

An aerial photograph of a rugged, rocky island in the middle of a deep blue ocean. The island is covered in sparse green vegetation and has several large, dark rock formations protruding from its surface. White waves are crashing against the base of the rocks, creating a stark contrast with the dark water. The sky is a clear, pale blue.

Aerial photographic surveys of Northern
Royal Albatross *Diomedea sanfordi* (toroa),
Chatham Is, September and December 2020

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Science Support Service,
Whanganui 4500

Photo: © Nicola Tuanui

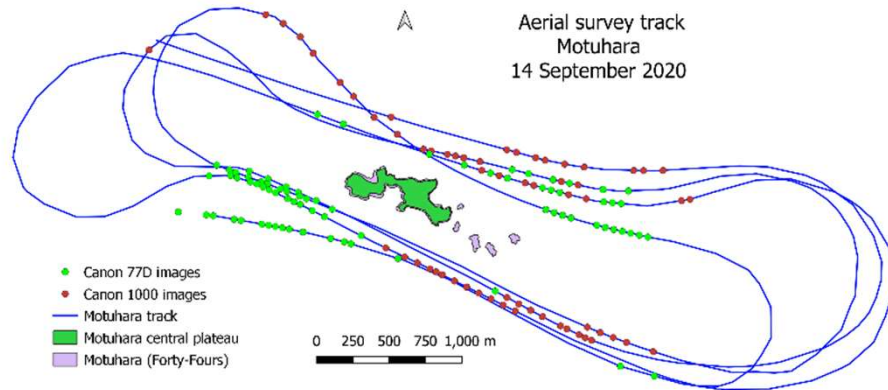
Background

- Northern Royal Albatross (toroa) global population currently ~6000 breeding pairs
 - Chatham Islands
 - ❖ Motuhara (Forty-Fours), 46%; Rangitautahi (Big Sister), 31%; Te Awanui (Middle [Little] Sister), 22%
 - Mainland NZ
 - ❖ Taiaroa Head (Dunedin) ~1%
- Biennial breeder
 - Successful breeding cycle ~240 days
 - Early failures (< ~110 days into breeding cycle) may re-nest the following season
- Intermittent surveys (early incubation [Nov-Dec]; late fledging [July-Aug])
 - 1973-1976 New Zealand Wildlife Service
 - 1989-1996 Department of Conservation (CJR Robertson et al.)
 - 2016-2020 DOC CSP contracts (Barry Baker et al., WMIL [Mike Bell et al.], DOC staff on the Chathams [analysed by Peter Frost])

Present report

- Two aerial surveys of toroa of the Chatham Is colonies
 - ❖ 14 September 2020 (chicks at the point of fledging)
 - ❖ 18 December 2020 (mid-incubation period)
- Census entire populations of birds present during these surveys
 - ❖ 14 September 2020 (fledglings; adults; fresh carcasses; and Northern Giant Petrels)
 - ❖ 18 December 2020 (apparently occupied sites (\approx 'incubating adults'); partners; 'loafers'; unclassified/uncertain individuals)
 - ❖ Northern Giant Petrels and Northern Buller's Mollymawks not counted in Dec 2017 – aerial photos too poorly resolved to allow consistent identification and counting
- Approach
 - ❖ Section the islands into discrete adjacent zones (no overlaps or gaps)
 - ❖ Categorise and count all the birds visible in each zone using DotDotGoose
 - ❖ Adjust the categories using proportions of birds in each class as determined by analysing samples of close-up images
 - ❖ Update estimate of global population of toroa

September 2020



Airspeed 197 ± 30.6 kph

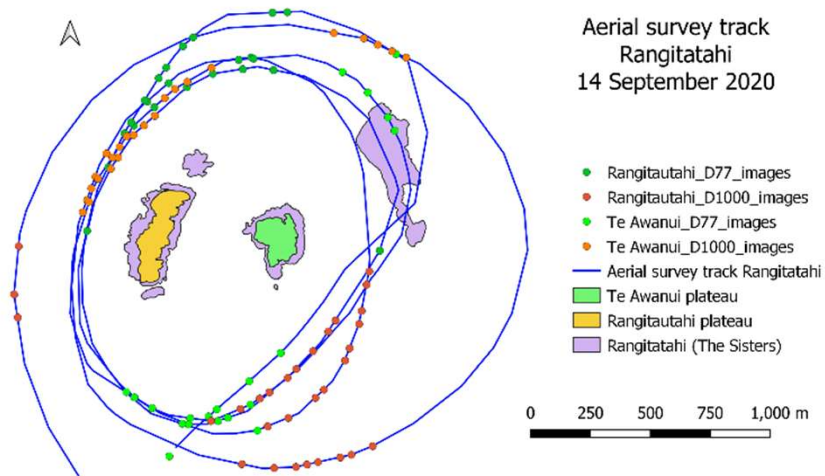


Altitude 224 ± 19.1 m asl

Distance 728 ± 385 m



Images 145



Airspeed 183 ± 23.5 kph



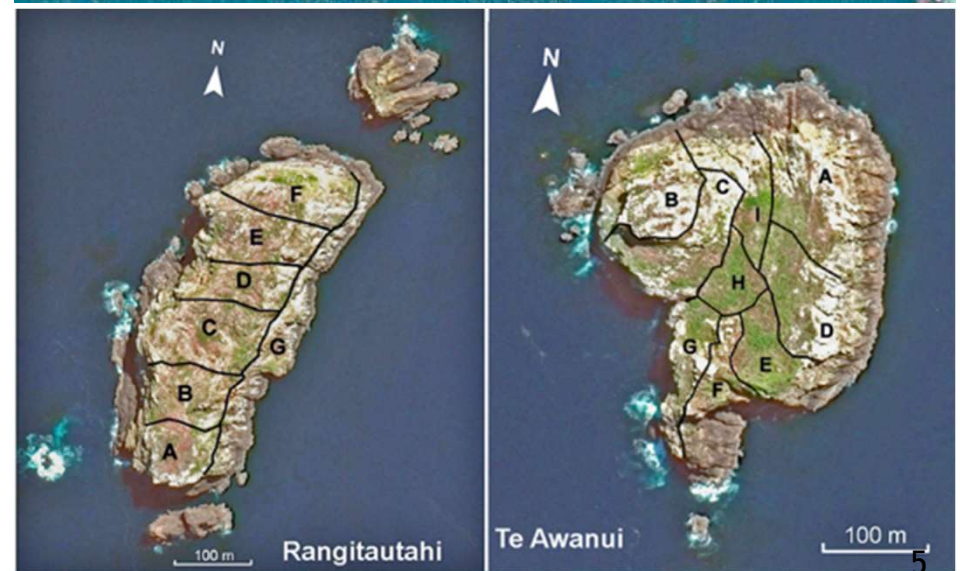
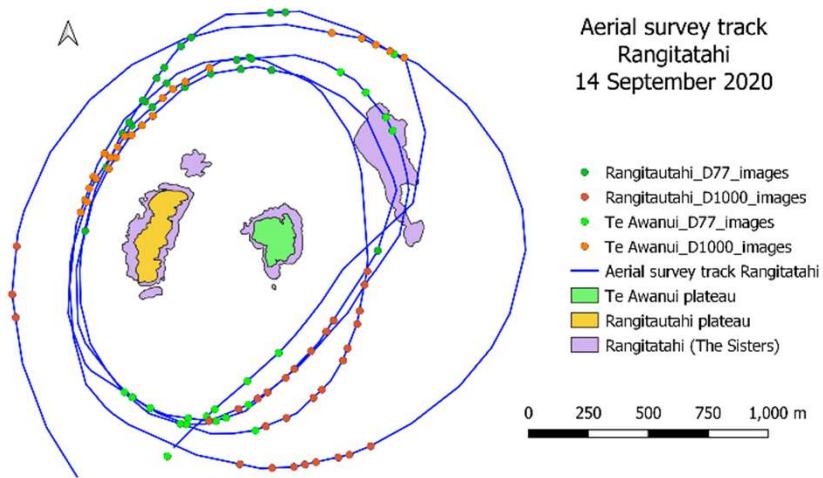
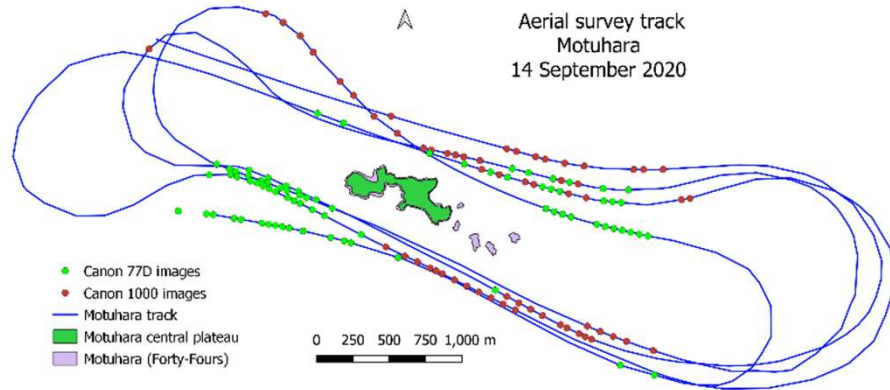
Altitude 225 ± 8.6 m asl

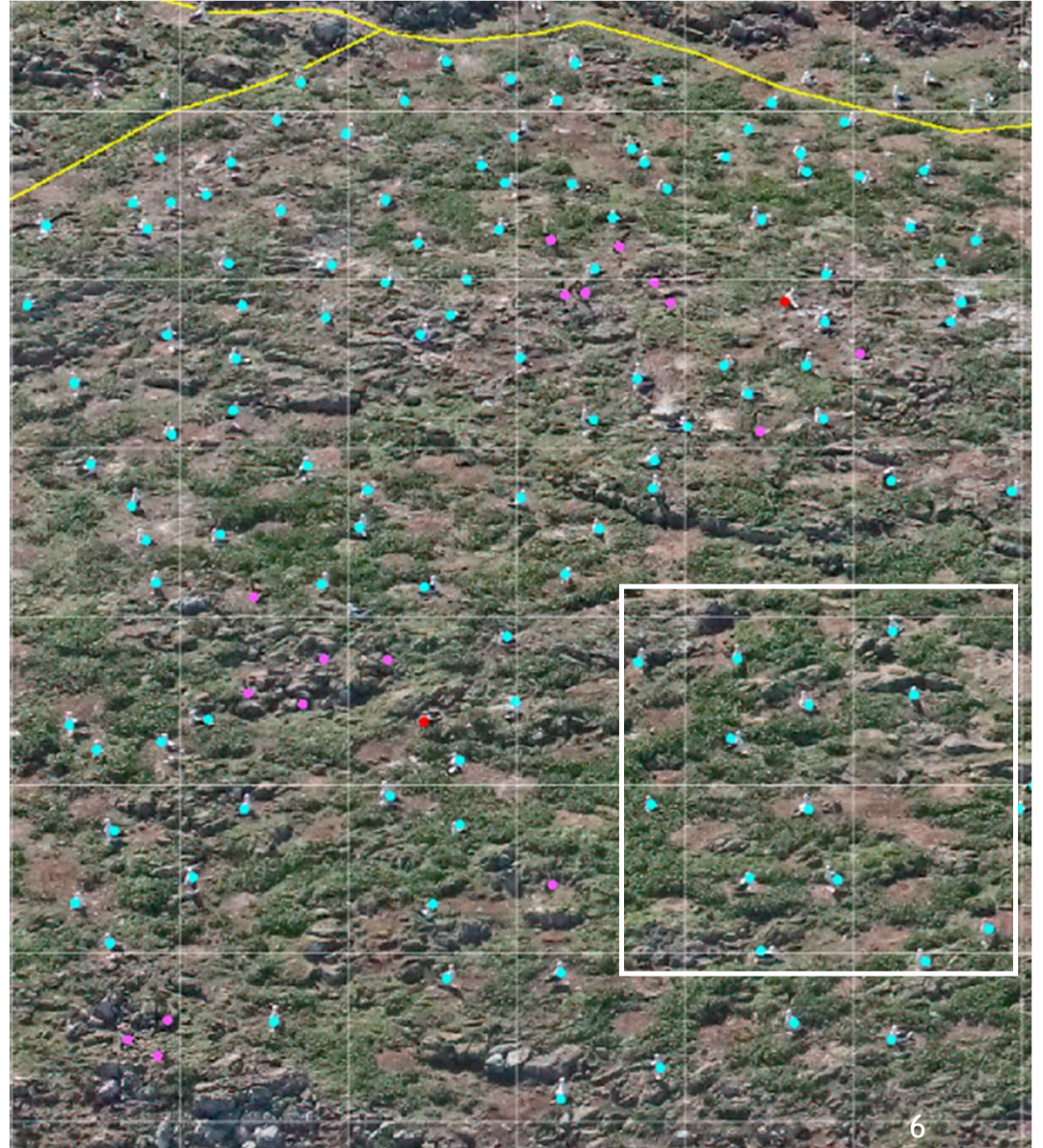
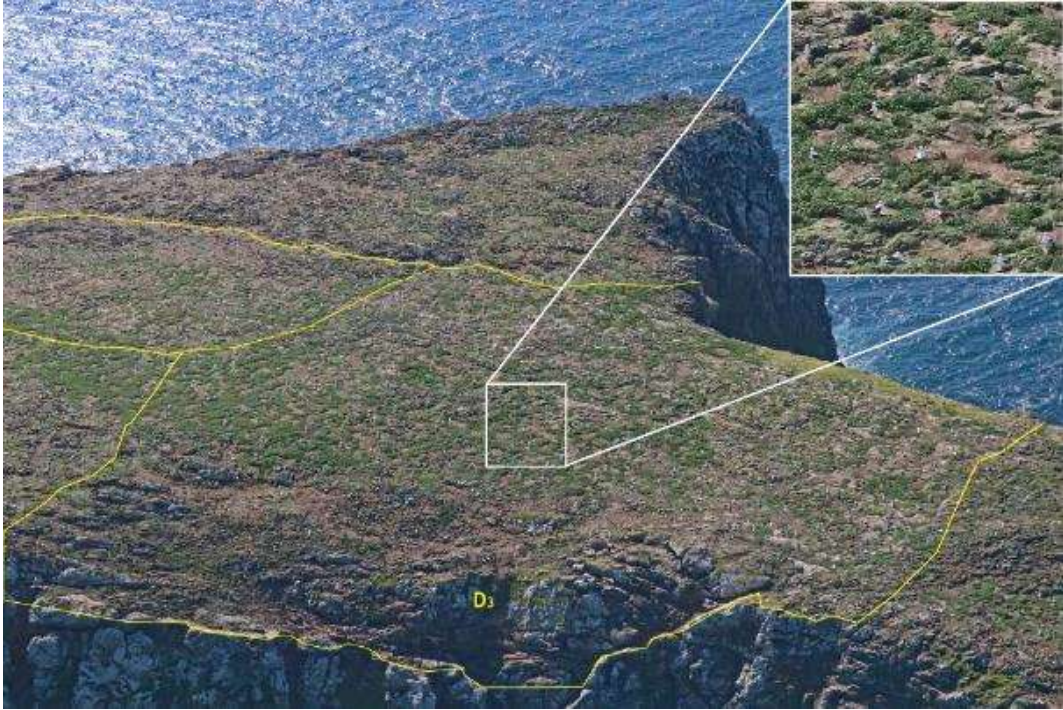
Distance 659 ± 186 m



Images 105

September 2020

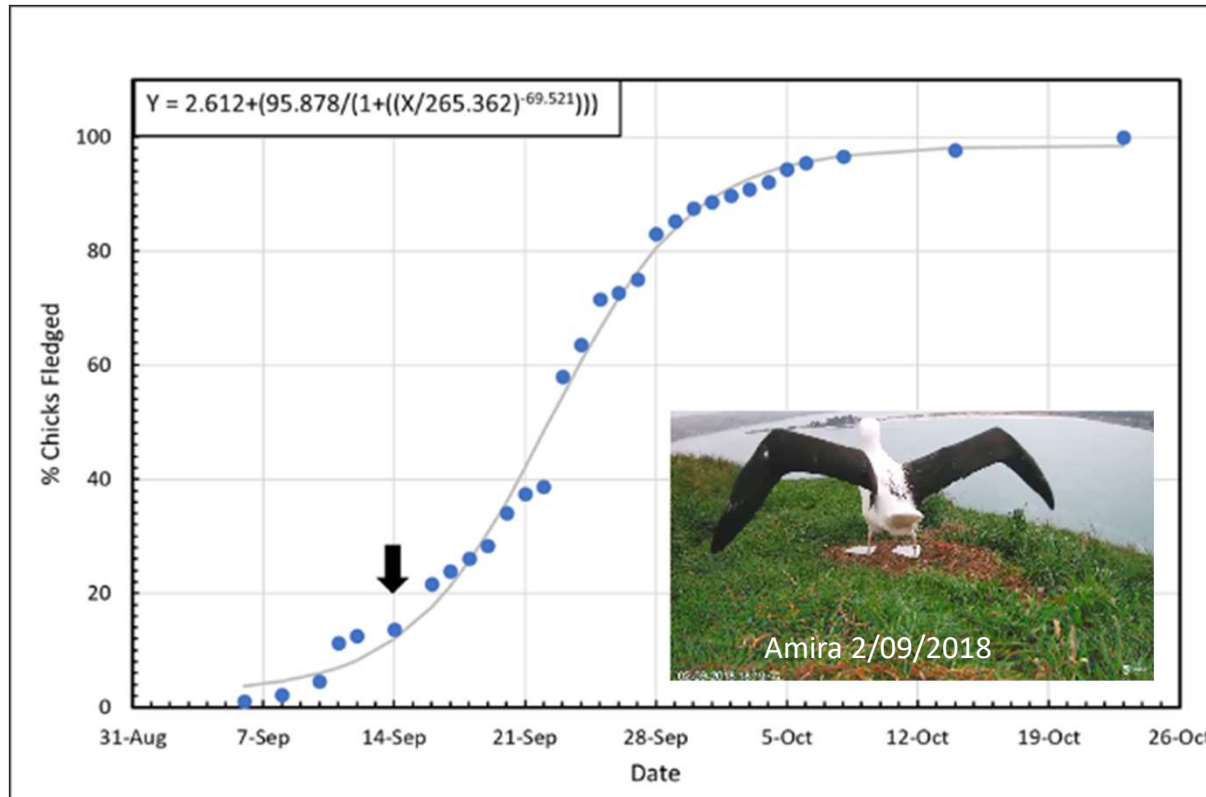




Counts of toroa fledglings and adults, 14 September 2020
 (i.e., after toroa chicks had begun fledging, but how many had left?)

Northern Royal Albatross	Rangitautahi	Te Awanui	Motuhara	Total
Toroa fledglings <i>95% CL¹</i>	425 333-539	314 222-435	1059 872-1289	1798 1427-2263
Toroa adults <i>95% CL¹</i>	4 1-15	2 0-12	10 1-35	16 2-62
<i>Images analysed</i>	9	9	18	36

¹ 95% confidence interval for individual counts (one-sample cases) were calculated with the R script *exactci* (settings *alternative* = ‘two-sided’, *tsmethod* = “central” and *conf.interval* = 0.95) for each section counted, and assume that the counts follow a Poisson distribution. The resulting limits were summed for each island and overall.





Time course of fledging of toroa chicks at Taiaroa Head, Otago Peninsula, over four seasons, 2016/17 – 2019/20 (data kindly provided by the Department of Conservation, Dunedin).

The fitted curve is a Four-Parameter Logistic (4PL) curve, calculated using Day of Year (Jan 1 = 1) on the X axis.

The arrow points to 14 September (Day 257), the date when the aerial survey was carried out on the Chatham Is. An estimated 12% of chicks had already fledged by then.

Numbers of toroa fledglings, adults and recent carcasses, as counted from aerial photographs, over three breeding seasons. No survey was possible in 2018/19 due to the aircraft being unavailable. The latest count, adjusted for 12% of chicks having already fledged, is marked.

Northern Royal Albatross	Breeding season	Survey date	Rangitautahi	Te Awanui	Motuhara	Total
Fledglings	2016/17	27/07/2017	574	539	1003	2116
	2017/18	23/08/2018	550	405	1194	2149
adjusted count 	2019/20	14/09/2020	483	357	1203	2043
Attendant adults	2016/17	27/07/2017	35	14	78	127
	2017/18	23/08/2018	21	3	41	65
	2019/20	14/09/2020	4	2	10	16



The 2019/20 cohort is the same as that which nested in 2017/18 (3919 nesting pairs). Assuming a similar number of pairs breeding in 2019/20, overall nesting success would therefore likely have been around 52% (cf. 55% in 2017/18).

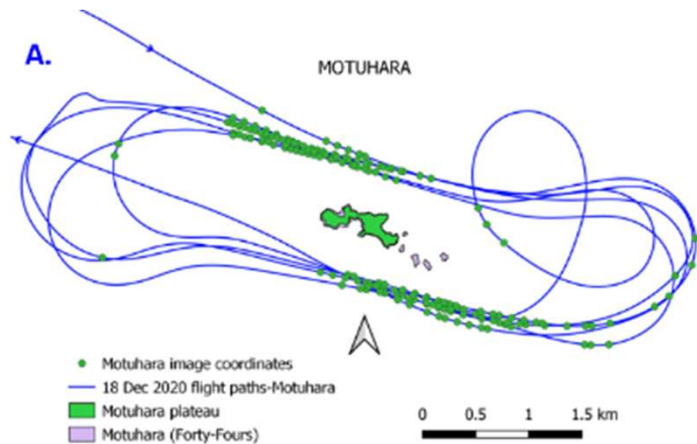
An aside

Counts of adult and sub-adult Northern Giant Petrels around the start of the breeding season, 14 September 2020

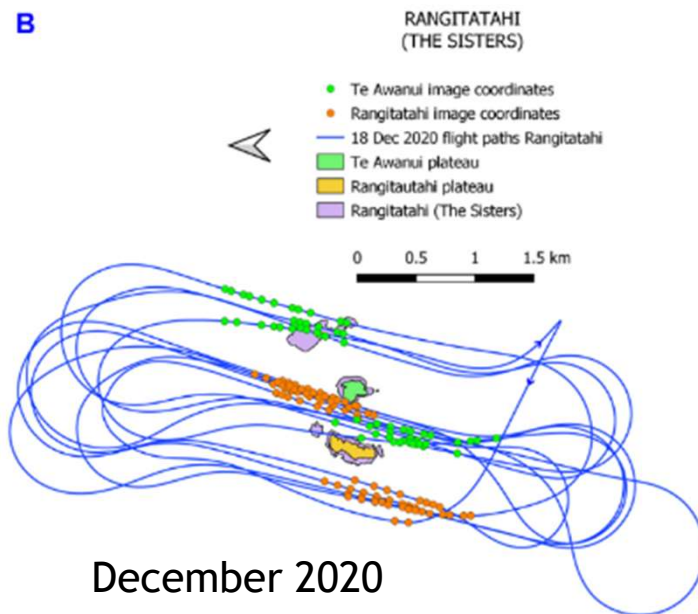
Northern Giant Petrel	Rangitautahi	Te Awanui	Motuhara	Total
Adults/subadults <i>95% CL</i>	125 <i>84-186</i>	88 <i>48-156</i>	1586 <i>1305-1782</i>	1799 <i>1437-2124</i>
cf. August 2018 <i>95% CL</i>	84 <i>67-104</i>	241 <i>212-273</i>	2506 <i>2409-2606</i>	2831 <i>2688-2983</i>



Clear images such as this were the exception rather than the rule, unfortunately.

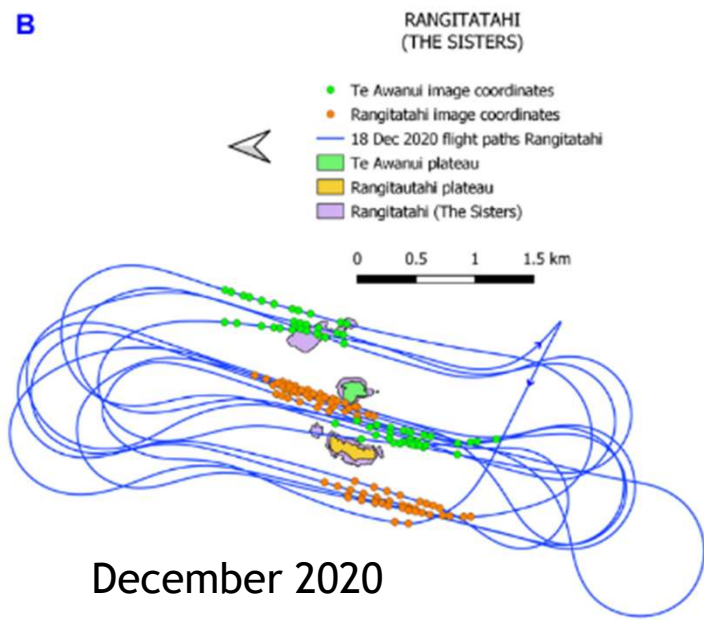
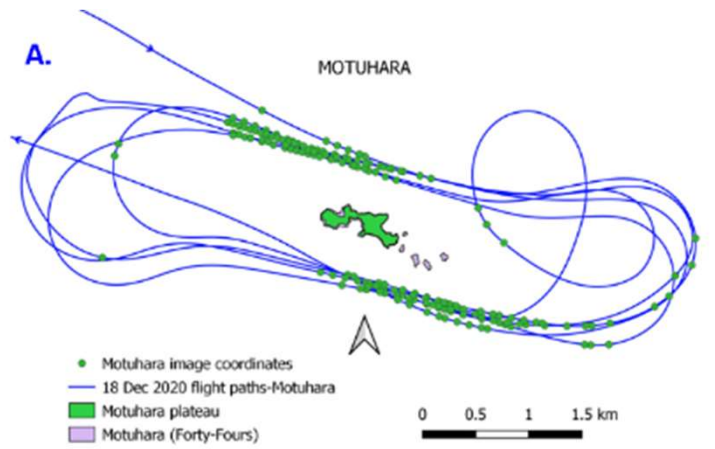


Airspeed 205 ± 9.6 kph ←
 Altitude 260 ± 39.1 m asl
 Distance 849 ± 266 m ←
 Images 188

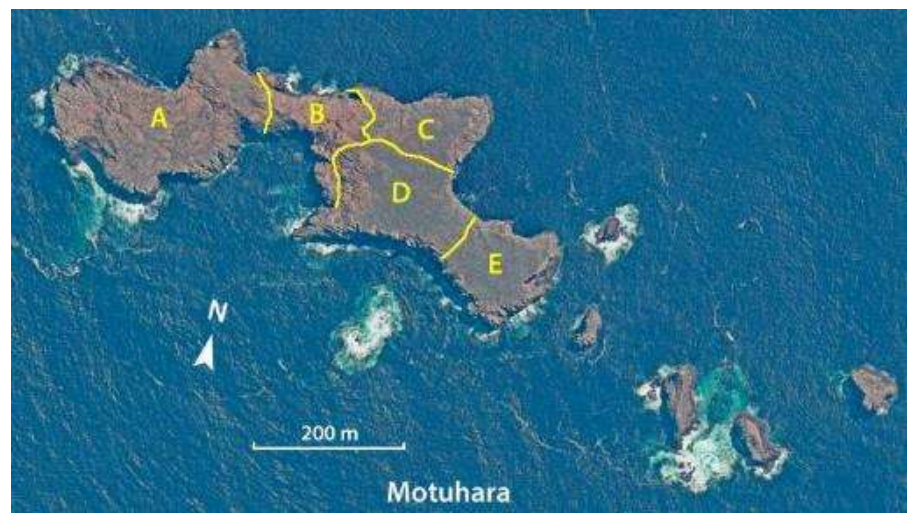


Airspeed 201 ± 8.8 kph ←
 Altitude 208 ± 26.3 m asl
 Distance 528 ± 237 m ←
 Images 141

December 2020



December 2020

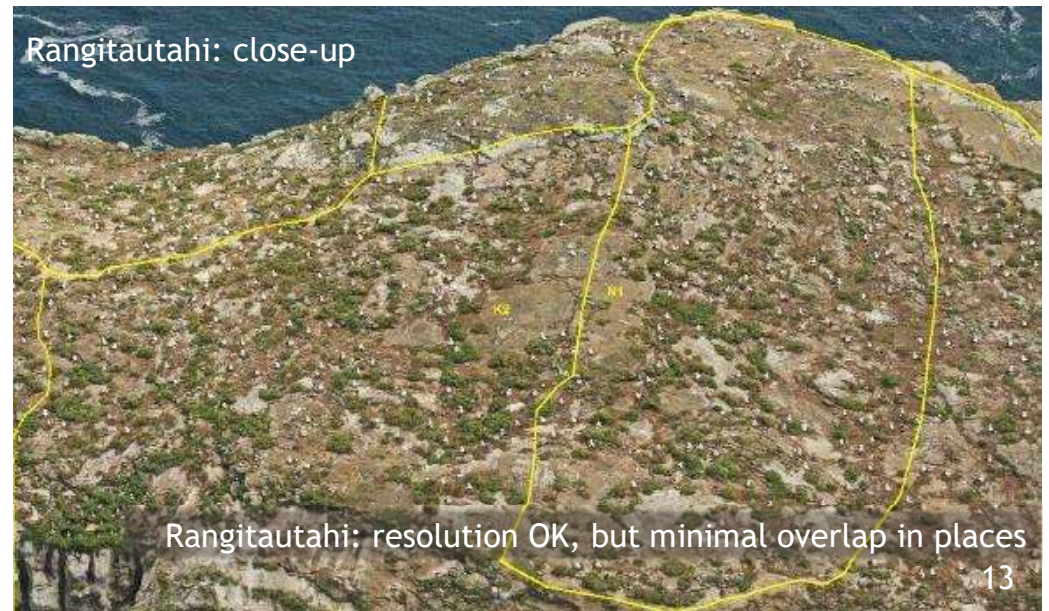
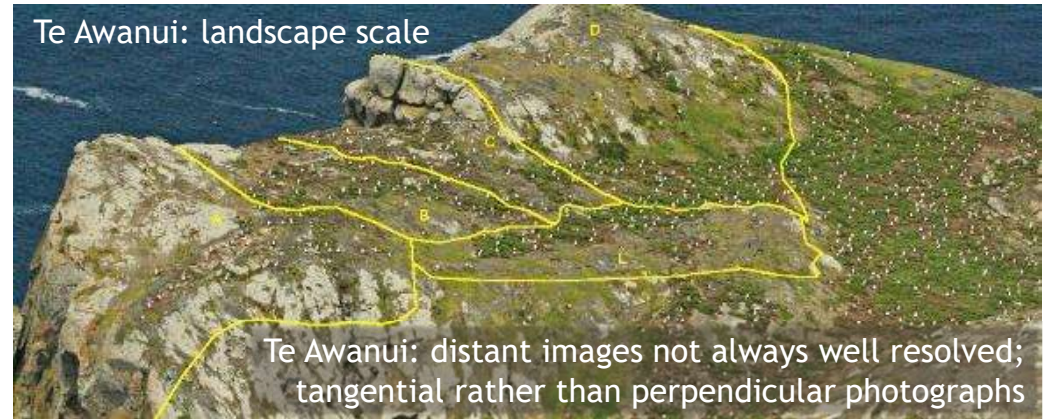


Some limitations

Motuhara: 2 cameras – 1 for landscape photos; 1 for close-ups



Rangitatahi: 1 camera used for both landscape and close-up photos



To categorise individuals more accurately, 39 close-up images (>270 mm focal length) across all three islands were examined and the activity of 3654 individuals assessed

Partner next to a nesting bird



Bird standing on nest; egg visible (i.e., bird nesting)

Birds largely obscured (i.e., unclassified [144])

Loafer or transient walking around

Bird sitting on bare rock, no nest visible: i.e., “loafing”

	Motuhara			Rangitautahi			Te Awanui		
Behaviour	Actual count	Proportion estimated from close-up photos	Adjusted number	Actual count	Proportion estimated from close-up photos	Adjusted number	Actual count	Proportion estimated from close-up photo	Adjusted number
Incubating (AOS) 95% CL	1575 1482-1655	0.952	1696 1616-1779	1351 1280-1425	0.956	1368 1297-1443	911 853-972	0.968	930 871-992
Partner of nesting bird 95% CL	15 8-25	0.018	32 22-45	11 6-20	0.009	13 7-22	7 2-14	0.007	7 3-14
Loafing 95% CL	76 60-95	0.031	55 41-72	66 51-84	0.035	50 37-66	39 28-53	0.025	24 15-36
Unclassified 95% CL	116 96-139			3 1-9			4 1-10		
Total on ground 95% CL	1782 1646-1914		1783 ¹ 1679-1896	1431 1338-1538		1431 1341-1531	961 885-1050		961 889-1042
Flying	3			0			0		
Carcass	0			6			0		

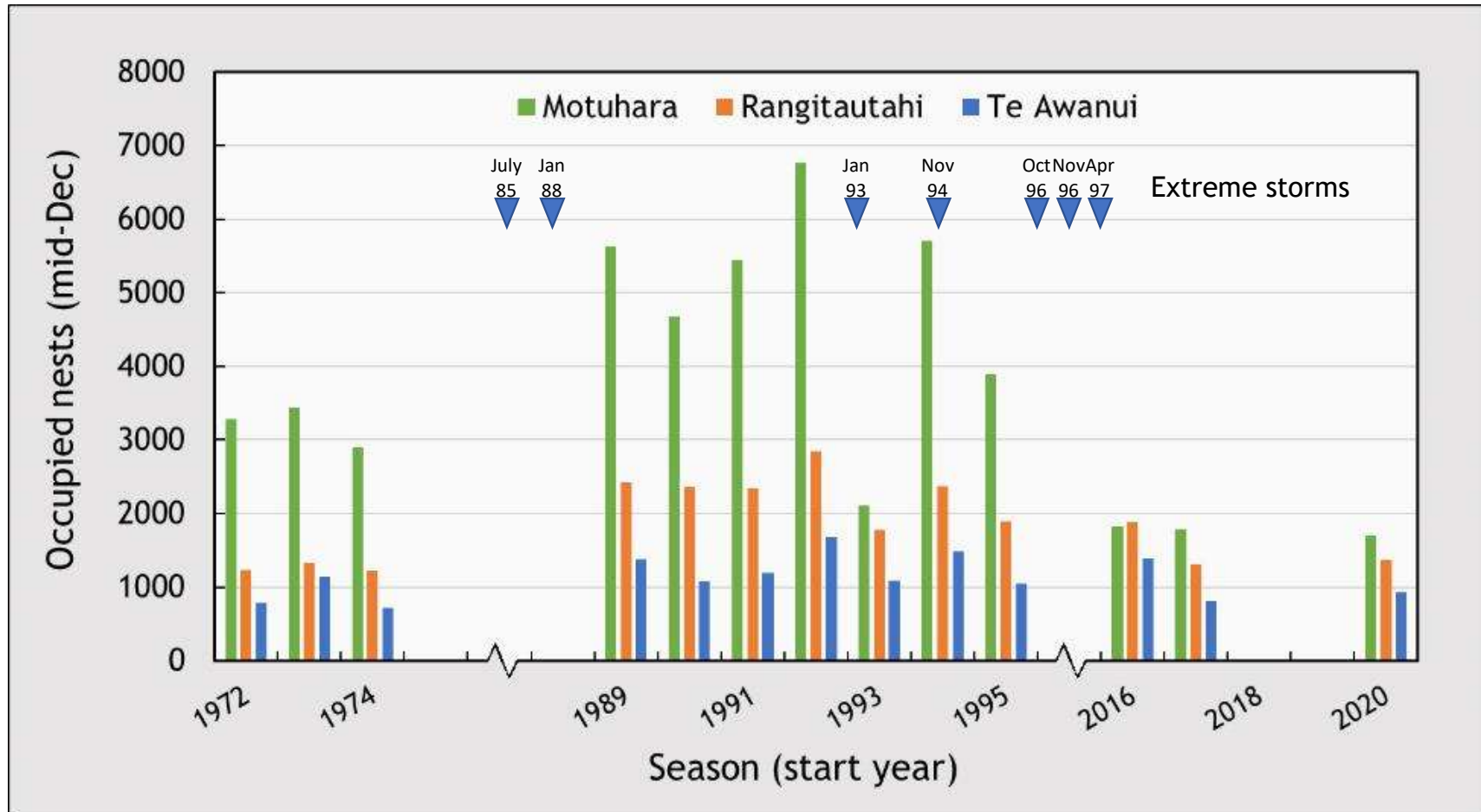
¹ The difference between the original number counted and the sum of the three adjusted categories on Motuhara is due to rounding.

Total AOS across all 3 islands:

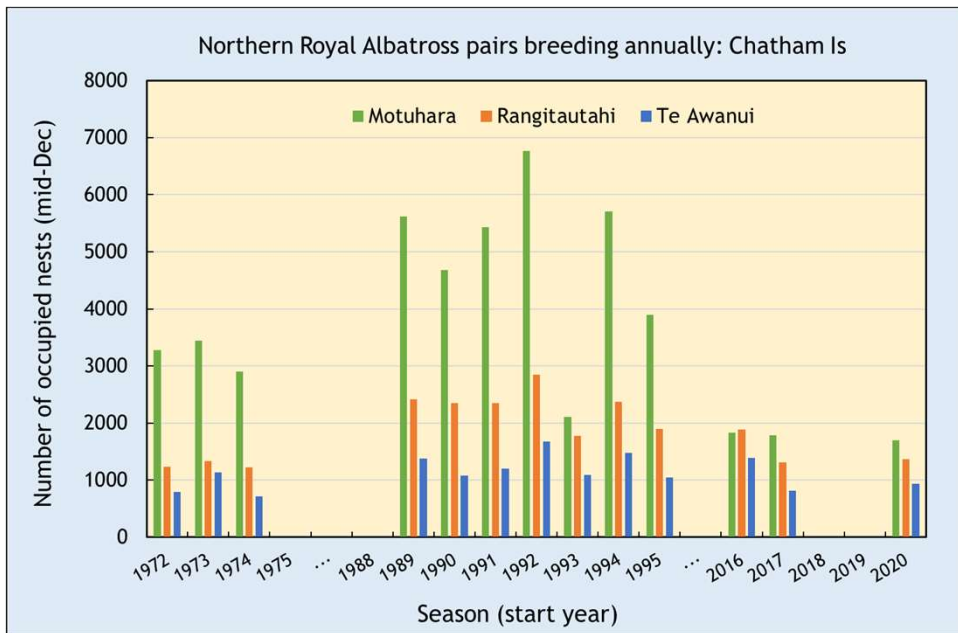
3994 (95% CL 3784–4214)

(includes an unknown percentage of
birds on empty nests)

How do these counts compare with earlier surveys?

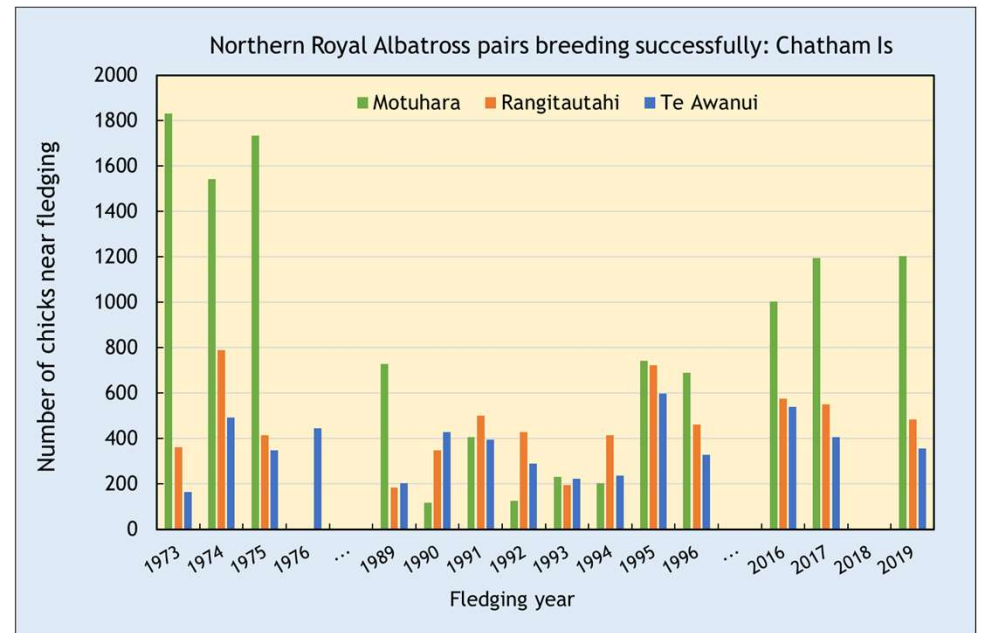


Estimating total breeding population of Northern Royal Albatross (after Bell et al., 2018)



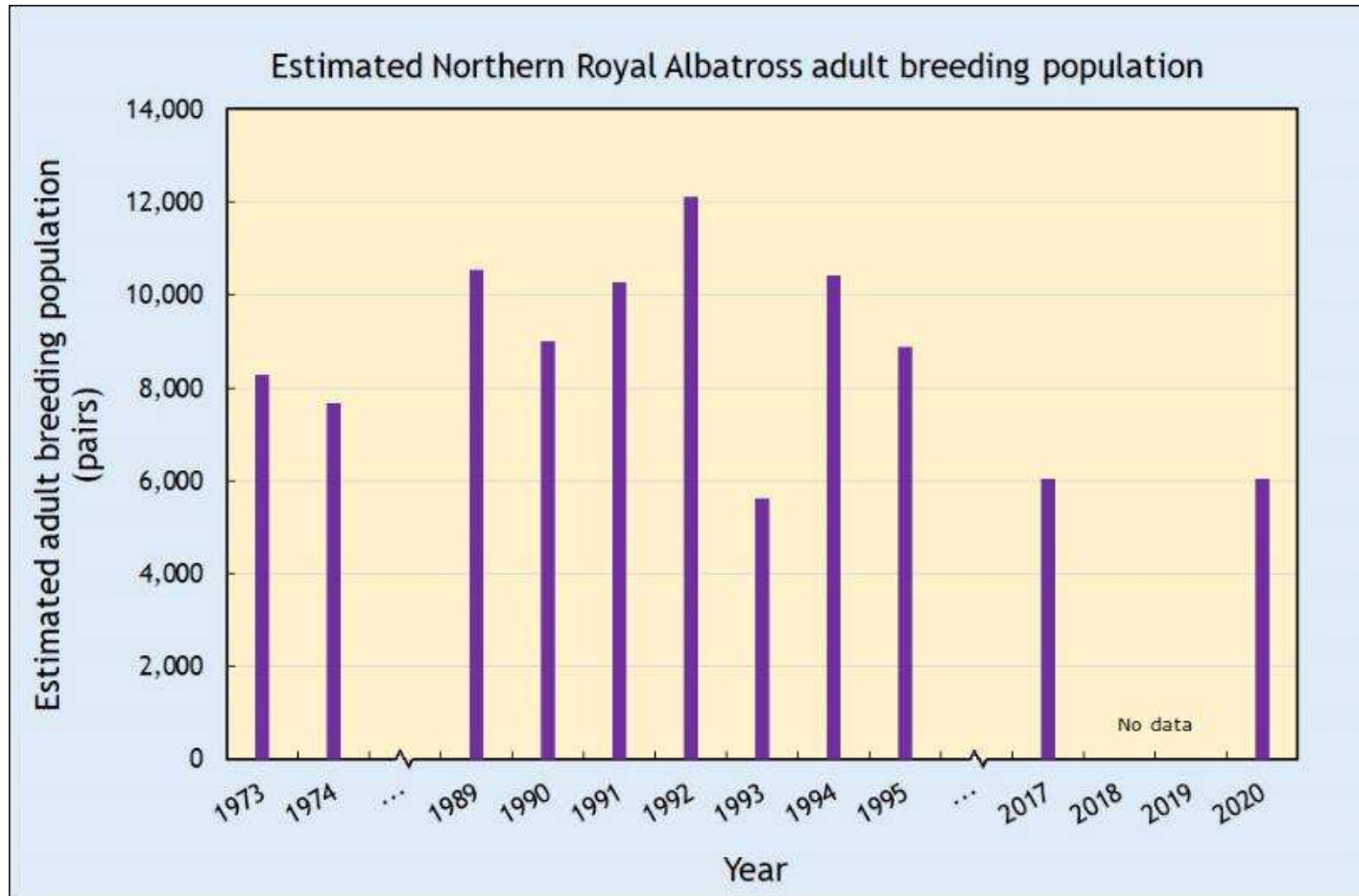
Year
(breeding pairs)

+



Year -1
(fledged chicks = successful pairs)

The current NRA population appears stable (~6035 pairs), following a 50% decline from a peak (~12,124 pairs) 18 years ago, but what built-in changes lie in the future within the non-breeding population?



Future work

- Continue twice-yearly aerial surveys of the islands (mid-December for nesting adults; mid- to late-August for near-fledging chicks)
 - ❖ from aircraft or drone/UAV ? (*Would be experimental at this stage, so probably need a period of overlap*)
- Improved aerial survey protocols
 - ❖ Slower airspeed when surveying the islands (140-155 kph, cf. 180-210 kph)
 - ❖ More images: 329-360 per survey in 2020 cf. 583-1179 in earlier years (*greater redundancy gives more choice and more overlap among areas*)
 - ❖ More and tighter circuits; more perpendicular photographs (→|✓... ↗|✕)
- Fixed-point cameras (to sample in-season nest success and behaviour)?
- Move to automated detection of birds using convolutional neural network (CNN) deep-learning algorithms ?

RESEARCH ARTICLE

Drones and deep learning produce accurate and efficient monitoring of large-scale seabird colonies

Madeline C. Hayes,^{1,*} Patrick C. Gray,¹ Guillermo Harris,² Wade C. Sedgwick,² Vivon D. Crawford,² Natalie Chazal,³ Sarah Crofts,⁴ and David W. Johnston¹



remote sensing

Remote Sens. 2020, 12, 2026; doi:10.3390/rs12122026



Article

Using Deep Learning to Count Albatrosses from Space: Assessing Results in Light of Ground Truth Uncertainty

Ellen Bowler^{1,*}, Peter T. Fretwell², Geoffrey French¹ and Michal Mackiewicz¹

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Gemma Green and Nicola Tuanui (Department of Conservation, Chatham Islands) undertook the September 2020 survey

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Dave Boyle took the August 2018 photographs of the islands and their Northern Giant Petrel populations

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