (main text) for nest-tag details.

Camera-Nest	NA	0	E	C	PG	F	D	Row totals
D1b			No images					0
D2b-1	75	70	2	0	0	0	0	147
D2b-2	0	0	0	0	0	0	0	0
D2b-3	0	0	0	0	0	0	0	0
D2b-4	0	0	0	0	0	0	0	0
D2b-5	0	0	0	0	0	0	0	0
D2b-6	0	0	0	0	0	0	0	0
D2b-7	0	0	0	0	0	0	0	0
D3b-1			No images					0
D4b-1	1	150	0	0	0	0	0	151
D4b-2	25	126	0	0	0	0	0	151
D4b-3	72	78	1	0	0	0	0	151
D4b-4	136	15	0	0	0	0	0	151
D4b-5	126	25	0	0	0	0	0	151
D4b-6	151	0	0	0	0	0	0	151
D4b-7	149	0	0	2	0	0	0	151
D4b-8	124	22	0	5	0	0	0	151
D5b-1	2	138	0	0	0	0	0	140
D5b-2	9	138	0	0	0	0	0	147
D5b-3	123	25	0	0	0	0	0	148
D5b-4	30	56	1	0	0	0	0	87
D5b-5	0	138	0	0	0	0	0	138
D5b-6	83	56	2	3	0	0	1	145
D5b-7	119	0	0	0	0	0	0	119
D6b-1	59	72	0	0	0	0	0	131
D6b-2	7	135	0	0	0	0	0	142
D6b-3	71	0	0	0	0	0	0	71
D6b-4	0	142	0	0	0	0	0	142
D6b-5	132	9	0	3	0	0	0	144
D7b-1	39	7	0	0	0	0	0	46
D7b-2	37	0	0	0	0	0	0	37
D7b-3	84	0	0	4	0	0	0	88
D7b-4	85	0	2	1	0	0	0	88
D7b-5	51	0	0	0	0	0	0	51
D7b-6	51	0	0	0	0	0	0	51
D7b-7	94	0	0	0	0	0	0	94

Table A-4 (continued)

Camera-Nest	NA	0	E	C	PG	F	D	Row totals
D8b-1	0	0	0	0	0	0	0	0
D8b-2	17	0	0	0	0	0	0	17
D8b-3	3	0	0	0	0	0	0	3
D8b-4	24	21	0	0	0	0	0	45
D8b-5	17	3	0	0	0	0	0	20
D8b-6	30	2	0	0	0	0	0	32
D8b-7	3	69	0	0	0	0	0	72
D8b-8	8	0	0	0	0	0	0	8
D9b-1	0	0	0	0	0	0	0	0
D9b-2	37	0	0	0	0	0	0	37
D9b-3	37	0	0	0	0	0	0	37
D9b-4	37	0	0	0	0	0	0	37
D9b-5	37	0	0	0	0	0	0	37
Totals	**2185**	**1497**	**8**	**18**	**0**	**0**	**1**	**3709**

Table A-5. Summary of numbers of daily records from each nest for each nest-tag category obtained from trail-camera imagery at White-capped Albatross nests on Disappointment Island for the period 13/02/2023–8/06/2023. See Table 1 (main text) for nest-tag details.

Camera-Nest	NA	0	E	C	PG	D	F	Total
D1a				No images				0
D2a-1	79	0	0	0	0	0	0	79
D2a-2	79	0	0	0	0	0	0	79
D2a-3	8	0	0	5	66	0	0	79
D2a-4	2	0	0	0	77	0	0	79
D2a-5	79	0	0	0	0	0	0	79
D3a-1	0	0	0	0	3	1	0	4
D3a-2	5	0	0	5	0	1	0	11
D3a-3	0	19	0	0	0	0	0	19
D3a-4	1	0	0	0	18	0	0	19
D3a-5	0	0	0	3	16	0	0	19
D4a-1	54	0	0	0	0	0	0	54
D4a-2	2	0	0	5	35	1	0	43
D4a-3	3	0	0	8	43	0	0	54
D4a-4	10	0	0	2	42	0	0	54
D4a-5	17	0	0	0	32	0	0	49
D4a-6	15	0	0	0	32	0	0	47
D5a-1	5	0	0	8	103	0	0	116
D5a-2	48	0	0	0	68	0	0	116
D5a-3	1	0	0	2	78	1	0	82
D5a-4	7	0	0	1	108	0	0	116
D5a-5	19	0	0	2	95	0	0	116
D5a-6	5	110	0	0	0	0	0	115
D6a-1	9	0	0	10	69	0	0	88
D6a-2	1	0	0	6	81	0	0	88
D6a-3	45	0	0	0	43	0	0	88
D6a-4	23	0	0	2	63	0	0	88
D6a-5	2	0	0	1	85	0	0	88
D6a-6	74	0	0	0	14	0	0	88
D7a-1	13	0	0	0	60	0	0	73
D7a-2	0	0	0	3	77	0	0	80
D7a-3	3	0	0	1	2	0	0	6
D7a-4	3	0	0	0	0	0	0	3
D7a-5	2	0	0	9	86	0	0	97
D7a-6	43	0	0	0	54	0	0	97
D7a-7	8	0	0	2	6	1	0	17
D7a-8	97	0	0	0	0	0	0	97
D7a-9	58	0	0	0	39	0	0	97
D7a-10	95	0	0	0	2	0	0	97

Table A-5 (continued)

Camera-Nest	NA	0	E	C	PG	D	F	Total
D8a-1	1	0	0	5	59	0	0	65
D8a-2	0	0	0	7	58	0	0	65
D8a-3	7	0	0	10	19	1	0	37
D8a-4	10	0	0	1	54	0	0	65
D8a-5	11	0	0	0	54	0	0	65
D8a-6	0	0	0	8	11	1	0	20
D9a-1	6	0	0	7	48	1	0	62
D9a-2	116	0	0	0	0	0	0	116
D9a-3	1	0	0	9	2	1	0	13
D9a-4	1	0	0	7	108	0	0	116
D9a-5	6	0	0	5	17	1	0	29
D9a-6	3	0	0	5	8	1	0	17
D10a-1	28	0	0	4	30	0	0	62
D10a-2	50	0	0	0	13	0	0	63
D10a-3	17	0	0	0	43	0	0	60
D10a-4	16	0	0	0	48	0	0	64
D10a-5	3	0	0	8	56	0	0	67
D10a-6	8	0	0	0	0	1	0	9
D10a-7	0	13	0	0	0	0	0	13
Total	**1199**	**142**	**0**	**151**	**2125**	**12**	**0**	**3629**

Annex 2

Side-by-side contrasts of the fields of view of trail cameras D1b–D9b positioned in February 2022, with their differently numbered and oriented apparent replacements put out in February 2023. Camera D10b (2022) failed at the start, so its field of view is unknown. The same happened to camera D1a (2023). The yellow circles denote control points used to determine the broad equivalence of the 2022 and 2023 camera fields of view. No control points could be identified for camera 3 (2022) and camera 6a (2023); see text for further discussion of these. The broad equivalents of the fields of view of camera D6b (2022) and D7a could not be identified. They may be those of the cameras that failed.


Camera D4b - Feb 2022


Camera 10a - Feb 2023


Camera D5b - Feb 2022


Camera D8a - Feb 2023


Camera D7b - Feb 2022


Camera D4a - Feb 2023


Camera D8b - Feb 2022


Camera D3a - Feb 2023

No obvious equivalent among the 2023 'after servicing' images

No obvious equivalent among the 2022 'after servicing' images. Downslope from cameras D9b and D7a (see above)

Annex 3

Images taken from camera 1B in 2018 showing the development of the chick 1B-2, from presumed hatching on 27 January 2018 to when it fledged on 12 July 2018, 166 days later. Other than the first couple of days, the remaining images are taken ca. 7 days apart.

Chick 1B-2 development continued

Chick 1B-2 development continued