EXTENSIVE PREALTERNATE MOLTS IN PERUVIAN KELP GULLS

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ABSTRACT: According to current literature, the Kelp Gull (*Larus dominicanus*) matures at the same rate and molts according to the same patterns as most other large gulls, such as the American Herring (*L. argentatus smithsonianus*) and Western (*L. occidentalis*). The Kelp Gull, however, is widespread through the Southern Hemisphere, with separate populations occupying no fewer than four different climate zones and breeding at different times of the year; the molt of some of those populations appears to have not been studied yet. Here we demonstrate that many immature Kelp Gulls of the Peruvian population undergo much more extensive first and second prealternate molts than has been known so far and achieve an adult-like plumage aspect in as soon as 2.5 years rather than the usual 4. In these respects, these Kelp Gulls recall the Yellow-footed Gull (*L. livens*) or subspecies *heuglini* and *fuscus* of the Lesser Black-backed Gull (*L. fuscus*).

The Kelp Gull (*Larus dominicanus*) is thought to acquire its adult (or definitive) plumage at four years of age and to go through two molts each year, a prebasic (or post-breeding) and a prealternate (or pre-breeding) molt. Therefore, it is generally considered to be a "four-year" gull with a simple alternate molt strategy (Howell and Dunn 2007). The prebasic molt is complete, while the prealternate molt has been characterized as partial and rather restricted, limited to the head, body feathers, and some wing coverts and tertials (Jiguet et al. 2001, Olsen and Larsson 2004, Howell and Dunn 2007, Olsen 2018). However, observations by Chris Gibbins at Cape Town, South Africa (*L. d. vetula*), in June 2013 and by Ayyash at Lima, Peru (*L. d. dominicanus*), in October and November 2018 suggested that in these populations the partial molts may be much more extensive than previously thought. Adriaens et al. (2022) briefly touched upon this, stating that some Kelp Gulls "may have already moulted some primaries during their first cycle" (p. 22) and that "the partial moult [in second-cycle birds] can be even more extensive than in the first cycle and may include not just tail feathers and secondaries but also a number of primaries" (p. 156).

Here, we quantify the extent of the first and second prealternate molts in Peruvian Kelp Gulls and show examples of interesting birds that contravene current knowledge, including individuals in which the primaries had been replaced seemingly randomly rather than in the standard sequence from the innermost primary (P1) to the outermost (P10). Our data are based on two trips to Lima, Peru: an exploratory trip in October and November 2018 by Ayyash, and a second in November 2021 by Adriaens. We supplemented our observations with photos from the Cornell Lab of Ornithology's https://eBird.org and from https://observation.org.

METHODS

We scored the number of molted primaries, secondaries (excluding tertials), and tail feathers in 631 first- and second-cycle Kelp Gulls, all photographed near Lima, Peru, 8–25 November 2021, a period of 17 days. Birds were photographed at four different locations along a 160-km stretch of coast (Figure 1), though primarily at Pantanos de Villa, Chorillos. At this lagoon, small flocks of Kelp Gulls come in to bathe from the nearby Pacific Ocean for brief intervals, and the turnover rate is high. Among the birds in our sample, 577 were approximately one year old and 54 were two years old. Birds could be recognized individually on the basis of their plumage, molt stage, and bill pattern, and we took care not to score the same individuals twice. We aged each bird by a combination of criteria, including the color and shape of the outer primaries (brown, narrow, and very pointed in the juvenile plumage; blackish, wide, and rounded in the succeeding second generation of feathers), the persistence of any juvenile secondaries or tail feathers, bill pattern (most notably the presence or absence of a red gonydeal spot like that of an adult), and pattern of underparts (mottled brown in one-year-olds; clean white in two-year-olds). These same criteria have been verified in Lesser Black-backed Gulls (*L. fuscus*; Winters 2006, Koskinen and Rauste 2006, Lindholm and Forsten 2010, Altenburg et al. 2011) and Western Gulls (*L. occidentalis*; Howell and Dunn 2007) of known ages. We categorized the one-year-old birds as those showing no active molt in their primaries (i.e., all primaries still juvenile or molt interrupted, leaving a mix of juvenile and

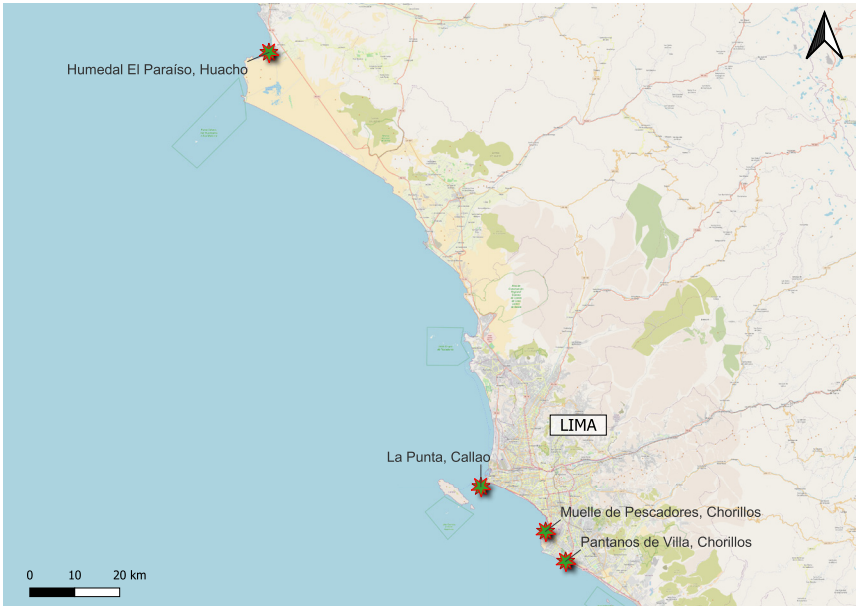

FIGURE 1. Locations of study of molt of the Kelp Gull in Peru, November 2021.

Table 1 Values for Scoring the Molt of Kelp Gulls near Lima, Peru[a]

Score	Feather state
0	Old
1	Old feather missing or new feather invisible
2	New feather just emerging from sheath, up to one third grown
3	New feather between one and two thirds grown
4	New feather more than two thirds grown, but not complete
5	New feather fully grown

[a]From Ginn and Melville (1983).

fully grown, first-alternate feathers), or as those with primaries in active molt. We use the term "interrupted molt" to refer to a molt that was either arrested or suspended (cf. Howell 2010). The distinction between active and inactive molt was not needed for two-year-old birds since none of these showed actively growing primaries. The number of three-year-old and adult birds we encountered near Lima was too small for meaningful analysis, but most of these older birds had not yet started to molt their primaries. We refer to the inserted molt in the first cycle as the "first prealternate molt"; see Pyle (2009) for a fuller treatment and discussion of this technical term.

We scored molt in the primaries according to the method outlined by the British Trust for Ornithology (Table 1; Ginn and Melville 1983). Thus each primary is given a score from 0 to 5 according to its molt stage. Because molt can be asymmetrical, we scored the molt of both wings, resulting in a maximum primary-molt score of 100 in birds that had replaced all primaries ([10 primaries left × 5] + [10 primaries right × 5]). Because secondaries often cannot be easily counted in photographs, we estimated the percentage that had been replaced. We excluded the tertials from consideration and did not score them. To describe the sequence of tail-feather replacement, we carefully checked photos of 66 birds in which the spread tail was clearly visible and showed signs of rectrix molt, either active or interrupted. We scored each rectrix according to Table 1, for both sides of the tail.

RESULTS

One-Year-Old Birds (Figures 2–15)

In our sample of 577 one-year-old birds, 12% did not show any signs of molt in their flight feathers (i.e., their primaries, secondaries, and tail feathers were all still juvenile; Figure 2), 32% showed interrupted molt in their flight feathers (e.g., all secondaries replaced but all primaries still juvenile; Figure 3), and 54% were actively growing flight feathers (Figures 6–14). Even by October (2018), slightly more than half of the one-year-old Kelp Gulls near Lima were actively molting their flight feathers.

The primary-molt score ranged from 1 to 87 in the actively molting birds and from 0 to 90 in the birds showing no actively growing primaries (Figure 16), meaning that primary molt was interrupted in some (4 birds). Nearly half of all the birds showed signs of molt in their primaries, either active or inactive: 45% had a primary-molt score >1. Naturally, most of these were actively molting these feathers, but even in the sample of eight individuals

FIGURE 2. First-cycle Kelp Gull, Lima, Peru, 18 November 2021. Primary-molt score = 0. Bird at a "normal" molt stage, with all flight feathers still juvenile. Of the one-year-old Kelp Gulls near Lima in November 2021, 13% looked like this.

Photo by Peter Adriaens

with no active primary molt, the score ranged from 1 to 90. This was due to one bird with one new and one growing primary in the right wing only, one bird with 13 new, fully grown primaries, one with 17, and one with 18 (across both wings). These four birds therefore represented interrupted rather than active molt. The other four birds (with a primary-molt score of 1) were

FIGURE 3. First-cycle Kelp Gull, Lima, Peru, 9 November 2021. Primary-molt score = 0. Primaries still juvenile, but all tail feathers and all secondaries but the outermost have been replaced, after which molt was interrupted. Age based on the shape and color of the outer primaries (brown, very pointed, and therefore still juvenile; compare with the outer primaries in Figures 14–15 and on this issue's back cover). Note also the streaked neck and the absence of distinct red gonydeal spot.

Photo by Peter Adriaens

FIGURE 4. One-year-old Kelp Gull, Lima, Peru, 31 October 2018. Its visible primaries are still juvenile (brown, narrow, and very pointed), but the secondaries, which can be seen below the greater coverts here, have been replaced. All of the tertials have also been replaced—one of them (the central feather) already twice. The age of one year is further supported by the extensive brown mottling on the lower body and the absence of a red gonydeal spot.

Photo by Amar Ayyash

each missing one primary in one wing only, which, judging from the worn state of their plumage, we interpreted as plumage damage rather than active molt. Birds with unusually high primary-molt scores were already present during the first few days of our sampling (Figure 17). In a few birds the molt was apparently eccentric, the outermost primaries replaced while the inner primaries were still juvenile (Figures 10, 11). In 2021 we encountered only one such bird, but in 2018 birds with eccentric primary molt made up roughly 3–5% of the sample.

A majority of the one-year-old birds, 60% (349 individuals), had replaced some secondaries (Figures 2–15), and 8% (47 individuals) had replaced all of them (Figures 9–15). Many birds had acquired new secondaries before starting to replace their primaries: 156 individuals (27%) showed some new, fully grown secondaries but no new primaries yet (Figure 3). Of the 47 birds with a full set of new secondaries, 5 had not started molting their primaries. In 128 birds, molt in the secondaries had been interrupted. Any replacement of the juvenile secondaries always included the inner feathers (close to the tertials) and was then either interrupted or continued outward, though some birds appeared to have replaced the central and outer secondaries in a more random order (Figure 6).

The state of the tail feathers could be assessed in 424 one-year-old birds. In this sample, two out of every three birds had acquired at least one new tail feather, and 166 birds (39%) had replaced all (Figures 3, 6–10, 14–15). New

FIGURE 5. One-year-old Kelp Gull, Lima, Peru, 2 November 2018. While this bird's plumage appears less "advanced" or mature than the one in Figure 4, the molt of its flight feathers has progressed much further: at least three outer primaries are new, second generation. We believe these feathers to represent the first alternate plumage since in early November the second prebasic molt should still be limited to one or two inner primaries only. The age of this bird is revealed by the old, juvenile P10 visible on the underside of the far wingtip, this feather being clearly narrower than the second-generation primaries, and so worn that its shaft projects at the tip. Note also the immature bill pattern and extensive mottling on the lower body.

Photo by Amar Ayyash

tail feathers were often present even when primary molt had not yet started; this was the case in 159 birds (38%). Of the 166 birds with a completely new tail, 64 (15%) had not started molting their primaries (Figure 3). Similarly, new tail feathers were already present in 51 birds (12%) that had not yet replaced any secondaries.

Analysis of the tail-feather molt suggests that these feathers are usually replaced in the typical sequence from the central pair (R1) outwards; R1 had the highest average molt score, which then gradually declined for each tail feather up to R5 (Figure 18). This means that most of the subset of 66 birds whose tails we analyzed thoroughly had molted the central pair, and only a (small) minority had replaced R4 and 5. However, it is interesting (although not unusual) to see that the outermost tail feather, R6, was replaced more frequently than R5. Thus tail-feather replacement is not perfectly sequential. Thirteen birds had replaced both of the outermost tail feathers while R5 was still juvenile on both sides of the tail; an additional four birds had replaced one R6 while R5 was still juvenile. On the same note, five birds had already replaced some of the outer tail feathers (mainly R3, R4, and R6) while both of the central tail feathers were still juvenile or were missing. Tail molt was asymmetrical in 40 out of the 66 birds, meaning that the number and order

FIGURE 6. One-year-old Kelp Gull, Lima, Peru, 16 November 2021. Primary-molt score = 10. Note the big gaps in the wing of this actively molting bird: most of its secondaries are missing, as well as three inner primaries. This indicates rapid replacement of these feathers. All tail feathers have been replaced at least once.

Photo by Peter Adriaens

FIGURE 7. One-year-old Kelp Gull, Lima, Peru, 15 November 2021. Primary-molt score = 10. Note the big gap in the outer wing, with half of the primaries missing. All tail feathers and half of the secondaries have been replaced, the latter already looking surprisingly adult-like. Age specified by the brown and sharply pointed juvenile outer primaries (compare with Figures 15, 19, and this issue's back cover), the brown juvenile outer secondaries with just a narrow white tip, the streaked neck pattern, and poorly developed gonydeal spot. Note that the bill is already quite yellow, as it is also sometimes in one-year-old Baltic and Heuglin's Gulls, and even first-cycle Yellow-footed Gulls (pers. obs.).

Photo by Peter Adriaens

FIGURE 8. One-year-old Kelp Gull, Lima, Peru, 11 November 2021. Primary-molt score = 28. Another example of a bird missing many flight feathers (notably, most of the secondaries in its left wing). Age determined by the color and shape of the outer primaries, which are clearly still juvenile. All tail feathers have already been replaced, at least once. Many secondaries in the right wing have also been replaced. Molt of the primaries, however, has proceeded only up to P4, indicating that the tail feathers and many secondaries were replaced earlier, as part of the prealternate molt. The primaries' molt could be second prebasic, overlapping with the end of the first prealternate molt. The rather adult-like aspect of the new primaries and secondaries could perhaps be explained by the bird's hormonal state, as it acquired these feathers later in spring than the tail feathers.

Photo by Peter Adriaens

of replaced or missing feathers on the two sides of the tail differed. In addition, the patterns of the new pairs of rectrices sometimes differed, e.g., one R1 showing more extensive white than the other.

In 2021 our sample did not include any one-year-old birds with a complete set of replaced flight feathers (primary-molt score = 100 and all tail feathers and secondaries new), but in early November 2018 we noted at least two birds that had undergone so complete a molt (Figure 15; see also this issue's back cover). Even though such advanced birds may resemble two-year-olds, we feel confident that we have correctly aged them: at least in October and November, the new, second-generation primaries of such advanced one-year-old individuals look clearly fresher and more glossy blackish than the worn, slightly brownish-tinged primaries (and primary coverts) of two-year-olds (see Figure 19 for comparison). Also, the bills and body plumage of two-year-old birds already resemble those of adults at that time of year, with an extensive red gonydeal spot, clean white head, neck, and underparts, uniformly blackish scapulars, and few (if any) brown spots on the white underwing coverts.

Two-Year-Old Birds (Figures 19–21)

Our sample of 54 two-year-old Kelp Gulls included only two birds that had not started to molt their flight feathers. The vast majority (50 of the 54) showed interrupted molt, while one bird was actively molting its tail feathers and one lacked two primaries in its right wing, which may have been a sign of active molt or of damage to the wing.

FIGURE 9. One-year-old Kelp Gull, Lima, Peru, 20 November 2021. Primary-molt score = 22. In this bird's left wing, a new innermost primary, P1, is just starting to appear and P4 is missing, while P5 and 6 are new and P7 is growing. In the right wing, P1 and P6 are missing, while P5 is new but still growing. Thus there appear to be three waves of molt in the primaries on the left and at least two on the right. The missing P1 could indicate the start of the second prebasic molt, but the new primaries were apparently acquired through an eccentric first prealternate molt. This bird's age of one year is based on the brown color and pointed shape of the outer primaries, which are clearly still juvenile feathers. Note also the streaked neck, brown scapulars. and extensively brown lower body. In addition, other photos of this bird show an immature bill pattern.

Photo by Peter Adriaens

The primary-molt score ranged from 0 to 95, as depicted in Figure 20. Most birds (67%) had not acquired any new primaries yet, but 11 birds (20%) had acquired more than 10, after which molt was interrupted (Figure 21). The starting primary was slightly variable. One bird had replaced P1, after which its molt was interrupted. In 11 molt had presumably started at P1 and then continued outward to anywhere from P4 to P9 before being interrupted (although one bird had skipped replacement of the juvenile P2 in its left wing). In two molt started at P2 and continued to P6–P10. One bird had replaced P3–P6 only, and one had replaced P4–P6 only.

Forty-five two-year-old birds (83%) had replaced some secondaries, and in 20% of the sample all secondaries had been replaced (11 birds). These 11 birds were not all the same as those mentioned above with more than 10 new primaries; their primary-molt score ranged from as low as 10 (i.e., showing only two new fully grown primaries) to 95. Approximately half of the two-year-old birds had acquired new secondaries before molt of their primaries began: 28 birds of the sample (52%) showed some new fully grown secondaries but no new primaries yet.

We could assess tail molt in 40 two-year-old birds. In this sample, most individuals (88%) had acquired at least one new tail feather, and 25 (63%) had replaced all tail feathers. New tail feathers were often present even when primary molt had not yet started; this was the case in 26 birds (65%). Of the 25 birds with a completely new tail, 15 (38%) had not yet started molting

FIGURE 10. One-year-old Kelp Gull, Lima, Peru, 1 November 2018. Primary-molt score = 41. This bird is remarkable in that it shows an eccentric first prealternate molt. On the left wing, the outermost three primaries have been replaced while all other primaries are still juvenile. On its right wing, the outermost five primaries are new, P5 is missing, and P1–4 are still juvenile. Apparently, that molt was interrupted, since all visible primaries are fully grown. All secondaries and tail feathers have also been replaced. This pattern, with tail feathers and secondaries replaced before the inner primaries, and eccentric, interrupted molt in the primaries, indicates an extensive first prealternate molt.

Photo by Amar Ayyash

their primaries. Four birds had acquired up to 12 new tail feathers but no new secondaries. Our sample of two-year-olds was too small for us to draw any firm conclusions about the sequence of rectrix replacement at this age. Only six birds that showed signs of rectrix molt were photographed with their tail fully spread. In these six birds, molt seemed to start from the central pair of feathers and then proceed outward on both sides of the tail, though one bird had replaced R6 while retaining the old R5. Tail-feather molt was asymmetrical in three of the six birds.

DISCUSSION

If we disregard the development from downy to full juvenile plumage, most first-cycle large gulls in general undergo their first complete molt (the "second prebasic molt") at 9 to 11 months after fledging, when they are approximately one year old. This molt starts with the innermost primary and continues outward, one primary feather at a time (Howell and Corben 2000a, 2000b, Howell et al 2003, Pyle 2008, Pyle et al. 2018). When molt reaches the outer primaries (typically P7–P8), the first rectrices are shed, followed shortly by the first few secondaries (Howell and Dunn 2007). In Peruvian

FIGURE 11. One-year-old Kelp Gull, Lima, Peru, 24 November 2021. Primary-molt score = 29. Another bird with eccentric first prealternate primary molt: on the right wing, P9–10 are new, on the left P10 only is new. Note the small white mirror on the underside of the new P10, as also shown by a few one-year-old Baltic and Heuglin's Gulls, and also that a new molt wave, the second prebasic, has started at the inner primaries (P1 new; P2 missing on left and growing on right). All secondaries and tail feathers had been replaced during the first prealternate molt. Age of one year attested by the worn, brown and pointed aspect of the retained, juvenile outer primaries (best visible on the left wing), the brown mottling on the belly, and the lack of a red gonydeal spot.

Photo by Peter Adriaens

FIGURE 12. One-year-old Kelp Gull, Lima, Peru, 15 November 2021. Primary-molt score = 59. In the left wing, molt of the primaries does not follow the regular sequence: P4 is still growing (possibly growing after an adventitious loss), but P5 and 6 have already been replaced and are fully grown. All secondaries have been replaced. This bird's molt is much more extensive than expected in November, indicating that some if not all of the new primaries were replaced previously during the first prealternate molt. Age of one year by the juvenile outer primaries (brown, narrow, and very pointed), immature bill pattern, heavily streaked neck, and barred undertail coverts.

Photo by Peter Adriaens

Kelp Gulls, however, this molt appears to be irregular, not only in its timing and extent but also its sequence. We found that in some Kelp Gulls the first molt of flight feathers seems to occur very early, possibly at 5 to 7 months of age, and the tail feathers and secondaries often appear to be molted before the primaries. In addition, Kelp Gull primaries are not always molted sequentially but sometimes randomly, and several primaries may be shed simultaneously rather than one by one, as judged from the large gaps in the outer wing of some birds (Figures 6–7). In these respects, molt in Peruvian Kelp Gulls resembles that of the Yellow-footed Gull (*L. livens*) and some taxa of the Lesser Black-backed Gull complex, including the Heuglin's [*L.* (*fuscus*) *heuglini*] and Baltic (*L. f. fuscus*) (Jonsson 1998, Rauste 1999, Gibbins 2004, Pyle et al 2018).

A better understanding of the molt of these Kelp Gulls should start with knowledge about the timing of their breeding season in Peru. According to the available literature and local researchers, egg laying starts in late October, and the first full-grown juveniles are seen in December or January (Figueroa 2010a, b, Carlos Zavalaga *in litt.*; see also Table 2). This is at odds with the statement in Harrison et al. (2021) that the "breeding season [is] year-round

Table 2 Estimated or Recorded Dates of Start of Egg Laying in Kelp Gull Colonies in South America

Location	Latitude (° S)	Month	Day	Expected start of second prebasic molt	Reference
Atlantic coast					
Argentina					
Golfo San Jorge	45	Nov	21	Nov	Figueroa 2010b
Punta Tombo	44	Nov	1	Nov	Figueroa 2010b
Punta Léon	43	Oct	1	Oct	Figueroa 2010b
Punta Pirámide	42	Oct	15	Oct	Figueroa 2010b
Punta Rasa	36	Sep	24–26	Sep	Mauco et al 2007
Islote La Pastosa	41	Oct	1–10	Oct	Yorio et al 1994
Isla Vernaci Sudoeste	45	Nov	15	Nov	Yorio and García-Borboroglu 2002
Brazil					
Bahía Saldanha	33	Oct	1	Oct	Figueroa 2010b
Santa Catarina	27	Jul	15	Jul	Figueroa 2010b
Isla Moleques do Sul	27	Jun	1	Jun	Figueroa 2010b
Isla Guararitama	24	Jun	24–30	Jun	Figueroa 2010b
Santa Catarina	27	Jul	24	Jul	Branco et al 2009
Pacific					
Chile					
Coquimbo	29	Nov	15–20	Nov	Chávez-Villavicencio 2014
(all)		Sep–Dec		Sep–Dec	Garrido 2018
islote Pájaro niño	33	Nov–Dec		Nov–Dec	Simeone 2018
Ecuador					
Salinas	2	Oct–Jan		Oct–Jan	Haase 1996
Peru					
Punta Campana	5	Oct	21–23	Oct	Figueroa 2010a
Isla Lobos de Afuera	6	Oct	22	Oct	Figueroa 2010b
Isla Lobos de Tierra	6	Oct	22	Oct	Figueroa 2010b
Punta Coles	17	Nov	14–20	Nov	Figueroa 2010b

FIGURE 13. One-year-old Kelp Gull, Lima, Peru, 20 November 2021. Primary-molt score = 34. Another bird that seems to have replaced its primaries in a random order: P1 is new, P2 is growing but is clearly shorter than the also growing P3 (best seen on the right wing), indicating that it is being replaced later. P4 is new (and fully grown), and P5 is growing (though not visible here), while P6–10 are still juvenile. Note the rather mature look of the new primaries. The age of this bird is revealed by the color and shape of its juvenile outer primaries (most obvious on the left wing), immature bill pattern, barred undertail coverts, and brown belly.

Photo by Peter Adriaens

FIGURE 14. One-year-old Kelp Gull, Lima, Peru, 20 November 2021. Primary-molt score = 87. A bird that underwent a very extensive primary molt: all primaries have been replaced, except for P3, which is still juvenile in the right wing (missing in the left wing, not visible here), and P2, which is missing in the right wing but new in the left wing. The extensive replacement of the central and outer primaries by November indicates that this replacement was part of an eccentric first prealternate molt, while the new P1 and missing P2 could indicate that the second prebasic molt has begun. Age of one year by the retained juvenile P3, two retained juvenile primary coverts, and extensive brown on the lower body and uppertail coverts.

Photo by Peter Adriaens

FIGURE 15. One-year-old Kelp Gulls, Lima, Peru, 1 November 2018. Primary-molt scores = 0 (left) and 100 (right). A nice comparison of the extremes of variation in molt at this age. The bird on the left has retained all of its juvenile flight feathers (as well as most of its juvenile wing coverts), while the bird on the right has replaced all of them, showing a full set of primaries, secondaries, and tail feathers representing the first alternate plumage. A retained juvenile central primary covert, heavily streaked neck, brown scapulars, barred uppertail coverts, and lack of the red gonydeal spot reveal the bird's age of one year. The outer primaries are quite fresh and thus were acquired recently. In November a two-year-old Kelp Gull would show significant wear on its outer primaries, which by then would be approximately 6 months old. Compare with the brown tinge on the outer primaries on bird in Figure 19.

Photo by Amar Ayyash

in Peruvian Humboldt," for which no source is mentioned and which is not borne out by the evidence: numerous photographs from Peru at https://eBird.org and https://observation.org show birds in full juvenile plumage only from January to March, not year round. Similarly, we did not see any juvenile Kelp Gulls during our visits in October and November. Therefore the breeding season in Peru appears to be from October to February or March.

In general, first-cycle large gulls start their first complete (second prebasic) molt 10 or 11 months after fledging, so birds that acquire juvenile plumage in (late) December or January could be expected to start replacing their flight feathers from late October to December. By late November, such birds should therefore have an expected primary-molt score of 0–22 (for both wings together), yet 7% of the one-year-old Kelp Gulls in our November sample were clearly further ahead, with a score of 23–90; one bird scored 84 even as early as 8 November. Similarly, two-year-old birds should start replacing their flight feathers beginning in December, slightly later than their one-year-old juniors, and can therefore be expected to have a primary-molt score of 0 in November. Nonetheless, 31% of birds in our sample had scores >2, and two had reached a score of 80 by 8 and 9 November.

There are three possible hypotheses for these unusually high molt scores:

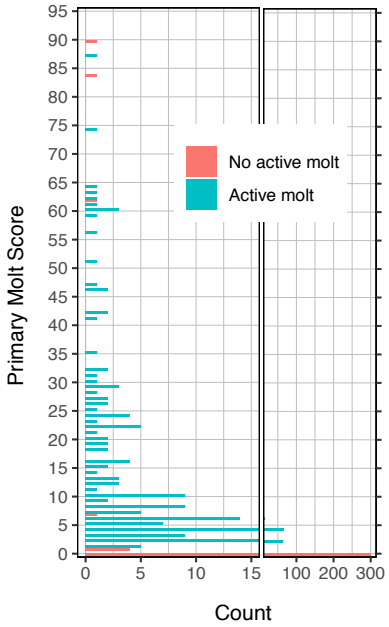

FIGURE 16. Primary-molt scores of 563 one-year-old Kelp Gulls photographed near Lima, Peru, 8–25 November 2021. Birds with scores of 100 were observed only in 2018 and are therefore not included in this diagram. Note break in the *x* axis and different scales across the two panels.

1. Could these extensively molting birds be migrants from a different population that breeds much earlier? In Brazil, for instance, egg-laying starts in June, and the complete second prebasic molt may therefore start in June or July (Table 2) and be completed from November to January. This hypothesis is not the most plausible one, however, since South American

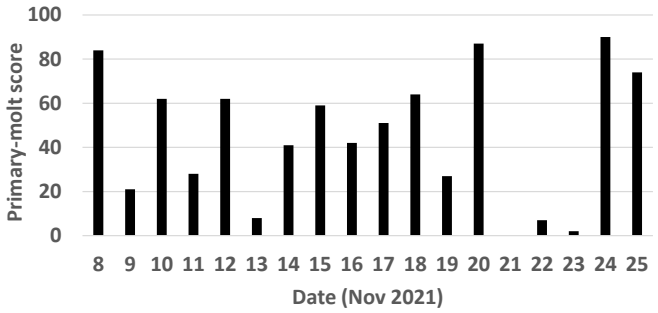

FIGURE 17. Highest primary-molt scores per day of 576 one-year-old Kelp Gulls photographed near Lima, Peru, November 2021. Very few birds were sampled on 13 and 21–23 November.

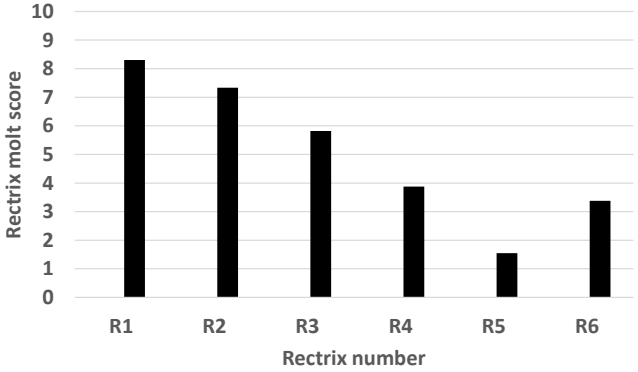

FIGURE 18. Average rectrix-molt scores of 66 one-year-old Kelp Gulls photographed near Lima, Peru, in November 2021.

Kelp Gulls are considered mainly resident, making only short-distance movements from the southern part of the range in winter and generating only a few extralimital stragglers (Olsen and Larsson 2004, Howell and Dunn 2007, Howell et al 2014). To reach coastal Peru, Brazilian Kelp Gulls would have to cross South America, over the Amazon basin and the Andes, or move south along the coast toward a colder climate zone before returning north on the other side of the continent, a flight distance of more than 10,000 km. Both scenarios seem highly unlikely. Moreover, if Brazilian birds were to migrate immediately after their breeding season, reaching

FIGURE 19. Second-cycle Kelp Gull, Lima, Peru, 19 November 2021. Primary-molt score = 40. This bird's partial second prealternate molt included all tail feathers, probably all secondaries, and four central primaries (P3–6). Age two years by the color (dark brown) and shape (rounded) of the outer primaries, which are retained second-generation feathers, presumably acquired through the second prebasic molt six months earlier.

Photo by Peter Adriaens

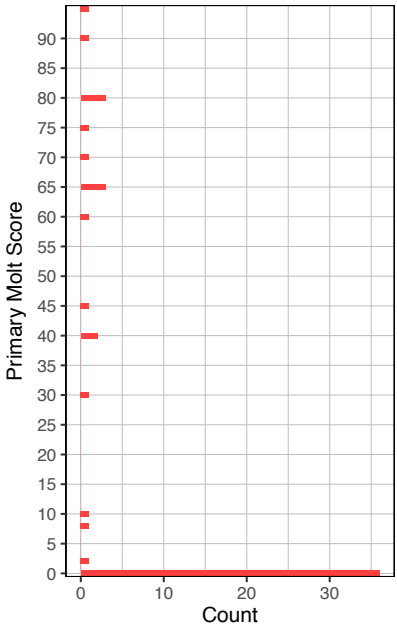

FIGURE 20. Primary-molt scores of 54 two-year-old Kelp Gulls photographed near Lima, Peru, 8–25 November 2021.

Peru in October and November, one could expect some fresh juveniles among them, yet this plumage appears to be absent in Peru at that time of year. Similarly, given the large number (138) of first-cycle Kelp Gulls in our sample in which remex molt had been interrupted, if there were some migration one would expect such birds to turn up south of Peru. Yet the photos available from Chile on eBird.org do not reveal any Kelp Gulls with interrupted molt in their primaries or secondaries.

2. Might a small minority of Peruvian Kelp Gulls breed year-round? Again, this does not seem the most likely explanation, since neither breeding activity nor birds with fresh juvenile plumage have been documented outside of the main breeding season.
3. The specifics of the molt indicate additional complexity. Could the first and second prealternate molts of some Peruvian Kelp Gulls be (almost) complete rather than partial? We infer that this is indeed the case: the rapid, simultaneous shedding of several remiges, the sequence of replacement of the feathers (with tail feathers and secondaries often replaced before the primaries), and the large number of birds with interrupted molt recall the pattern seen in gulls in which extensive first prealternate molt has been well documented, such as the Heuglin's and Baltic gulls. We conclude that one-year-old Kelp Gulls with high primary-molt scores in October and November, even those actively growing new primaries, are finishing their first prealternate molt, and will either complete this molt

FIGURE 21. Second-cycle Kelp Gull, Lima, Peru, 24 November 2021. Primary-molt score = 90. This bird's partial second prealternate molt was so extensive that the plumage now closely resembles that of an adult. All primaries have been replaced, except the outermost (P10), which is still second generation. Molt was arrested when P9 was fully grown. Age as two years by the strongly brown color of the retained outermost primary (contrasting with the black of all other primaries, which are new and fresh) and by extensive black on the outer tail feathers.

Photo by Peter Adriaens

quickly or will interrupt it. Likewise, a high primary-molt score in two-year-old birds at that time of year and interrupted flight-feather molt are signs of an extensive second prealternate molt.

This conclusion raises the question of why the Kelp Gull should have such an extensive prealternate molt, since such a molt is usually seen in long-dis-

FIGURE 22. Adult Kelp Gull, Lima, Peru, 18 November 2021. Primary-molt score = 82. Even some adults appear to show rapid molt. This bird has two waves of molt in its primaries: one, presumably prebasic, in the inner primaries, where P3 and P4 are missing, and one, presumably prealternate, in the outermost primaries, where P10 is still growing.

Photo by Peter Adriaens

tance migrants, which may need to counter increased feather bleaching and wear caused by higher levels of ultraviolet radiation at more tropical latitudes (Howell 2010: 50). Prealternate molts are rarely complete in resident gulls. Examples include the Yellow-footed Gull, in which the second prealternate molt may include a number of primaries (Howell and Dunn 2007, Pyle et al. 2018, Adriaens pers. obs.), and the southernmost breeding populations of Heermann's Gull (*L. heermanni*), in which some birds seem to replace all of their primaries during their first cycle (Howell and Wood 2004, Howell 2010). These gulls are exposed to intense tropical or desert sunlight year-round and therefore may need to replace their flight feathers more than once a year. The same is true for Peruvian Kelp Gulls, which live in a coastal desert climate where they are exposed to tropical temperatures and strong sunlight all year. In addition, Peruvian Kelp Gulls benefit from the food-rich waters of the Humboldt Current, which, except in years of El Niño, provides them with the energy needed to replace large feathers quickly (cf. Guerra et al. 1988, Howell and Corben 2000c). It is probably no coincidence that Franklin's Gull (*Leucophaeus pipixcan*), another gull with a nearly complete prealternate molt, winters in this same region in huge numbers.

Although our observations of adult Kelp Gulls are limited, it seems that at least some adult birds show two simultaneous waves of molt in their primaries: one adult in Lima on 18 November 2021 was replacing its inner four primaries while also still growing P10 (Figure 22), and one adult photographed in the Galápagos Islands on 27 August 2013 exhibited a similar molt pattern (https://ebird.org/checklist/S63540336). Examples of adult large gulls with multiple simultaneous waves of molt in their primaries are very rare, but this molt sequence has also been documented in adult Lesser Black-backed and Yellow-footed gulls (Pyle et al. 2018).

CONCLUSIONS

Peruvian Kelp Gulls may undergo rapid and extensive first and second prealternate molts, which in many ways recall those of Heuglin's Gull. Most one-year-old birds (66%) in our sample from November had replaced ≥1 tail feather, and half of these birds had also replaced ≥1 secondary. In a small minority (at least 7%), the first prealternate molt also appeared to include some primaries, since in October and November these birds already had a primary-molt score >22, much higher than expected at that time of year. Some individuals had also interrupted their primary molt, which suggested that they were undergoing a rapid, incomplete first prealternate molt rather than a complete, second prebasic molt (Figures 10, 11, 14). In two-year-old birds, 88% had replaced ≥1 tail feather, 83% had replaced ≥1 secondary, and 31% had replaced ≥1 primary. Replacement of the flight feathers seemed to occur sometimes in random order and quite rapidly, with many feathers shed simultaneously, leaving big gaps in the wings. A few two-year-old birds had already acquired completely white rectrices. New secondaries and inner primaries appeared surprisingly adult-like in some immature birds, even in a few one-year-olds. Peruvian Kelp Gulls' plumage therefore seems to mature quickly, and second-cycle birds that undergo a nearly complete second prealternate molt can look very similar to adults, as in some Lesser Black-backed

and Yellow-footed gulls (Altenburg et al 2011, Pyle et al. 2018). Distinguishing these from third-cycle birds may not always be possible.

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