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Identifying northern Buller´s albatross (*Thalassarche bulleri* subsp.) in offshore waters of southern Perú

JAVIER QUIÑONES
Oficina de Investigaciones en Depredadores Superiores, Instituto del Mar del Perú, Callao, Perú

CARLOS ZAVALAGA
Unidad de Investigación de Ecosistemas Marinos-Grupo de Aves Marinas,
Universidad Científica del Sur, Lima, Perú

CHRISTOPHER J.R. ROBERTSON*
PO Box 12397, Wellington, New Zealand

Abstract: The current Buller's albatross taxa (*Thalassarche bulleri bulleri* [southern] and *T. b. platei* [northern]) engage in transpacific migrations from breeding sites on New Zealand offshore islands to non-breeding areas in the south-eastern Pacific Ocean. Both taxa are identifiable from a combination of plumage colour features in the head and bill that are easy to detect at short distance (<15 m). There is also breeding allopatry between the taxa, with the onset of breeding 2.5 months earlier in the 'northern taxon'. In this study, close-range sightings and captures of lured Buller´s albatross individuals off southern Perú were carried out during two pelagic trips in May–July 2021 onboard a small-scale longline fishery wooden boat (12 m long), during their normal operations when targeting sharks. We report on the presence of 41 Buller´s albatross, of which 40 were recognized as 'northern taxon' and one as 'southern taxon'. The great majority of the 'northern taxon' were adults (92.5%), with the remaining identified as sub-adults (7.5%). Birds were sighted between 126 and 223 km offshore west-south-west from the port of Ilo, Perú (17°38.64´S, 71°20.77´W). Birds sighted were preferentially in oceanic areas above the abyssal plain (68% of sightings), with a mean depth of 4,537 m, demonstrating that the 'northern taxon' is a truly oceanic species. No birds were observed by us over the continental shelf. Discrimination of 'northern taxon' from 'southern taxon' is possible from a combination of the plumage colour features in the head and bill. However, identification and comparison of photographs for both taxa taken at sea can be problematic, due to varying light conditions, unless the birds can be drawn close to the photographer using attractants, such as offal discards.

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INTRODUCTION

The coastal and pelagic sea off western South America is the preferred habitat for four medium/small New Zealand breeding albatrosses (mollymawks) for much of their juvenile, adolescent, and adult non-breeding stages of their life cycle (Robertson 1985; Robertson & Gales 1998; Robertson *et al*. 2003a; Checklist Committee 2022). The largest is Salvin's albatross (*Thalassarche*

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*Correspondence: *cjrr@wildpress.org*

salvini), breeding at the Bounty Islands and The Snares (Sagar *et al*. 2011, 2015), and the Chatham albatross (*Thalassarche eremita*) confined to The Pyramid in the southern Chatham Islands group (Robertson 1991; Robertson *et al*. 2003b). The two smaller albatrosses – northern and southern Buller's albatross – are currently classified as sub-species (ACAP 2010; del Hoyo & Collar 2014), but recent genetic studies (Wold *et al.* 2018, 2021) indicate a valid specific separation. Southern Buller's albatross (*Thalassarche bulleri bulleri*) breed at The Snares (48°01′S, 166°36′E) (Sagar & Warham 1998; Sagar 2014) and Solander Island (46°56′S, 166°85′E) (Thompson *et al.* 2017), while northern Buller's albatross are found in the Chatham Island group at the Sisters islands [Rangitatahi] (43°56′S, 176°81′W) and The Forty-Fours [Motuhara, Bertier Rock] (43°44′S, 175°50′W) (Robertson 1991; Robertson & Sawyer 1994; Robertson 1998; Bell *et al*. 2018), with a further small colony at Rosemary Rock in The Three Kings Islands [Manawatāwhi] (34°17′S, 172°09′E), close to the northern tip of the North Island (Frost *et al*. 2018).

The few published South American at-sea sightings (Spear *et al.* 2003; Spear & Ainley 2008; Quiñones *et al*. 2021) all refer to Buller's albatross without noting subspecies. Museum specimens for northern Buller's albatross from Peruvian locations are also few. Those published records do not provide sufficiently precise identification of observations at sea to determine a timetable of when the two Buller's albatross subspecies are present in western South American waters. However, Deppe (2012) used GLS trackers on northern Buller's albatross breeding adults from The Forty-Fours to show that they reach Chilean and Peruvian waters from March–July and depart August–October. The BirdLife International Seabird Tracking Database contains a dataset (# 636) of non-breeding southern Buller's albatross tracked with GLS loggers, and Roberts *et al*. (2022) using those records show them reaching Peruvian waters from August to September.

There are marked differences in the breeding cycles of the Buller's albatross taxa. In southern Buller's albatross, breeding birds return to The Snares and Solander islands from mid-December onwards with an extended egg-laying period from the end of December through to the end of February. Peak laying is from 21–26 January (Sagar & Warham 1998). Fledging of chicks occurs from 22 August to 23 October (Sagar & Warham 1998). The cycle of northern Buller's albatross is less well documented, but pre-breeding birds return to their colonies from early September, and egg-laying from 27 October to 23 November with a peak at 10–11 November (CJRR *pers. obs.*). Fledging of chicks occurs from late May to early July (Robertson 1991; Robertson & Nunn 1998; CJRR *pers. obs.*), suggesting that an approximately 2.5-month gap separates the breeding activities of the two taxa.

Both taxa have well-documented interactions with fisheries in New Zealand waters, with captures throughout the fishing year peaking from April to June. Two banded birds, one from each taxon, have been recovered close to western South American waters: M-19006 banded as a 'southern taxon' chick at The Snares on 6 August 1972 was captured on a longline on 11 October 1979 at 12°23′S, 105°06′W (Warham 1982), and M-33196 banded by CJRR on 30 October 1973 as a 'northern taxon' adult at the Middle Sister Island was caught in January 2007 on a longline by an artisanal fisher targeting mahi-mahi (*Coryphaena hippurus*) at 13°S, 80°W, in oceanic waters 180 nautical miles (333 km) off the coast from the port of Callao near Lima.

The American Museum of Natural History (AMNH) has two important groups of specimen skins for the 'northern taxon'. The first group was obtained by Rollo Beck from the Brewster-Sanford expedition in 1913–1914. Two birds (AMNH 445390[M] and 445391[F]) were collected on 26 June 1913 some 20 miles west of Cañete, Perú (13°S, 78°W). The female bird had previously bred, and showed signs of moult in the head plumage, while the tail has a mix of old and new feathers. The wing tips of both birds were very worn. The male bird had small testes. A third bird AMNH 445392 (male, with small testes) was collected off Valparaiso, Chile on 9 March 1914. This bird is illustrated in Murphy (1936, p493) and shows the narrow yellow stripe on the lower mandible often cited as typical of the 'northern taxon' and the squared base of the culmen plate often present in 'northern taxon' males in specimen skins from the Chatham Island colonies (CJRR *pers. obs.*). Beck, subsequently with the Whitney South Sea Expedition, collected a large group of the 'northern taxon' at the Chatham Islands, mainly about The Forty-Fours on 8 March 1926 (12 specimens held at the AMNH).

A fourth specimen from the western South American coast is the type specimen of *Thalassarche platei* (Reichenow 1898; Godman 1907–10; Jouanin & Mougin 1979), (specimen # 47-77) held at the Museum fur Naturkunde in Berlin. The specimen was collected 13 July 1893 at Cavancha in Iquique, Chile (20°14'S). CJRR has viewed the specimen and agrees with Murphy (1936), J. Warham, and W.R.P. Bourne (*in litt.* to CJRR) in their various assessments that the bird was a typical young of *T. b. bulleri.* Warham and Bourne were able to compare the *platei* specimen with a specimen of a fledgling from the Chatham Islands sent to Berlin by the Museum of New Zealand for comparison. The *platei* type specimen shows overall pale head plumage and a smaller bill depth at base of the culmen than northern juveniles. These features suggest that it is not a recent northern Buller's albatross fledgling but was a southern Buller's albatross fledgling probably

half-way through its first year, with no obvious body moult, but having worn wing tips.

CJRR has undertaken field studies and collected voucher specimens of both taxa at their breeding sites and has studied specimen skins in 20 museums internationally. Both taxa are morphologically close, both in measurements and plumage. The identification from photographs in the field can be bedevilled by varying light conditions and in New Zealand waters they are rarely observed in concurrent feeding zones. Field guides for oceanic birds (Onley & Scofield 2006; Shirihai 2008; Howell 2009; Scofield & Stephenson 2013; Howell & Zufelt 2019; Harrison *et al.* 2021) all illustrate the 'northern taxon' with varying levels of detail and accuracy, using adult plumage identifications based on birds about New Zealand during the breeding season, and not during the non-breeding season offshore. Studies of DNA tested bycatch samples indicated that the width of the yellow stripe in both taxa is variable and overlapping between taxa and sexes (CJRR *pers. obs.*). An adult 'northern taxon' has a distinctively dark grey/brown head and neck, similar in tone to that seen in the Chatham albatross (*T. eremita*). The adult 'southern taxon' head and neck is paler, like the head and neck tones of Salvin's albatross (*T. salvini*). A practical example of Gloger's Rule, where plumages darken in similar taxa closest to the equator.

A close examination of head plumage in

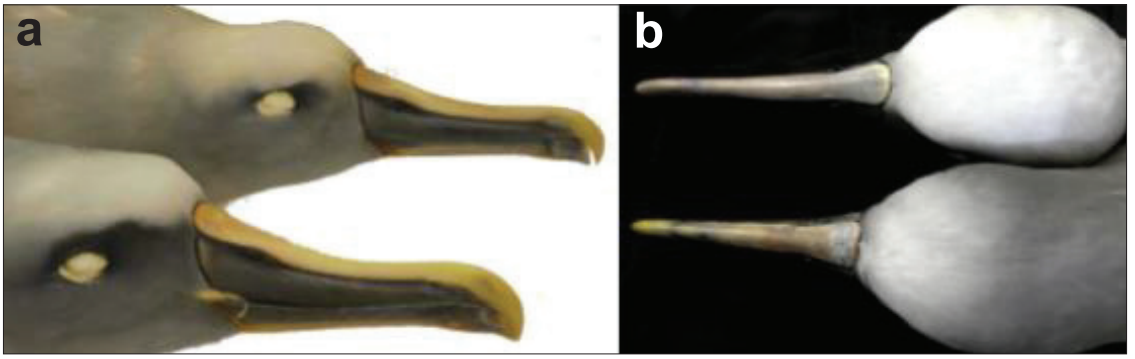

Figure 1. **(a)** Heads of Buller's ssp. albatross collected during the respective breeding seasons. TOP. A southern Buller's albatross from North-East Island, The Snares (48°01'S, 166°36'E) (MONZ 18632 F. 28/07/1975). Actual culmen length 117 mm. Length distorted by photograph depth of view and angle. BOTTOM. A northern Buller's albatross from Middle Sister Island (43°56'S, 176°81'W) (MONZ 18635 F. 18/11/1974). The principal distinguishing feature here is the extensive dark patch forward of the eye/lores, usually reaching the base of the bill in the northern bird. Actual culmen length 120 mm. **(b)** Heads of representative museum skins, not those featured in (a), indicating the differing extent of white plumage in the forehead and crown/nape of each Buller's albatross taxon. Top = 'southern', bottom = 'northern'. (Photographs: C.J.R. Robertson).

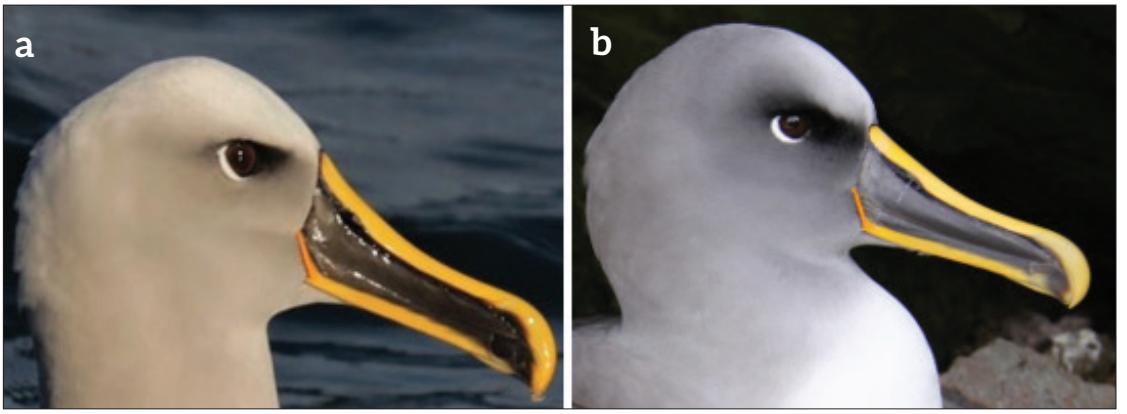

Figure 2. (a) Head view of a southern Buller's albatross, at sea in July (near Taiaroa Head, Dunedin) showing the extensive pale cap reaching to the hind neck and pale grey head and neck plumage. The limited eye patch does not reach the base of the bill. (Photograph: M. Szabo). **(b)**. Head of a northern Buller's albatross on The Forty-Fours breeding colony (Chatham Islands), showing the limited pale cap and overall dark head plumage for this taxon, and the clearly distinguishing dark eyebrow/lores patch. (Photograph: M. Fraser).

museum skins allows a consistent identification of both taxa from birds collected at breeding colonies. The 'southern taxon' (Figs. 1 & 2) has a much paler general grey/brown head and neck plumage (like that found in *T. salvini*), with the pale forehead/crown extending to the back of the head and nape. The eyebrow/lores dark patch is small and rarely extends to the base of the bill but is occasionally darker in fresh breeding plumage.

In the 'northern taxon' (Figs. 1 & 2) the pale silvery cap is restricted to the front part of the forehead/crown and changes to the dark grey of the head and neck beyond the back of the eye (similar in tone to that seen in *T. eremita*). The sooty black eyebrow extends forward of the eye to the base of the bill, while the area below the front part of the eye (the lores) is similarly dark, and when combined with the dark head plumage produces a frowning appearance. The yellow stripe along the lower mandible is generally narrower in 'northern taxon' birds with a trend towards further narrowing of the stripe towards the tip of the bill. The combination of dark head colour, restricted pale crown, extended dark eyebrow/cheek/lores, and occasionally narrow yellow bill stripe give a good guide to this taxon in adult plumage.

The discrimination of the two Buller´s albatross taxa using the external features described above is challenging during conventional vessel surveys at sea, as birds are usually sighted at some distance from the observer. Further, when both taxa are on the South American coast, their non-breeding plumages (often modified by moult) are imperfectly known, or have been described from birds of known origin during the breeding season in New Zealand waters. This study of closely observed and handled birds at sea, addresses the distinguishing diagnostic mix of plumage and behavioural features of the northern Buller's albatross upon their arrival at non-breeding locations in Perú.

METHODS

These observations were a by-product of the principal study to evaluate the interactions between small-scale long-line fisheries and Chatham albatross (*T. eremita*) in their wintering grounds. Sightings and captures of Buller's albatrosses were undertaken during two pelagic trips from 29 May – 6 June 2021 and 1–9 July 2021 onboard a small-scale longline fishery (SSF) wooden boat (12 m long) during their normal operations targeting Blue sharks (*Prionace glauca*) and Mako sharks (*Isurus oxyrhynchus*). A close approach to the birds (2–10 m) allowed the capture of high-resolution pictures and to unequivocally identify northern Buller´s albatross based on plumage and bill colour features, recorded during their wintering non-breeding cycle. We departed from the port of Ilo (17°38.64´S, 71°20.77´W), heading to the south-west in May–June and July out to 180–250 km offshore (Fig. 3).

Bird captures were conducted as part of other field work to apply GPS-satellite transmitters. The permit to undertake this research was issued by Servicio Nacional Forestal y de Fauna Silvestre – SERFOR (Resolución de Dirección General No. D000381-2021-MIDAGRI-SERFOR-DGGSPFFS. Código de Autorización No AUT-IFS-2021-045). Ethical considerations for capturing and handling albatrosses were reviewed by Universidad Científica del Sur and approved by a certificate No. 082-CIEI-AB-CIENTIFICA 2021.

Luring birds

For both sightings and captures, we used 'chumming' (discharging of fish offal bits) to lure birds close to the boat. Once sharks were captured and butchered onboard by fishermen, intestines and liver were stored to be used as 'chum' bait. Usually, the boat was stopped near groups of flying birds (petrels and albatrosses) in daylight. When white-chinned petrels (*Procellaria aequinoctialis*) and south polar skuas (*Catharacta maccormicii*) were sighted, we threw shark intestines to create feeding frenzies where birds fought for food and 'shouted aggressively' during antagonistic encounters. The petrel and skua behaviour attracted first black-browed albatrosses (*T. melanophris*) and then Buller´s albatross (*T. bulleri* ssp.). When the Buller´s albatrosses were at close range, we threw the shark liver close to the boat to attract them closer (Bugoni *et al.* 2008). The liver attracted birds more effectively than the intestines.

Sightings

Close-proximity sightings were made possible by throwing shark offal overboard at fixed points along random time intervals of 0.75–1.5 hours. When birds approached, we recorded the species, number of individuals per species, and behaviour. Close-range photographs (2–10 m from the boat) were taken of Buller's albatrosses from different angles to record the plumage-colouring features of the crown, head, and nape, as well as the patterns of bill colouring. A Canon Powershot SX70HS camera, with 70X optical zoom was used for all field photographs. All individuals were photographed on multiple occasions and at different angles and at short distances to record all their specified plumage characteristics.

Captures

We used 'chumming' to attract birds, and once in range, captures were made using either a dip-net,

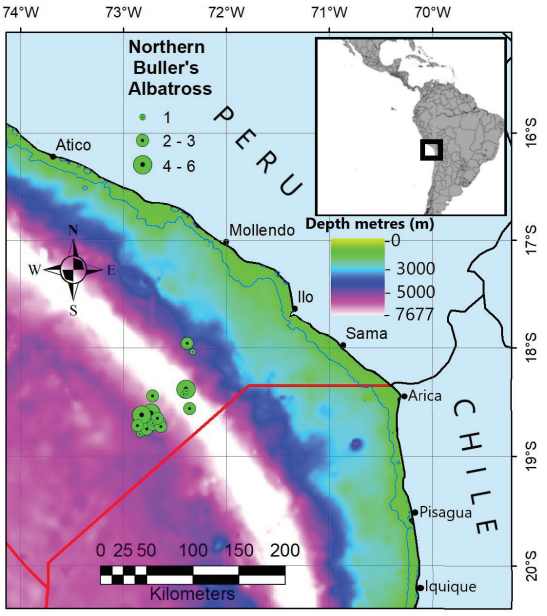

Figure 3. Geographical distribution of our northern Buller's albatross observations in southern Perú. The fine blue line (following the coastline) represents the 200 m isobath where the shelf breaks. The bold black line is the country boundary. The bold red line represents the oceanic national limits, that extends up to 370 km offshore.

or rapidly throwing a modified hoop-net (Ronconi *et al.* 2010). The dip-net on a 4-m pole had a lightweight aluminium 75 cm diameter ring with a sardine net (36 mm mesh) attached to the perimeter. The modified hoop-net was made of a 1.8 m diameter lightweight wire circular hoop lined with a plastic hose, with sardine netting (36 mm mesh) attached to the perimeter.

Habitat

The habitat classification used was an adaptation of Wakefield *et al.* (2011) for the specific bathymetric zones off the Peruvian coast. We characterized the habitat used by albatrosses according to ocean depth: continental shelf (0–200 m isobath), continental slope (201–4,500 m), Perú-Chile Trench (>4,500 m), and the Abyssal plain (offshore, beyond the Perú-Chile Trench).

RESULTS

We recorded a total of 41 individuals of Buller´s albatross ssp., of which 40 corresponded to the 'northern taxon' based on the colouration characteristics described in the introduction above. Only one individual had plumage characteristics suggestive of the 'southern taxon' (Fig. 4a). Of the 41 identified birds, five were captured to attach the satellite transmitters, all of the northern taxon.

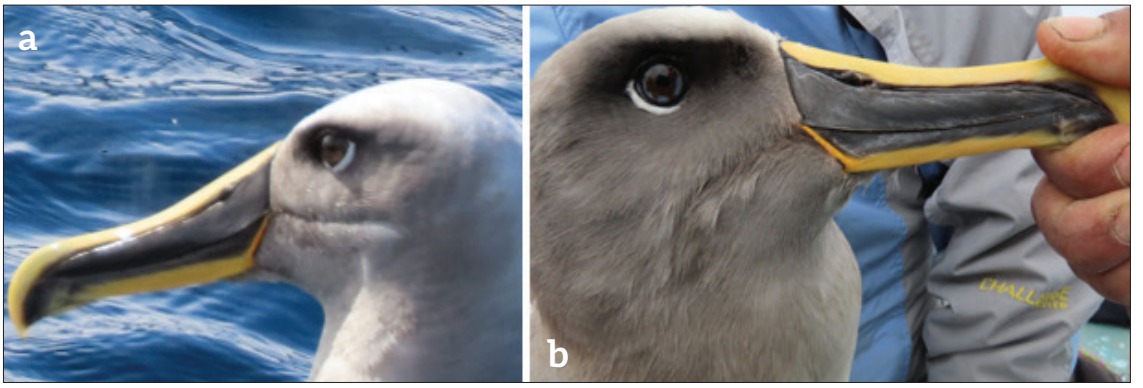

Figure 4 (a). A probable 'southern taxon' with noticeably paler head and small eye patch and pale lores. Note broad yellow stripe on lower mandible, (18°26'S, 72°23'W) recorded on 8 July 2021. (Photograph: J. Quiñones). **(b).** A close-up view of the head characters of a 'northern taxon' bird in the hand matching the description given in the introduction. A northern Buller's albatross in the hand (18°36.32'S, 72°43.63'W) on 31 May 2021 (Photograph: J. Quiñones).

The great majority of the 'northern taxon' were adults (92.5%, n=37). We recorded only three sub-adults (7.5%), all showing a well-developed pale forehead/crown and dark head and neck plumage (Fig. 6b). None were as pale as birds on the breeding islands at fledging (CJRR *pers. obs.*). Most birds presented with some obviously worn body feathers and a moulting mixture of old and new feathers. Figures 5 & 6 show examples of new and old feathers in tail, back and most parts of the upper wing. From the five captured northern Buller's albatross the mean measures were as follows:

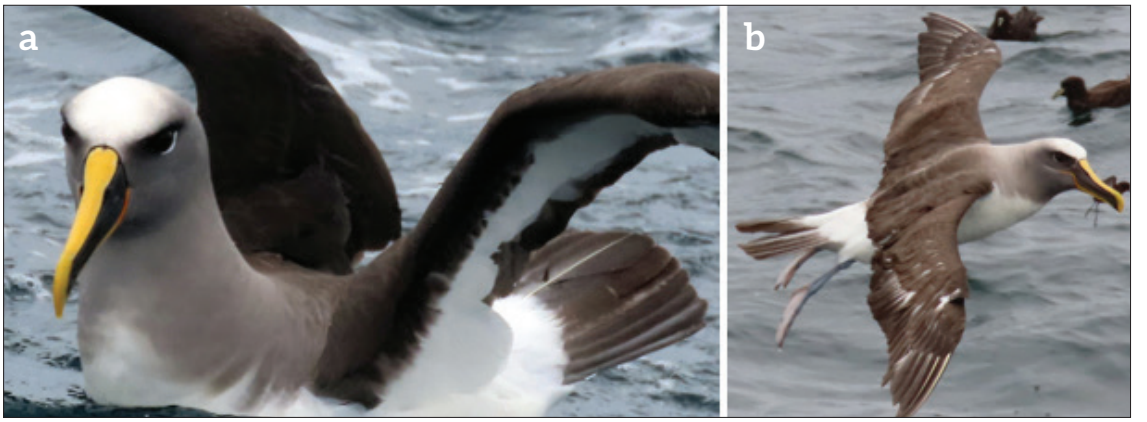

Figure 5 (a). A northern Buller's albatross (18°45.541'S, 72°48.839'W), recorded 1 June 2021 (Photograph: J. Quiñones). This illustrates an adult 'northern taxon' showing the distinctive pale forehead/crown, dark head, and neck, and showing moult with a mix of old and new feathers in the tail, and layers of old feathers in the back. **(b).** A northern Buller's albatross with extensive wing moult, restricted pale cap, and dark eye patch/lores. (18°25.175'S, 72°42.188'W) recorded on 31 May 2021 (Photograph: J. Quiñones).

Figure 6 (a). A northern Buller's albatross (centre) and Chatham albatross (right) showing closely related dark grey head and neck plumages (except crown) (18°36'S, 72°48'W) 31 May 2021. The bird on the extreme left is showing extensive nape, back and wing moult of a northern Buller's albatross, typical of an end of season breeder (Photograph: J. Quiñones). **(b).** Buller's albatross ssp. sub-adult. Probable 'northern taxon' based on darkness of head and neck plumage and eye patch, plus small pale forehead/cap. (18°23.013'S, 72°23.400'W) 8 July 2021. This is not a plumage recorded at the breeding grounds for the 'northern taxon' (Photograph: J. Quiñones).

culmen length 123.1 ± 3.5 mm, wing-chord length 97.5 ± 4.6 cm, and body weight 3.02 ± 0.14 kg.

Our observations occurred between 30 May and 7 July 2021, coinciding with the late autumn and early winter seasons. The number of 'northern taxon' sightings per day ranged from 1–6 over oceanic areas (>120 km offshore). This timing matched the nonbreeding distribution of 15 breeding birds (on eggs in December 2007) that were tracked with GLS loggers (Fig. 7) from The Forty-Fours within the Chatham Islands group. L. Deppe provided us with general data on these 15 birds. Seven birds (failed breeders) departed from The Forty-Fours from late February to late April and averaged 25 (8 to 57) days to reach the Humboldt current. Eight successful breeders departed from mid-May to early July and averaged 11 (7–20) days to reach their destination. Arrival and occupation latitudes averaged 26–30°S (March to May), moving north to <20°S during June and July. Departure from the Humboldt current occurred from August to October centred on 28°S.

During our observations, most of the 'northern taxon' birds (28, 70%) occurred offshore in the ocean above the abyssal plain, in areas with a depth range from 4,057 to 4,972 m. Ten other birds (24% of the total), including the 'southern taxon' individual, were recorded over the Perú–Chile trench where the mean depth of the ocean was around 6,300 m (rounded to the nearest 100 m). Only three birds, all 'northern taxon' individuals, were observed over the continental slope, in waters with a mean depth of only 3,200 m. No birds were observed over the continental shelf. The mean distance from shore

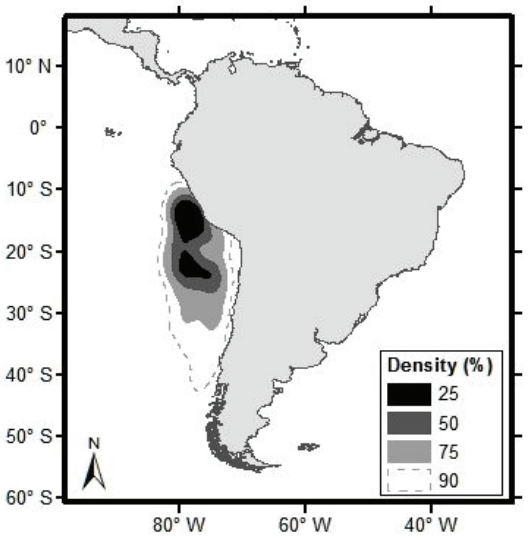

Figure 7. Non-breeding kernel density estimates of northern Buller's albatross distribution. Derived during 2008 from 15 GLS loggers deployed on breeding birds incubating eggs at The Forty-Fours in December 2007. Seven birds arrived March–April (probable failed breeders), eight birds May–July. Birds departed August to October. (Published with permission from Deppe [2012]).

of these sighting locations was 184 ± 32 km (range: 126–223 km, n=18) (Table 1).

Behaviour:
During fishing activities, we observed that discarded shark offal triggered different scavenging behaviours depending on the type of discard. With intestines, white-chinned petrels (*Procellaria aequinoctialis*) were the first to approach and after 'shouting' high-pitch vocalizations, black-browed albatross (*Thalassarche melanophris*) cautiously approached. With shark liver, the approach of the birds was much more intense, and fights were generated between these two species. The northern Buller's albatrosses arrived late, having to fight aggressively with black-browed albatrosses. The shark liver discards also catalysed the presence of Chatham albatrosses (*T. eremita*) and northern giant petrels (*Macronectes halli*), which displaced all other species to obtain food.

DISCUSSION

The northern Buller's albatross is a poorly documented small albatross with their main breeding sites in the Chatham Islands, east of New Zealand. Its taxonomic status is becoming

Table 1. Observed northern Buller's albatross (n=40). * Represents a probable southern Buller's albatross. DC = distance to coast.

Date	Lat. (S)	Long. (W)	Number	% Adults	DC (km)	Habitat	Depth (m)
30 May 2021	18°26′	72°43′	2	100	192	Perú-Chile Trench	5,502
31 May 2021	18°36′	72°44′	6	100	201	Abyssal Plain	4,972
01 June 2021	18°37′	72°49′	4	100	214	Abyssal Plain	4,540
01 June 2021	18°45′	72°48′	3	100	217	Abyssal Plain	4,068
02 June 2021	18°02′	72°19′	1	100	128	Cont. Slope	3,476
02 June 2021	17°57′	72°23′	2	100	126	Cont. Slope	3,102
03 July 2021	18°43′	72°52′	2	100	222	Abyssal Plain	4,173
03 July 2021	18°48′	72°50′	1	100	223	Abyssal Plain	4,057
04 July 2021	18°45′	72°46′	3	66	211	Abyssal Plain	4,107
04 July 2021	18°43′	72°42′	2	100	199	Abyssal Plain	4,453
05 July 2021	18°41′	72°39′	2	100	193	Abyssal Plain	4,784
05 July 2021	18°44′	72°38′	2	100	184	Abyssal Plain	4,714
06 July 2021	18°41′	72°43′	1	100	198	Abyssal Plain	4,466
06 July 2021	18°39′	72°40′	2	100	197	Abyssal Plain	4,878
07 July 2021	18°33′	72°21′	2	100	152	Perú-Chile Trench	6,309
08 July 2021	18°26′	72°23′	1*	100	154	Perú-Chile Trench	6,767
08 July 2021	18°24′	72°23′	1	100	149	Perú-Chile Trench	6,643
08 July 2021	18°23′	72°23′	4	50	150	Perú-Chile Trench	6,475

clearer following the genetic studies published by Wold *et al.* (2018, 2021). The current Buller's albatross taxa (*Thalassarche bulleri bulleri* [southern] and *T. b. platei* [northern]) have asynchronous breeding seasons with a gap of 2.5 months between the start of their respective breeding seasons. Limited trans-Pacific tracking studies for the 'northern taxon' (Deppe 2012) and 'southern taxon' (Roberts *et al.* 2022), and single band recoveries for each taxon in Peruvian waters, support the transpacific migration to non-breeding areas off South America over the Humboldt current, but have not previously provided morphological guidance for the identification of non-breeding adults when seen or photographed.

Both taxa are identifiable at, and around, their breeding islands in New Zealand waters, both in the hand as live adults, or as museum specimen skins. Identification is from a combination of the plumage colour features in the head and bill. Identification and comparison of photographs for both taxa taken at sea can be problematic, due to varying light conditions, unless the birds can be drawn close to the photographer using attractants.

The asynchronous breeding cycles of both taxa mean that there will be differing periods of peak attendance at non-breeding areas. Further, as little is known of the progress of moult in the non-breeding birds, observers need to assess whether this can frustrate identification. The study of photographic material in eBird for the Perú and Chile locations of adult birds, shows many examples of the pale-headed, small-eyebrowed 'southern' birds and few of the darker-headed, dark-eyebrowed/lores 'northern taxon' birds. The eBird Basic Dataset (2021) distribution of observations throughout the year (Fig. 8) is biased by not distinguishing between adult and sub-adult/juvenile birds but shows a heavy concentration in austral summer months. This is indicative of observations from short birdwatching excursions, or views from large cruise vessels transiting the coast, whose habitat coverage is generally <40 km close to shore.

The Deppe (2012) map of GLS kernel density estimate distributions (Fig. 7) show the 15 'northern taxon' birds remaining well offshore in pelagic waters west of 75°W longitude until reaching 25°S and then increasing in density northwards. The only area closer to shore was along the Peruvian coast between 18°to 10°S.

Our observations and photographs suggest that during the period of study, late May to early July, 'northern taxon' birds were prevalent. Viewing of 'southern taxon' birds with light heads (eBird – pictures for both New Zealand and South American locations) showed that the small eyebrow of the 'southern taxon' remained constant throughout all locations throughout the year. The 'northern taxon'

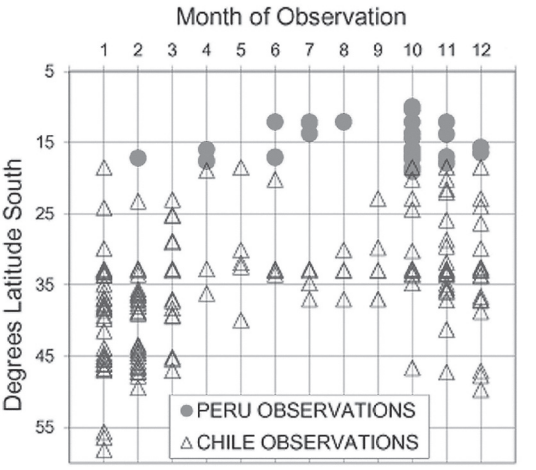

Figure 8. Monthly latitudinal distribution of eBird observation reports for Buller's albatross ssp. of unknown age, origin, and status, off the coasts of Chile and Perú (eBird Basic Dataset 2021). Country as recorded by observer in eBird. Perú n=66 records (1974–2019), Chile n=988 records (1990–2020).

birds retained the dark eyebrow/lores stripe even when birds were showing heavy head, wing, and body moult. The birds recorded during this study had a wide range of moult states, suggesting early arriving failed or non-breeders were followed progressively by breeding birds showing the most obviously moulting states in head, wing, tail, and body.

All our observations of these birds were >126 km from shore. These records provide more specific evidence that northern Buller's albatross prefer deep temperate oceanic waters (SST range of 17–19°C, Deppe [2012]) during their non-breeding period. The timing of their breeding season means that the bulk of the end-of-season breeding birds will arrive in South American waters during May–July. Adult non-breeders can be expected to arrive earlier. These are times when the bulk of the 'southern' taxa are attached to breeding colonies in New Zealand and rearing chicks.

Both, northern and southern Buller's albatross visit the south-eastern Pacific off Perú during the austral autumn-winter from 14°S to the border with Chile (Quiñones *et al.* 2021). However, northern Buller's albatross seems to use more oceanic habitats, preferably over the abyssal plain and the Peruvian-Chilean trench, while southern Buller's also include the continental slope, with aggregations closer to the coastline, and in the vicinity of the submarine Nazca seamounts (Quiñones *et al.* 2021). However, the trophic landscape of these two albatrosses in

the oceanic zones of southern Perú may be similar. Cherel *et al*. (2013) using chest feather samples showed that the two Buller's taxa have almost identical C and N isotopic signatures, though the northern Buller's albatross had slightly lower $\delta^{13}C$ (15.9) compared to southern Buller's (16.3). Neritic waters are represented by higher $\delta^{13}C$ values and this suggests that northern Buller's albatross have slightly more oceanic foraging habitats than the southern Buller's albatross. Oceanographic features during the austral autumn-winter, including eddy like-structures and fronts could well influence the presence of northern Buller's albatross in the south-eastern Pacific between 15°S and 17°S (Chaigneau *et al.* 2013). In southern Perú eddies can extend the propagation of high primary productivity to oceanic waters well offshore of the Humboldt Current (Chaigneau *et al.* 2008).

Notably, no newly fledged birds of the year were recorded during this study. Additional GLS, GPS, or PTT tracking studies are needed to reveal a more precise timing of events for both taxa and the distribution of juvenile, sub-adult, and pre/post-breeding adult age groupings in South American waters. Plumage identification studies on juvenile and sub-adult birds would benefit from the DNA identification of captured and photographed birds, allowing for better identification, recording of seasonal movement patterns and their timing.

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