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Southern royal albatross at Enderby Island — analysis of aerial photographs 2014

Draft Report

Report prepared for

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1. Introduction

The southern royal albatross (*Diomedea epomophora*) is an endemic New Zealand seabird species that breeds on sub-Antarctic islands. Most birds (99%) breed on Campbell Island with a small number of birds breeding on the Auckland Island group, including Enderby and Adams Is (ACAP 2009). The species is a biennial breeder and is currently assessed as Vulnerable to extinction. Historically all colonies were impacted to some extent by human exploitation, agriculture and introduced mammals, but the major threat is now considered to be fisheries bycatch in longline and trawl fishing operations (ACAP 2009).

The global population is estimated to number 8,300-8,700 annual breeding pairs on Campbell Island (Moore et al. 2012), with a further 60 pairs breeding each year on Enderby Island. Recent counts on Enderby Island in 2002-2008 have fluctuated from 52 to 66 nests annually (L. Chilvers unpublished data, in ACAP 2009).There are no recent data on the number of pairs breeding on Adams and Auckland Island but in the early 1990s there were 15 and five pairs, respectively. The main population of southern royal albatrosses on Campbell Island is thought to have recovered following a major reduction due to human settlement and introduced mammals and to have stabilised between 1995 and 2004-08 (Moore et al. 2012). On Enderby Island, where royal albatrosses were extirpated by human exploitation by about 1868 (Taylor 1971), the population has steadily increased after re-colonising the island in the 1940s (Childerhouse 2003, ACAP 2009). Trends for the Adams and Auckland Island populations are unknown.

Accurate estimation of numbers is critical for determining conservation status, and for identifying the key factors influencing changes in population size and demography of albatrosses. In recent years technological advances in both cameras, lenses and image processing software, have led to aerial photography becoming increasingly preferred as the census method of choice for surface nesting seabirds, especially in remote locations (Wolfaardt and Phillips 2011). The technique has been applied to a range of colonially nesting albatross and petrel species including black-browed albatross *Thalassarche melanophrys* and grey-headed albatross *T. chrysostoma* in Chile (Arata et al. 2003; Robertson et al. 2007), black-browed albatrosses in the Falkland Islands (Strange 2008), white-capped albatrosses *T. steadi* in New Zealand (Baker et al. 2014), shy albatross *T. cauta* in Australia (Alderman et al 2011) and southern giant petrels *Macronectes giganteus* in the Falkland Islands (Reid & Huin 2008).

Not all colonies lend themselves to being censused accurately by aerial photography, and those photographed successfully at this stage have been high-density colonies. Techniques used for colonial species have involved low altitude flights over colonies and taking sequential overlapping photographs which are later stitched together using software to form photomontages, from which apparently occupied nests are counted on-screen (Wolfaardt and Phillips 2011). Most of the great albatross (*Diomedea spp*.) species are not highly colonial and nests are typically widely dispersed. As a result aerial censusing has not been attempted so far for albatross populations that possess these characteristics. Large distances between nests that are placed in essentially featureless topography pose challenges that may not be easily addressed through existing techniques, and their effectiveness needs to be tested for these more dispersed species.

In January 2014 we took a series of aerial photos of southern royal albatross breeding on Enderby Island, looking to build on a study we commenced in 2013 (Baker and Jensz 2013). At the same time, we carried out a similar study on Gibson's albatross breeding on nearby Disappointment Island (reported on separately, Baker and Jensz 2014). The aim of these two studies is to better assess the suitability of aerial methods for these species or sites; and ultimately provide recommendations for developing a standard aerial survey methodology for great albatross species.

2. Methods

The Site

The Auckland Islands (50^0 44'S, 166^0 06'E) lie 460 km south of New Zealand's South Island, and comprise the largest island group in the New Zealand sub Antarctic. The archipelago consists of four larger islands (Auckland, Enderby, Adams and Disappointment Islands), together with a set of smaller islands (Peat 2006). Within the archipelago, southern royal albatrosses breed mainly on Enderby Island, with a few birds nesting on the high slopes of Adams Island, notably above Gilroy Head and between Fly Harbour and Lake Turbott (Tickell 2000).

Enderby Island (50°30´S, 166°20´E) is a small (710 ha) low lying island with a maximum elevation of 45 metres located at the northern end of the Auckland Islands archipelago. Southern rata *Metrosideros umbellata* form thick forests and scrub along the south and east side of the island, but elsewhere the vegetation changes to a moorland that covers a broad belt in the centre of the island, with tussock grassland dominating the lower lying, more exposed areas (Russ & Terauds 2009). Most of the c. 60 pairs of southern royal albatross breeding each year on Enderby Island nest within the moorland and grassland vegetation.

Field Work

On 20 January 2014 between 1900 to 2030 NZDT we used a helicopter chartered from Southern Lakes Helicopters Company as an aerial platform to photograph nesting southern royal albatrosses on Enderby Island. This timing was not ideal but was selected for operational reasons. Flight times between 1000 to 1600 NZDT are preferred as most non-breeding birds are not present in colonies during these times. The aircraft, a single-engined Squirrel AS350B3, was piloted by Mark Deaker (Southern Lakes Helicopters Company). On board was Barry Baker (photographer and project coordinator), Mark Holdsworth (back-up photographer), and Louise Chilvers (Department of Conservation representative).

We flew a series of nine transects (Figure 1) spaced at 200 m centres that ran from west to east, and took a series of overlapping photographs as each transect was traversed. Transect start and end points, shown below, were programmed into the on-board GPS system and the helicopter was flown along each transect at a constant flight height of 600 ft.

Transect No.	**Start (**decimal mins)		**End (**decimal mins)	
	Latitude	**Longitude**	**Latitude**	**Longitude**
1	50 30.270	166 16.0	50 30.270	166 19.417
2	50 30.162	166 16.0	50 30.162	166 19.417
3	50 30.054	166 16.0	50 30.054	166 19.417
4	50 29.946	166 16.0	50 29.946	166 19.417
5	50 29.838	166 16.0	50 29.838	166 19.417
6	50 29.730	166 16.0	50 29.730	166 19.417
7	50 29.622	166 16.0	50 29.622	166 19.417
8	50 29.514	166 16.0	50 29.514	166 19.417
9	50 29.405	166 16.0	50 29.405	166 19.417

For the photography, two photographers were positioned on the port side of the aircraft to permit each to take photographs of the island simultaneously. All photographs were taken through the open port side of the aircraft using Nikon D800 digital cameras and Nikkor 24— 70 mm F2.8 or Nikkor 16—35 mm F4 VR zoom lenses. Shutter speeds were set at 1/1000 s or faster to minimise camera shake, and the camera held facing downward at an angle of 70 degrees. This ensured the plane of focus was as parallel to the surface as possible without allowing the aircraft landing skid to appear in the camera viewfinder. The focal length of the zoom lens was not adjusted as transects were traversed. From each transect we produced a series of overlapping images that covered the entire length of the transect. All photographs of the colony were saved as fine JPG format files. The survey photographs of Enderby Island were taken at an altitude of 600 feet with the zoom lenses set at a focal length of 35 mm (note that in 2013 all photographs were taken at an altitude of 700 feet). The combination of flight height and focal length was derived from an earlier trial of lens/flight height combinations designed to ensure complete ground coverage (adequate overlap between transects) when used with 200 m transects, and analysis of photographs taken in 2013 at 700 feet, where overlap was found to be excessive. At the time of the flight the weather was calm and clear with minimal cloud, and we were able to obtain clear photographs of the island during the flight. The entire sets of photographs were subsequently replicated to ensure that complete back-up sets existed both on portable hard drives and in at least three different locations. A full collection of photographs will also be submitted to the Department of Conservation on the completion of the contract.

Counting protocol

We used protocols previously developed for aerial censuses of Chilean albatross colonies (Arata et al, 2003; Robertson *et al*. 2007) and refined in other aerial surveys work in the Auckland Islands (Baker et al 2014). Briefly, photographic montages of each transect (Figure 2) were constructed from overlapping photographs using the image editing software package ADOBE PHOTOSHOP (http://www.adobe.com/). Counts of all royal albatrosses on each montage were then made by magnifying the image to view birds and using the paintbrush tool in PHOTOSHOP to mark each bird with a coloured circle as they were counted. To assist with counting we used a hand held click counter. Once all birds had been counted on a photo-montage, the file was saved to provide an archival record of the count. Each single bird was assumed to represent a breeding pair. While most birds were alone at nest sites, we also counted instances when two birds were sitting close together and assumed to both be members of a nesting pair. In this situation, both birds were counted, and the number of pairs recorded. The number of pairs was subsequently deducted from the total number of birds to derive an estimate of annual breeding pairs.

Diomedea epomophora breeds biennially if successful in rearing a chick. Birds return to colonies in October. Eggs are laid from late November to late December Incubation takes on average 78.5 ± 2.8 days with chicks hatching in early February to early March, and fledging in early October to early December. Age of first return to colonies is at least 5 years and age at first breeding is thought to be around 6-12 years of age (ACAP 2009 and references therein). The photography was undertaken during the mid-incubation period and when chicks hatched in the previous year had fledged and left the island. However, pre-breeding juveniles (age >5 years) were also present on the island, usually occurring in groups comprising two of more individuals. We also counted non-breeding birds, assuming that any birds that were visibly standing or associated with other birds to be non-breeders.

Counts of photo montages were undertaken by one observer only and no attempt was made to investigate counter variability associated with miscounting and misidentifying white spots on the ground as birds, or confusing age classes.

Ground counts

Between 8-15 February 2014 (three weeks after the aerial photography) a complete search of Enderby I. for royal albatross nests was made using techniques described by Childerhouse et al (2003). Briefly, searching was undertaken on foot generally starting at the western end of the Island and moving to the eastern end. Searches were undertaken by up to 2–3 people, walking 20–40 m apart, keeping in visual and voice contact. Most of the effort was spent searching the relatively clear herbfields and along the edge of the rata forest and mapou (*Myrsine* sp.) bush on the top (approximately 40 m a.s.l.) of the Island. Other parts of the Island were surveyed opportunistically as time permitted. The only areas which were not searched were inside the dense rata forest which has an average canopy height of 4–5 m.

Most searches were conducted by naked eye, but binoculars were used to scan areas from high vantage points prior to ground searches. If a bird or suspected nest was seen from a distance, it was visited to confirm the presence of a nest. The locations of all nests were marked on a map and GPS positions of nests were taken using a handheld GPS.

3. Results

3.1 Aerial counts

We counted a total of 80 birds on the transect photomontages, of which 44 were clearly associated with a nest, and 12 which were clearly non-breeding birds. Breeding status was uncertain for the remaining 24 birds (Table 1). No birds visible in the photomontages were considered as being the partner of an incubating bird. Using the proportion of nesting birds to total birds where breeding status was clear (0.79), we estimate that a further 19 birds were nesting. Consequently we estimate there were 63 nesting pairs of southern royal albatross breeding on Enderby Island in January 2014.

3.2 Ground counts

Ground searches found 52 pairs of nesting southern royal albatross breeding on Enderby Island in January 2014. The location of these nests were plotted and overlain on an aerial photograph of Enderby Island (Figure 1).

4. Discussion

In 2013 the counts of nesting royal albatross breeding pairs derived from aerial photography were very similar to those resulting from ground searches, demonstrating that the methodology we used had good potential for use with other great albatross species nesting in similar habitat. In 2014, the estimate of breeding birds based on aerial photography was 21% higher than the estimate derived from ground counts.

It was not always possible to align nest sites plotted from ground counts with birds identified in aerial photos. However, an area was identified on Transect 5 where at least five birds (2 clearly sitting on nests, 3 uncertain) had not been sighted during the ground count (Figure 1). If all these birds were breeding, the difference between the two estimates would be reduced by up to 10 %. The difference may also have been due, in part, to the three week difference in timing of the counts, with some level of nest failure possible between the timing of both counts.

The over-flight height and lens/camera combination (700 feet/35mm focal length on a full-frame sensor) selected for the 2013 counts provided practical spatial coverage and adequate overlap between transects, while also providing image quality that allowed easy detection of nesting birds. In practice, the 2013 photos had more overlap than was needed, and image quality, while fit for purpose, did not allow close inspection of birds when magnified to the level necessary to be confident of assessing breeding status in most situations. For this reason, we felt that reducing the flight height to 600 feet, while maintaining the other aspects of the flight height and lens/camera specification, would lead to improvements in image quality. This did not prove to be the case: we did not achieve complete overlap in c.60% of the images (although in practice this was only a minor problem that would have led to very few, if any, birds being missed) and the image quality was not improved. The loss of coverage may have been due to slight flight deviations in the course of a transect. Failure to improve image quality may have been due to the lens used, which differed from that used in the 2013 counts, or because photos taken in 2013 were taken in raw, rather than fine JPEG, format. Future work should critically appraise the use of both raw and fine JPEG files for surveys of great albatrosses, taking into account the issues of slow-write speed and camera buffering issues associated with taking many large raw files in rapid succession, which is often necessary with photographic projects of this type.

Photo resolution at the flight height and lens combination selected was generally adequate for determining breeding status of many birds but was not at the level currently achieved in photographic surveys of white-capped albatross in the Auckland Islands (Baker et al 2014). This is to be expected because of the wider focal length selected for this project (35mm v 70mm minimum selected for white-capped albatross surveys) but we would have preferred greater resolution to improve confidence when assessing the status of birds detected. We classified any bird clearly sitting on the ground to be nesting, but we were unable to actually see nesting material, which would have been useful. Birds that were clearly non-breeding were obvious because their feet were evident or it was clear from their posture they were standing, but it is possible some loafing non-breeders may have been resting on the ground and assumed to be incubating. Taking further photographs of a random selection of birds using a longer focal length lens following the completion of transect work may be useful in future studies. This would provide a representative sample of ‘close-up’ photographs that could be used to confirm the proportion of breeding/non-breeding birds in colonies, as is currently practice in white-capped albatross surveys (Baker et al 2014).

Stitching of photographs along transects was easily achieved but determining areas of spatial overlap between each transect was time consuming and, at times, difficult. This problem was largely due to the slight distortion between the top and bottom of each photograph, caused because it was not possible to hold the camera directly parallel to the ground surface. Ideally the camera should be held facing downward at an angle of 90 degrees, and not 70 degrees, as was necessary because of the layout of the aircraft. The photographic distortion was comparatively small but when looking to find visible features that can be used to assess overlap in photographs, it was sufficient to make the task more difficult than it would be with distortion-free images. With widely dispersed species, as is the case with southern royal albatross, the error associated with either missing birds due to minimal overlap (e.g. 2014 photographs) or double-counting birds when overlap is greater (e.g. 2013 photographs) is likely to be less than 2%.

Given the spatial extent of some great albatross populations, it may be more appropriate to use randomised or stratified transects to sample populations and develop scaled-up estimates of population size. The technique we trialled would be suitable for this purpose, but it would be necessary to accurately assess the spatial coverage (transect width) obtained by a particular camera/focal length/flight height combination. Although this can be calculated theoretically using camera and lens specifications for a specified flight height, experience has shown that such data are not always accurately stated by gear manufacturers and we would recommend that this be determined by measurement in the field prior to commencing such surveys. Specifying camera/lens combinations and flight heights would enable transect widths to be standardised. In conducting fixed width transects for sampling populations consideration should be given to the use of a fixed focal length lens to avoid accidental movement of zoom lens settings for focal length, and appropriate GPS technology in selected aircraft to ensure specified flight heights are maintained over variable terrain. It is also necessary to specify a lens and camera specification that has been field tested, as the specifications prepared by lens manufacturers do not accurately state focal lengths.

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Table 1. **Counts of nesting and non-breeding southern royal albatross, made from photomontages taken on nine aerial transects, Enderby Island, 20 January 2014.**

Bird		Assessment			Nest ground
	Transect	Breeding	Non-breeding	Uncertain	count number
1	T2			1	
2	T2			1	
3	T2	1			24
4	T3	1			21
5	T3	1			22
6	T3	1			Not ID'd
7	T3	1			Not ID'd
7a	T3		1		
8	T4	1			17
9	T4	1			16
10	T4	1			15
11	T4		1		
12	T4	1			18
13	T4	1			14
14	T4	1			Not ID'd
15	T4			1	
16	T4			1	
17	T4			1	31
18	T5	1			Not ID'd
19	T5			1	11
20	T5	1			12 or 13
21	T5		1		
22	T5	1			Not ID'd
23	T5		1		
24	T5	1			Not ID'd
25	T5			1	Not ID'd
26	T5			1	Not ID'd
27	T5			1	Not ID'd
28	T5			1	5
29	T5	1			2
30	T5	1			1
30a	T5		1		
31	T5	1			26
32	T5			1	33

33	T5			1	
34	T5	1			28
35	T5	1			32
36	T5			1	29
37	T5			1	30
38	T5	1			51
39	T5	1			52
40	T5			1	
41	T5	1			Not ID'd
42	T6		1		
43	T6		1		
44	T6			1	6
45	T6	1			8
46	T6	1			9
47	T6	1			10
48	T6	1			Not ID'd
49	T6			1	
50	T6			1	7
51	T6			1	
52	T6			1	4
53	T6	1			Not ID'd
54	T6	1			Not ID'd
55	T6	1			3
56	T6	1			Not ID'd
57	T6	1			25
58	T6	1			Not ID'd
59	T6	1			Not ID'd
60	T6	1			41
61	T6	1			40
62	T6	1			39
63	T6			1	47
64	T6		1		46
65	T6			1	36
66	T6	1			38
77	T6			1	33
68	T6	1			34
69	T6		1		
70	T6		1		49

71	T6	1			50
72	T7	1			42
73	T7	1			43
74	T7	1			48
75	T7	1			44
76	T7		2		
78	T7			1	35
Totals		**44**	**12**	**24**	

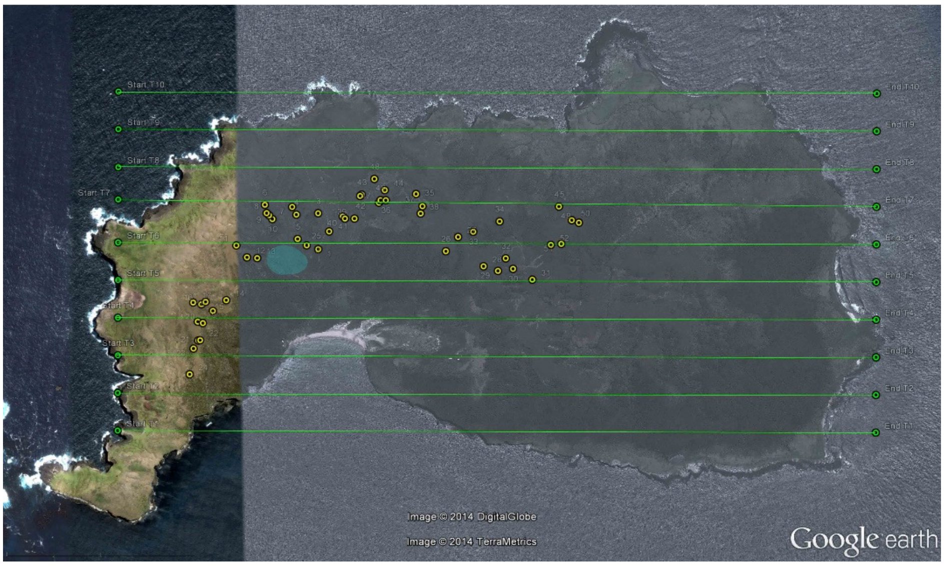

Figure 1. **Location of transects spaced at 200 m centres, Enderby Island, and nests identified from ground counts (yellow dots). The green shading indicates an area where at least five birds (2 on nest, 3 uncertain) evident in photos were not sighted during the ground counts.**

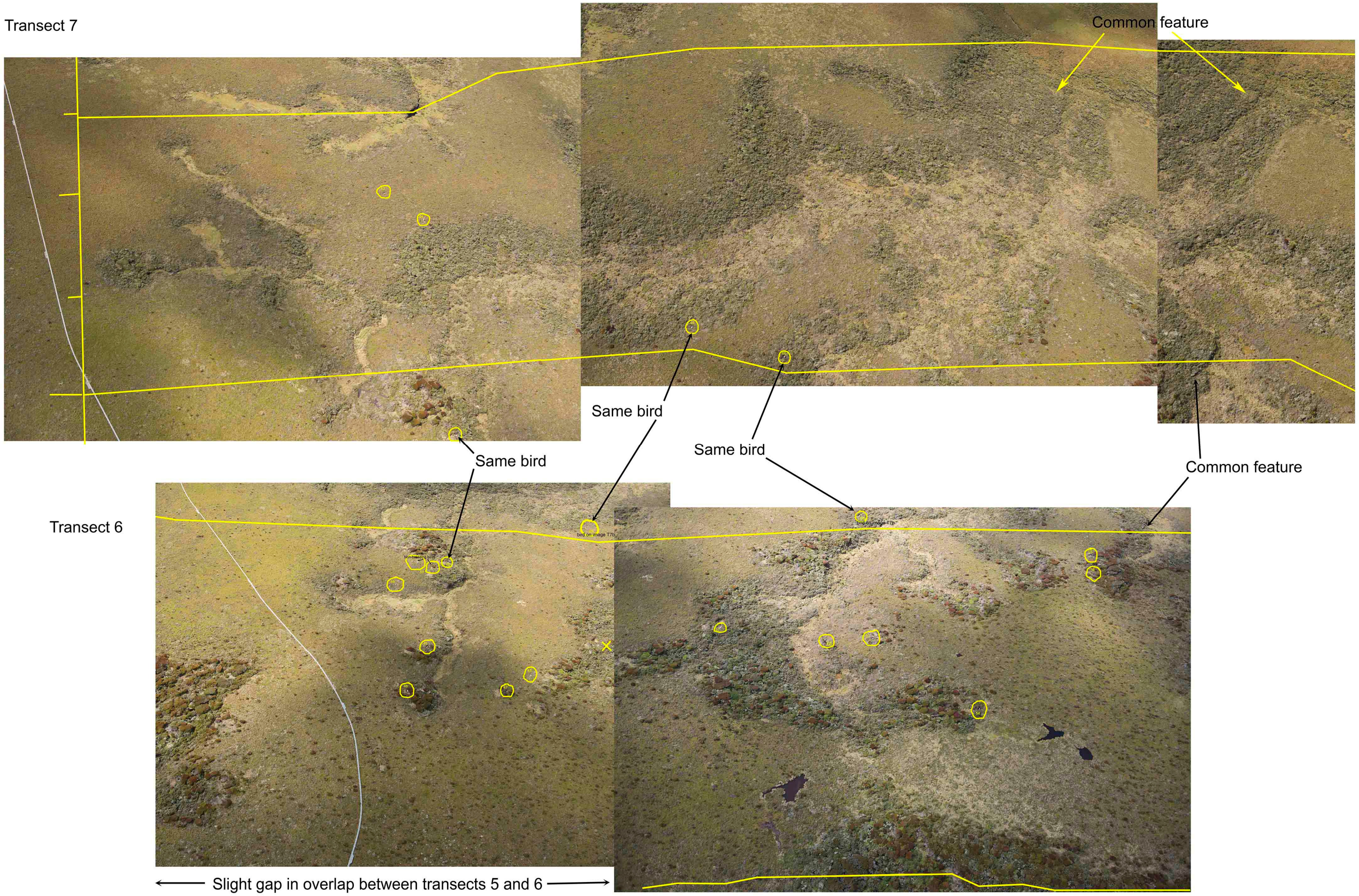

Figure 2. **Example of photographic montages of two transects constructed from overlapping photographs (2013 data). Southern royal albatross nesting birds are indicated by the yellow circles. Common features are used to identify overlap between transects.**

Figure 3. **Examples of images of southern royal albatrosses and their breeding status assessed from aerial photograhs.**