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Data collection of demographic, distributional and trophic information on the white-capped albatross to allow estimation of effects of fishing on population viability — 2009 Field Season

Report prepared for

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Data collection of demographic, distributional and trophic information on the white-capped albatross to allow estimation of effects of fishing on population viability — 2009 field season

Objective 3 — Milestone 3

White-capped albatross — gather data to estimate population size and trend on Disappointment Island. Pilot study

1. Introduction

White-capped albatrosses *Thalassarche steadi* are endemic to New Zealand, breeding on Disappointment Island (72 000 pairs), Adams Island (100 pairs) and Auckland Island (3 000 pairs) in the Auckland Island group, and Bollons Island (50-100 pairs) in the Antipodes Island Group (Gales, 1998). These population size estimates of Gales (1998) suggest most (95%) of the global population breeds on Disappointment Island, an area where access is restricted to maintain environmental values at the site. Virtually all aspects of the biology and ecology of white-capped albatrosses are poorly known and although approximate population sizes are given above there have been no well-documented population estimates for any of the colonies (Taylor 2000).

This project aims to conduct repeated population censuses of the white-capped albatrosses breeding on Disappointment Island using aerial photography. These population censuses will be conducted over five years and will be used to estimate population size and track population trends. Ground and aerial photographs were under taken of Disappointment Island colony in 1972, 1981, 1985, 1990 and 1993 by others (Taylor, 2000) but no reports or papers have been produced from these surveys. In 2006, 2007 and 2008 we undertook surveys of the Auckland Island and estimated the total count of nesting white-capped albatrosses for Disappointment Island, South West Cape and Adams Island (Baker et al. 2007b, 2008, 2009). Here, we report on the results of counts undertaken in December 2009 following the successful completion of the fourth of a five year aerial survey program. This report also consolidates data from counts undertaken in earlier years, to provide a complete picture of the surveys to date.

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 are 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, white-capped albatross breed mainly on Disappointment Island, located to the west of the main Auckland Island, with smaller colonies situated on the South West Cape of Auckland Island and on the southwest coast of Adams Island (Tickell 2000). Disappointment Is is 4 km long by up to 1 km wide, and is covered in *Poa* grassland and giant herbs, with scattered areas of shrubland and fellfield around the top of the island (Peat 2006). The island rises steeply from the sea to a plateau, with white-capped albatrosses breeding extensively on the slopes but avoiding the plateau. Birds breeding at the colonies on South West Cape and Adams Island also confine nesting to steep, tussock-covered slopes.

Field Work

Field work for 2006, 2007 and 2008 has been previously described in Baker et al (2007b, 2008, 2009). On the 3 December 2009 we chartered a helicopter from the Southern Lakes Helicopters Company to conduct a return flight to Disappointment Island in the Auckland Islands group. The aircraft, a single-engined Squirrel AS350B3, was piloted by Richard Hayes (Southern Lakes Helicopters Company and Heliworks). On board was Barry Baker (photographer and project coordinator), Rachael Alderman (photographer), Nathan Walker (Ministry of Fisheries) and Pete McClelland (DOC representative).

The flight was conducted in early December to coincide with the early incubation period of the breeding cycle. At this time it was anticipated that birds would have just completed egg laying (M. Double unpublished; P. Sagar unpublished), and hence most of birds that attempted to breed in 2009/10 would still be attending active nests. The dates of our previous visits to the Auckland Islands were 16 December 2006, 13 December 2007 and 14 December 2008 (Baker et al 2007b, 2008, 2009).

We selected a weather window for the operation that predicted clear flying conditions with minimal low-level cloud. At the time of the 2009 flight the weather around the Auckland Islands was calm but overcast with the cloud base over 1,200 metres. During the photography of Disappointment Island we encountered light showers and sea fog during the flight. While these conditions generally had minimal effect on visibility, the fog did obstruct visibility of the top of the island on a couple of occasions. We were, however, able to obtain clear photographs of all colonies at least once during the two photographic circuits of the island. Weather conditions during previous flights are shown below:

Date	Weather conditions encountered during photographic survey
16/12/2006	calm and fine, no cloud
13/12/2007	calm and fine, minimal cloud
14/12/2008	calm and overcast, cloud base over 1,200 metres. On a couple of occasions light showers encountered
3/12/2009	calm but overcast, cloud base 600 metres. Light showers and sea fog encountered during flight over Disappointment Island, obstructing visibility of the top of the island on occasions.

Photography was timed to occur between 11.00 to 14.00 hours. Although there is little information on the behaviour of breeding white-capped albatrosses, information from the closely-related shy albatross *Thalassarche cauta* indicates that at this time the ratio of incubating to loafing birds is high as most loafers are at sea during the middle of the day (B. Baker unpublished). This assumption has subsequently been confirmed by observations at the South West Cape colony (Paul Sagar and David Thompson, unpublished).

In 2009 we left Invercargill at 0750 hours and arrived at Enderby Island (Auckland Islands) at 1015 hours. After removing the door on the port side of the helicopter and refuelling, the survey flight left Enderby Island at 11.50 hours and approached Disappointment Island at 12.00 hours. We conducted three circuits of the island: the first circuit to familiarise ourselves with the island again and to obtain more distant photographs that would assist in compiling photo-montages; and then two closer circuits to provide the images that were used to count the breeding birds on the island. Additional photographs using maximum photo-extension (200mm) to assist in determining the proportion of empty nests and non-breeding birds in the colonies were also taken. The survey of Disappointment Island was completed by 1310 hours and we proceeded to the smaller white-capped albatross colonies at South-West Cape on Auckland Island and Adams Island which we also photographed. These were photographed between 1330—1348 and 1351—1355 hours, respectively. After photographing these two smaller colonies, the helicopter landed near South-West Cape for a scheduled break (1401 — 1536). We then flew to Enderby Island for refuelling and departed there at 1739, arriving back at Invercargill airport at 2000 hours.

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 D200 or D300 digital cameras and image-stabilised Nikkor 70—200mm F2.8 and 18—200 zoom lenses. Shutter speeds were set at 1/1000s or faster to minimise camera shake, and every effort made to ensure that the photographs were taken perpendicular to the land surface. The focal length of the zoom lens was not adjusted within each pass sequence over the island. From the circuits of the island we produced a complete series of overlapping images that covered the entire area of the island where albatrosses were nesting. The two photographers took approximately 3,000 digital photographs each during the survey flight. All photographs of the colony were saved as fine JPG format files. The survey photographs of Disappointment Island were taken at an altitude of about 400 metres, well above the minimum limit of 300m recommended by DOC. Most photographs were taken with the zoom lens set at a focal length of 70mm. The close-ups were taken

with the zoom lens set at 200mm. The full flight path and altitudes were recorded using a GPS receiver and have been downloaded and archived along with the photographs. The entire set of photographs were subsequently replicated to ensure that six complete back-up sets existed both on DVDs or hard drives and in at least three different locations. A full collection of photographs and details of the flight path will also be submitted to the Ministry of Fisheries 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 our survey of the Auckland Islands in 2006 (Baker et al 2007b). Briefly, 30 photographic montages of Disappointment Island (Figures 1—3), 8 of South West Cape and 1 of Adams Island were constructed from overlapping photographs using the image editing software package ADOBE PHOTOSHOP (http://www.adobe.com/). The boundary of the photographic montages for Disappointment Island generally followed those selected in previous flights (Baker et al. 2007b, 2008, 2009) although slight differences between years are inevitable due to different photographic angles. We have now standardised the boundaries used for the photomontages based on our experience over the first three years of surveys of this project, and re-numbered some of the photomontages produced in 2006 and 2007 accordingly to be consistent across all years. Photomontages were only made of the slope habitats of Disappointment island, South West Cape and Adams Island because an earlier site visit revealed that this was the habitat preferred by white-capped albatrosses — Gibson's albatross *Diomedea antipodensis gibsoni* nests only on the plateau at Disappointment and Adams Islands and the two species do not form mixed breeding colonies (Mike Double unpublished). Counts of all white-capped 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 (Figures 4 and 5). To assist with counting we used MOUSECOUNT software (http://www.kittyfeet.com/mousecount.htm) and 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 (i.e. inside the pecking distance that defines the minimum distance between nests) 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.

Counts of photo montages in all years except 2006 were undertaken by one observer only. Previously we undertook multiple counts of photomontages from the December 2006 census to estimate counter variability associated with miscounting and misidentifying white spots on the ground as birds. These count data were statistically modelled by Poisson regression, a special case of a Generalised Linear Model (McCullagh and Nelder, 1989), with observer and area as fixed effects. After allowing for both mean observer and mean area differences, there was no evidence to suggest that our model and data were incompatible, based upon regression diagnostics and model checking. There was also no evidence of a difference between observers and hence an observer bias. We have no reason to believe that data collected subsequently should have different distributional properties to our 2006 data and so we assume the current data are also compatible with a Poisson model. Thus we present raw counts only and assume the standard deviation is estimated as the square root of the count, a property of the Poisson model.

Ground counts

Ground counts were undertaken at SW Cape in 2007 and 2008 and on Disappointment Island in 2008. All ground-truthing activities were undertaken within a week of the 2007 and 2008 aerial counts.

At Disappointment Is counts of occupied nests were undertaken by two observers to determine the proportion of nests containing eggs. All occupied nests encountered 1 m either side of a randomly placed transect were inspected and the presence of eggs recorded. These counts were undertaken on 9 December 2008 between 12.00 and 12.30 pm.

At South West Cape counts were conducted by three observers who independently recorded the number of birds sitting or standing on nests, the number of pairs (partners accompanying an

incubating bird), and the number of non-breeding birds present in four well defined areas of the colony. Counts were made every hour between 10.30 to 16.30 hours.

3. Results

We estimated the total count of nesting white-capped albatrosses to be 70,975 (95%CI 70,442 — 71,508) for Disappointment Island (Table 1); 4,178 (4,049 — 4,307) for South West Cape, Auckland Island (Table 2); and 132 (109— 155) for Adams Island. Of these, 406 (366—446), 17 (9— 25) and 0 birds were assessed as being the partners of incubating birds at Disappointment Island, South West Cape and Adams Island, respectively. Therefore, we estimate that there was 70,569 (95%CI 70,038 — 71,100), 4,161 (4,032 — 4,290) and 132 (109— 155) annual breeding pairs at Disappointment Island, South West Cape and Adams Island, respectively, in 2009 giving a total for these sites of 74,862 (74,315—75,409) breeding pairs (Table 4).

Analysis of 15 close-up photographs randomly selected showed that in 2009 most (937 of 978, or 96%) of the birds visible in the photographs were sitting on nests (Table 5). Only 13 birds (1%) were clearly not associated with a nest, although we were unclear of the status of a further 23 birds. Across three years of close-up counts 3,332 of the 3,537 visible birds (94%) were sitting on nests, while 109 birds (3%) were not associated with nests (Table 6). These results indicate that our photography was carried out when there were few non-breeding birds in the colony. Also apparent in the close-up photographs were a large number of empty nests. For the three years 2007, 2008 and 2009 we counted a total of 1,397 empty nest pedestals compared with 3,332 occupied nests in the 15 randomly selected close-ups each year (30% unoccupied).

Ground counts of nests inspected on the ground on Disappointment Island on 9 December 2008 showed that 447 occupied nests (93.5%) contained eggs and 31 (6.5%) were empty.

At SW Cape ground counts confirmed the impression provided by the close-up photos that few non-breeding birds are generally present in the colony during the time that the aerial photography was undertaken. From 84 observations, ≤ 2% of birds present were non-breeders on 86% of observations, and ≤ 5% on 97% of the total observations. The maximum number of non-breeders present at any one time was 10%.

4. Discussion

Comparison of Annual Photographic Counts

The counts of nesting white-capped albatross in December 2007, 2008 and 2009 were significantly lower than the counts taken in the first year of this study (Table 4), with an estimated 26,252, 20,108 and 42,335 fewer annual breeding pairs present in those years, respectively. We are confident that the observed differences are real and not an artefact of technique. The methods employed and the personnel we used for the photography, construction of photo montages and counting were essentially identical for all years. It is also clear from an analysis of the close-up photos photographs taken in 2007 2008 and 2009 that there were a number of visibly unoccupied nest pedestals across the two larger colonies. Such a high proportion (0.3) of empty to occupied nests is usually not apparent in colonies of the medium to small albatrosses until later in the breeding season.

There are a couple of possible explanations for the differences observed between the years. Breeding may have commenced earlier in the last three years, placing our counts at a time after significant early nest failure may have occurred. It is also possible that the difference may represent normal inter-annual variation in breeding, with reduced resource availability in 2007, 2008 and 2009 causing many birds to not breed in those years. A third possibility is that we are observing a population decline, although we are reluctant to make this judgement until we have a few more years' data. White-capped albatrosses are now considered to be biennial breeders, as recent research by NIWA has indicated (Paul Sagar and David Thompson unpublished). As such, we would expect to see larger inter-annual fluctuations in counts than that typically observed with annual breeding species where populations are stable. We need to quantify with precision the inter-annual variability before we can confidently assess whether a long term change is occurring; this will require at least another year of data. To assist in

understanding the levels of inter-annual count variance associated with biennial breeding albatrosses, it is our intention over the next 12 months to examine other long-term count data for stable biennial breeding species and compare this with the five year data set we will have for white-capped albatross in the Auckland Islands.

Sources of Error in Photographic Census

Ground-truthing has been used in other photographic censuses of albatross colonies to estimate the bias associated with birds 'loafing' in colonies, birds sitting on nests without an egg, and to identify areas where nests may be obscured from the air by topographical features (Robertson et al. 2007). The information gained from ground surveys can then be used to estimate the total number of breeding pairs from the total number of birds counted. Unfortunately, ground-truthing at Disappointment Island has only been possible in 2008 because of logistics and access restrictions, and this situation is unlikely to change in the foreseeable future.

There are several likely sources of bias and identifiable components of variability in using aerial survey techniques, some of which can be addressed with ground truthing, and some of which cannot.

(1) The total number of active nests will be overestimated due to the presence of loafing birds and birds sitting on nests without eggs. For black-browed albatross colonies in Chile, Robertson et al (2007) estimated that nearly 12% of birds attending a colony fell into one of these two categories. Simultaneous ground-truthing revealed that 5% of the birds photographed were loafing in the colony and a further 7% were sitting on empty nests. The size of these errors would differ depending on the time of day and stage of breeding that surveys were conducted.

    Evidence from the close-up photographs indicates that the number of loafing white-capped albatrosses at Disappointment Island is similar or less than that observed for black-browed albatrosses. Our analysis indicated that most (94%) of the birds present were clearly associated with nests and unlikely to be loafing. Of the remaining birds, we were unable to determine the breeding status of 2% (i.e. it was unclear if birds were associated with a nest and hence non-breeders); or birds were either apparently non-breeding birds (35%) or the partners of other birds associated with nests (1%).

(2) Differences between observer counts will generate variability in the total count, as will misidentification of birds in mixed species colonies. Fortunately, the error associated with our counts was no larger than the intrinsic error expected in count data, and there were no other species nesting amongst the white-capped albatross colonies.

(3) Poor stitching of the photographs will generate variability in counts. Omission or double-counting of albatrosses near stitch lines due to parallax has been considered a problem in other studies (Robertson et al. 2007). For the counts at all breeding sites in the Auckland Islands the nature of the terrain was such that we were confident that on most stitch lines errors such as this did not occur. On the few occasions where this may have been a problem, it was not possible to measure the degree of double counting because there was no clear topographical features that permitted the edge of stitch lines to be defined for overlapped montages. However, any error would not have exceeded two hundred birds in total across all stitched images in any year.

(4) Ground-truthing may permit identification of 'detection error' in areas where nests may be obscured from the air by topographical features such as jumbled rock substrate, but this is unlikely to have been a problem for the Auckland Island sites. Note however, that in some cases where site topography is rough, it is possible to miss small colonies in ground counts that may be readily observed from the air (Robertson et al 2007; G. Robertson unpublished).

While ground-truthing may improve the accuracy of population estimates derived from aerial surveys, it needs to be recognised that the timing of aerial and on-ground counts needs to synchronous if meaningful correction factors are to be developed. In any albatross colony, nests fail regularly after laying as eggs are broken or become buried in the mud-nest pedestals. In the closely related shy albatross, some birds may continue to attend nests for some time after eggs are lost or broken. However, as the time-lag between an aerial and on-ground count increases, the relativity between estimates derived from both counts is likely to decrease. Access to many sub Antarctic islands is often difficult for both logistic and financial reasons, and the uncertainty associated with access may provide a valid reason to solely rely on aerial counts for estimating population size at sites where it is feasible

to do so. As advocated by Robertson et al (2007) and used by Arata et al. (2003) and in this study, the use of larger scale digital photographs and subsequent magnification on the computer screen to enhance the images of individual birds, can provide improved information on posture and behaviour that may enable nesting and loafing birds to be separated. Elimination of ground truthing has further benefits in reducing disturbance at nesting colonies, and efforts to develop survey techniques that will minimise disturbance to nesting birds should be encouraged.

Conservation implications

The remoteness of breeding sites and difficulty of access has previously constrained development of a comprehensive estimate for size of the breeding population of white-capped albatross (Taylor 2000; Croxall and Gales 1998). While attempts have been made at times over the last 20 years to conduct counts at Disappointment Is and South West Cape, where the bulk of the global population breeds, details of these have never been published and it is difficult to assess the methodology used, the time of year counts were made, the completeness of the counts, and any population trend.

With only the reputedly small colony on Bollons Island (Gales 1998; Tennyson et al, 1998; Robertson 1975) not counted in this study, our estimates represent the first reliable population estimate for this species. These estimates indicate that global population was c.117,000 annual breeding pairs in 2006, which is much larger than previously thought. This may be the result of sustained population growth since the 1970s, or simply reflect inaccuracy of the earlier counts in a population that is stable.

In a recent global review of fisheries-related mortality of shy and white-capped albatrosses Baker et al. (2007a) estimated that 8,000 white-capped albatrosses were killed each year as a result of interactions with trawl and longline fisheries in the Southern Ocean. This level of mortality highlights the need to continue to acquire accurate population estimates and trends for white-capped albatross populations to assess the impact of fisheries operations on this species. The lower numbers observed each year since the 2006 count may be indicative of a population decline, and a further count later this year should indicate if the population is stable or declining and if the current level of fishing mortality is sustainable.

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Table 1. Counts of nesting white-capped albatrosses, made from photomontages of Disappointment Island, Auckland Island, 3 December 2009.

Area	Count	
	Pairs	Total
1	0	525
2	8	1,801
3	0	538
4	0	142
5	3	1,122
6	71	12,875
7	12	1,730
8	8	698
9	6	1,032
10	2	48
11	4	779
12	8	2,771
13	26	5,556
14	66	6,683
15	78	9,426
16	46	8,335
17	55	12,591
18	5	918
Castaway a	0	55
Castaway b	8	3,350
TOTAL	**406**	**70,975**
SE	20.15	266.41

Table 2. Counts of nesting white-capped albatrosses, made from photomontages of South West Cape, Auckland Island, 3 December 2009.

Area	Count	
	Pairs	Total
1	9	1,737
2	4	350
3	3	711
4	0	61
5	0	84
6	0	254
7	0	606
8	1	375
TOTAL	**17**	**4,178**
SE	4.12	64.64

Table 3. Counts of nesting white-capped albatrosses, made from a photomontage of the Adams Island colony, 3 December 2009.

Area	Count	
	Pairs	Total
1	0	132
TOTAL	**0**	**131**
SE	0.00	11.49

Table 4. **Estimated annual breeding pairs of white-capped albatrosses in the Auckland Islands in December 2006, 2007, 2008 and 2009, with 95% Confidence Intervals.**

	Adams Island			Disappointment Island			SW Cape, Auckand Island			Total		
Year	Count	CIL	CIU	Count	CIL	CIU	Count	CIL	CIU	Count	CIL	CIU
2006	no data			110,649	110,040	111,258	6,548	6,400	6,695	117,197	116,570	117,823
2007	79	61	97	86,080	85,493	86,667	4,786	4,648	4,924	90,945	90,342	91,548
2008	131	108	154	91,694	91,088	92,300	5,264	5,119	5,409	97,089	96,466	97,712
2009	132	109	155	70,569	70,038	71,100	4,161	4,032	4,290	74,862	74,315	75,409

Table 5. Counts of 15 randomly selected close-up photographs taken at the Disappointment Island colony in December 2009.

Photo ID	On Nest	Not sure	Not on nest	Pairs	Empty nests
1 (B 1294)	120	1	2	0	52
2 (B 1296)	93	4	4	0	42
3 (B 1298)	45	5	0	0	26
4 (B 1300)	16	1	1	0	29
5 (B 1302)	18	0	2	0	26
6 (B1304)	62	2	0	0	60
7 (B 1306)	35	1	0	0	47
8 (B 1308)	110	0	0	2	27
9 (B 1310)	138	4	1	3	19
10 (B 1312)	63	1	0	0	51
11 (B 1314)	61	4	0	0	47
12 (B 1316)	37	0	2	0	43
13 (B 1418)	26	0	1	0	32
14 (B 1320)	61	0	0	0	67
15 (B 1322)	52	0	0	0	65
Totals	**937**	**23**	**13**	**5**	**633**

Table 6. Summary of counts of 15 randomly selected close-up photographs taken each year at Disappointment Island in December 2007, 2008 and 2009.

Year	On Nest	Not sure	Not on nest	Pairs	Empty nests
2007	805	21	4	5	326
2008	1,590	20	92	22	438
2009	937	23	13	5	633
Totals	**3,332**	**64**	**109**	**32**	**1,397**

Figure 1. Boundary of photographic montages 1 to 8 and Castaway Bay, Disappointment Island

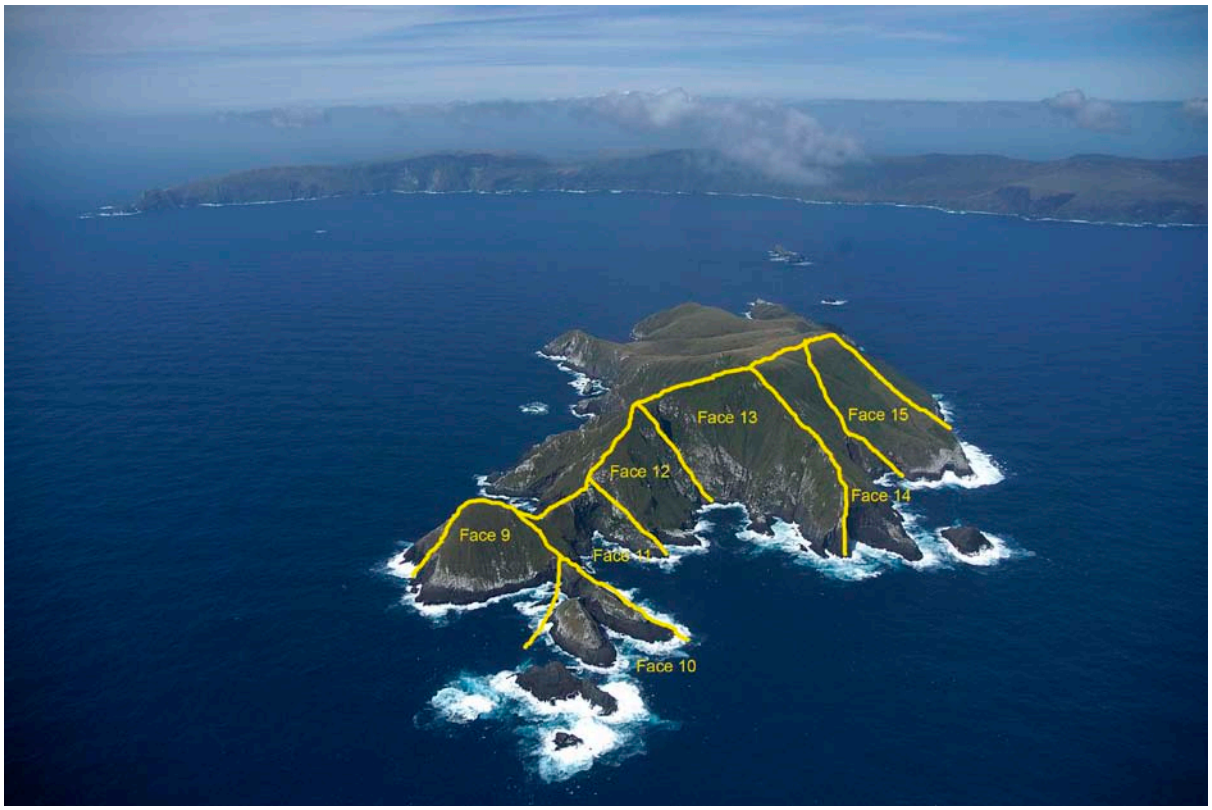

Figure 2. Boundary of photographic montages 9 to 15, Disappointment Island

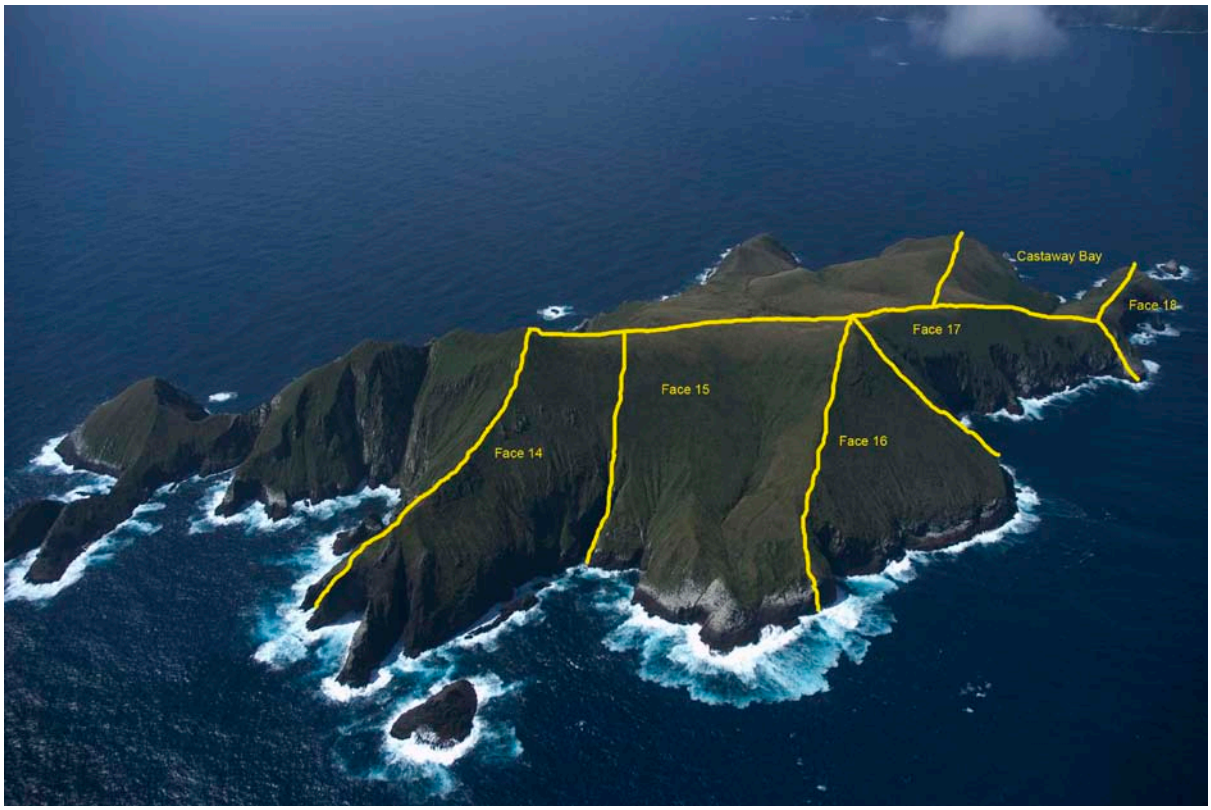

Figure 3. Boundary of photographic montages 14 to 18 and Castaway Bay, Disappointment Is.