DISTINGUISHING BLACK-LEGGED KITTIWAKE MATES AT THE NEST-SITE USING WING TIP PATTERNS

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Chardine, J.W. 2002. Distinguishing Black-legged Kittiwake mates at the nest-site using wing tip patterns. Atlantic Seabirds 4(3): 81-90. *Inter-individual differences in the patterns of black and white on the tips of primary feathers 5 through 10 are reported for Black-legged Kittiwakes* (Rissa tridactyla) *from Arctic Canada and Newfoundland. Primaries were classified into five types according to the amount of white at the tip. Primaries 5 or 6 (depending on location) were the most variable between individuals and fell more evenly into the five types, compared with primaries 9 and 10, almost all of which were of one type. The Shannon-Weaver index was used to quantify this variation. The shape, number and position of the black patches at the tip of primaries 5 and 6 also varied between individuals, as did the relative size of apical white spots on primaries 6 through 10. These differences could be observed in the field with a spotting scope or binoculars and were used successfully to distinguish between members of the pair at the nest-site with 100% accuracy. Left-right symmetry in wing tip pattern within a bird was high but not perfect. Similarly, patterns were largely, but not perfectly, consistent across two successive wing moults. In conjunction with observations of courtship feeding or copulation, individual differences in wing tip pattern allow the study of birds of known sex at the nest-site, in situations when their capture and marking is undesirable or not possible. Other gull species may exhibit similar variation in wing tip patterns between individuals.*

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INTRODUCTION

Although individual animals often look superficially alike to human observers, closer inspection sometimes reveals extensive inter-individual variation in external characteristics such as coloration or patterning. Such differences have been used to identify individuals without having to mark them (e.g. Humpback Whale *Megaptera novaeangliae*, Katona and Whitehead 1981; Leatherback Turtle *Dermochelys coriacea*, S. Sadove, *pers. comm.*). A good example of individual variation in patterning or coloration is Bewick's Swan *Cygnus columbianus bewickii*, where bill and facial patterns have been used to distinguish individuals (Evans 1977; Scott 1966). Bretagnolle *et al.* (1994) found variation in the head patterns of Ospreys (*Pandion haliaetus*) that could be used to recognise individuals.

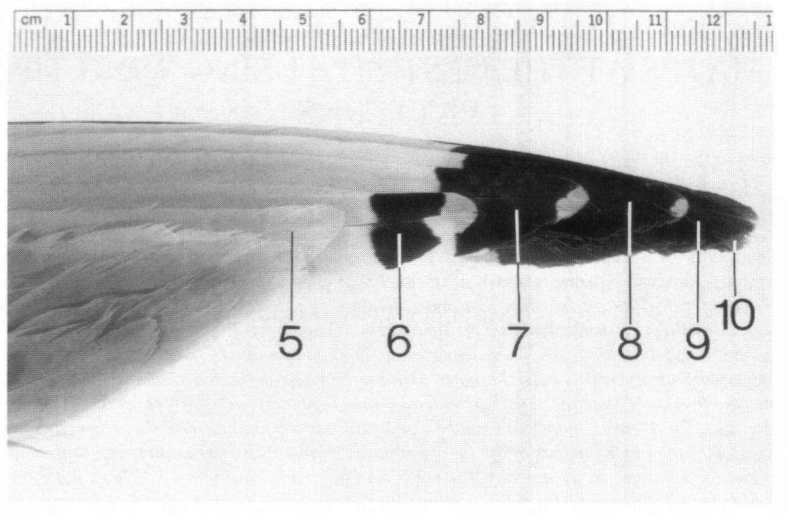


Figure 1. Right wing tip of a Black-legged Kittiwake showing how the pattern is typically presented in a folded wing. Primaries 5 through 10 are labelled.
Figuur 1. Rechtervleugelpunt van een Drieteenmeeuw, waarbij het patroon bij een gevouwen vleugel zichtbaar is. Handpennen P5 t/m P10 zijn aangegeven.

Studies of birds at the nest-site often require that males and females in each pair are identifiable. This is straightforward in sexually dimorphic species but for monomorphic species, at least one member of the pair would need to be marked in some way, and this usually entails capture. The ability to tell individual birds apart through variation in some external feature would be an obvious advantage in situations where capture and/or marking are not possible or are undesirable.

The Black-legged Kittiwake *Rissa tridactyla* is a small, sexually monomorphic gull that usually nests on steep cliffs by the sea (Baird 1994). Capture of breeding Black-legged Kittiwakes for purposes of individual identification is often difficult or impossible and, if attempted, can result in disturbance of breeding birds and possible loss of eggs or chicks. While studying geographic variation in the amount of white and black in the wing tips ("wing tip pattern") of Black-legged Kittiwakes (Chardine 2002), I noticed considerable variation among individuals that was easy to assess in the field from a distance. Here I report on this variation and explore its utility in distinguishing partners at the nest-site.

METHODS

I observed 119 Black-legged Kittiwakes at Prince Leopold Island (PLI), Nunavut (74° 02' N, 90° 00' W) in August 1988, 20 at Cape St. Mary's, Newfoundland (46° 50' N, 54° 12' W) in June 1991, and 15 at Great Island, Newfoundland (47° 11' N, 52° 49' W) in July 1992. Newfoundland samples were combined in the analysis. When on the nest, adult Black-legged Kittiwakes usually oriented themselves facing or parallel to the cliff (see Hodges 1975) such that at least one wing tip was almost always in view. Figure 1 shows a Black-legged Kittiwake wing tip as it typically would be seen in a folded wing. The tips of each primary were usually visible with the exception of primary 10 (p10), which was sometimes obscured by p9, and p5, which was sometimes obscured by tertial feathers. Movement of the bird during preening or wing-flapping usually allowed examination of these primaries.

During observations a 20x or 25x spotting scope, or 7x binoculars were used to examine the dorsal side of the outermost six primaries (p5-p10) of breeding birds attending nest-sites. I observed either the right or left folded wing of one or both birds nesting in one study plot at each location, and classified each primary into one of five types according to the scheme outlined in Figure 2. For each classified primary, I calculated the Shannon-Weaver Index (H') within samples from PLI and Newfoundland thus:

$$H' = -\sum_{i=1}^{s} (p_i)(\log_2 p_i)$$

where p_i is proportion of sample belonging to the i^{th} primary-type and s is the total number of types. The index combined a measure of the "type" variability of each primary and the evenness of the distributions among each of the types, and so provided a numerical index of the usefulness of each primary in differentiating individuals. I also sketched the pattern of black and white at the tip of p5 and p6 and from this determined differences in the shape, size, and position of black patches between mates. If both mates at a nest were examined, the relative size of any apical white spots in the primaries also was recorded.

In order to study right-left symmetry in wing tip patterns I classified primaries on both wings of a small sample of skins (n = 12) collected in Newfoundland and held by Memorial University, St. John's. A preliminary assessment of the consistency of patterns within the same individual between moults was made by classifying the primaries of seven colour-marked individuals captured on Gull Island, Newfoundland (47° 16' N, 52° 46' W) in 1996, and again in 1997.

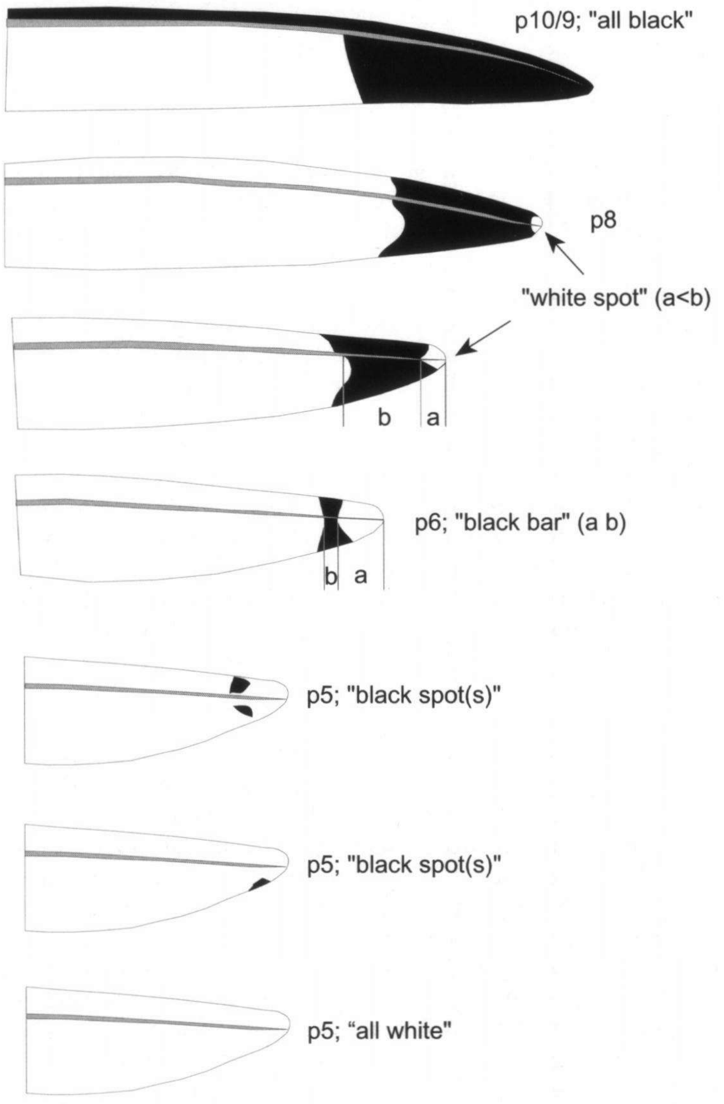


Figure 2. Sketches of each Black-legged Kittiwake primary-type. Typical types for each primary are illustrated.

Figuur 2. Schets van de verschillende karakteristieke "handpentypen" van de Drieteenmeeuw.

Table 1. Proportions (%) of primaries 5 through 10 falling into each primary-type in 119 Black-legged Kittiwake adults examined at Prince Leopold Island (PLI) and in 35 examined at Cape St. Mary's and Great Island, Newfoundland (NF).

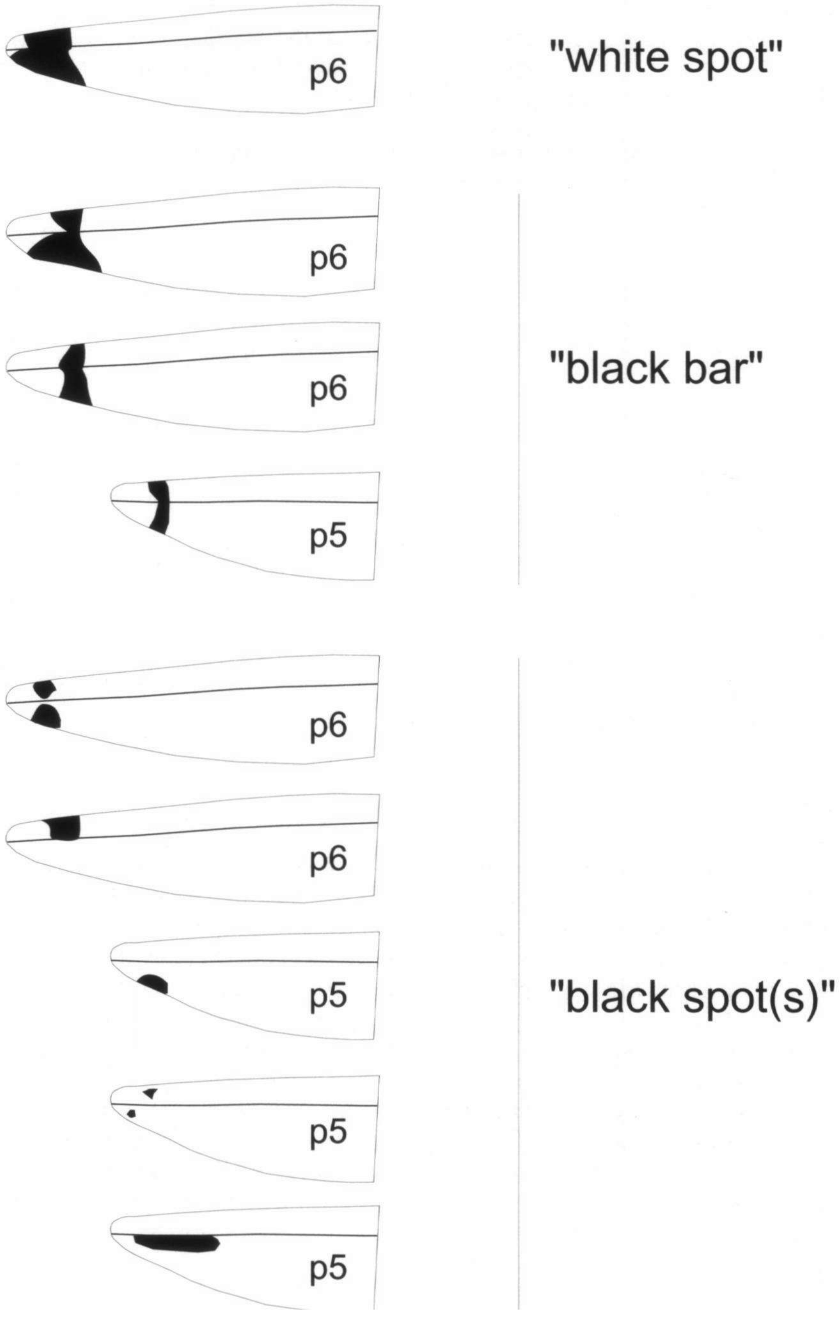
Tabel 1. Aandeel (%) van P5 t/m P10 per "handpentype" voor adulte Drieteenmeeuwen op Prince Edward Island (PLI, n = 119) en op Cape St. Mary's en Great Island, Newfoundland (NF, n = 35)

Type[1]		all black	white spot	black bar	black spot(s)	all white	H'[2]
p5	PLI	0	0	0	7	93	0.36
	NF	0	0	6	37	57	1.23
p6	PLI	0	22	56	18	4	1.58
	NF	0	77	20	3	0	0.90
p7	PLI	11	89	0	0	0	0.50
	NF	46	54	0	0	0	1.00
p8	PLI	54	46	0	0	0	1.00
	NF	97	3	0	0	0	0.19
p9	PLI	99	1	0	0	0	0.07
	NF	100	0	0	0	0	0.00
p10	PLI	100	0	0	0	0	0.00
	NF	100	0	0	0	0	0.00

[1] For primary-type definitions see Fig. 2
[2] Shannon-Weaver Index of diversity and evenness

RESULTS

Observable variation in p5-p10 Table 1 shows the proportion of primaries 5 through 10 classified as each type in the samples from Prince Leopold Island and Newfoundland. Birds from different locations were considered separately because of inter-regional differences in wing tip patterns (Chardine 2002). The outer four primaries (p10-p7) were classified only as either "all black" or "white spot". In contrast, p6 and p5 were more variable, and were of all types except "all black". Also, the frequencies of each primary type were more evenly distributed in some primaries (e.g. p7 and p6) than in others (e.g. p9 and p10). The Shannon-Weaver Index for each primary (Table 1) confirmed these differences. Primary 6 for PLI and p5 for Newfoundland had the highest indices and thus contained the most information with which individuals could be identified. Primary 8 in Newfoundland birds, and p9 and 10 in both groups contained little or no information.


p6
"white spot"
p6
p6
p5
"black bar"
p6
p6
p5
p5
p5
"black spot(s)"

Opposite page: Figure 3. Drawings of the tip of primaries 5 (p5) and 6 (p6) showing examples of the variation in black and white patterning observed in Black-legged Kittiwakes in this study. Primaries are labelled according to types shown in Figure 2.

Tegenoverliggende pagina: Figuur 3. Variatie in tekening van de zwart-witpatronen van de top van de vijfde (P5) en zesde (P6) handpen bij Drieteenmeeuw. Handpennen zijn gekwalificeerd volgens de typen in figuur 2.

In addition to variation among birds in the way primaries were classified, there was also considerable variation in the size, shape, position, and number of black patches or spots on each vane of p5 and p6. Figure 3 shows a sample of p5 and p6 patterns from sketches made of birds at PLI and Cape St. Mary's; examples were chosen to show the wide variation observed in these primaries.

Differentiation of mates at the nest-site I tested the ability to distinguish mates at 23 nest-sites at which I was able to record wing tip patterns for both members of the pair (18 at Cape St. Mary's and five at Prince Leopold Island). Partners could be identified unambiguously in all pairs, but by different means. Partners in 15 of the 23 pairs could be identified readily based on differences (either type or shape of black patch) in p6 alone. For pairs in which p6 was similar, the primary type or number of black spots on p5 differed in four pairs. In the remaining four pairs, differences in the type of p8 or the size of apical white spots on p6 and 7 were sufficient to distinguish mates. Despite the small sample size, the success in distinguishing mates at the nest-site was significantly better than random (Fisher Test, $p < 0.0001$).

Left-right symmetry in wing tip patterns Of the 10 skins examined for left-right symmetry, eight showed virtually identical patterns of black and white on p10-p5 of both left and right wings. The left and right wings of the other two birds were also similar, with the exception that in one, the size of the apical white spot on p7 was larger in the left than in the right wing, and in the another, the black spot at the tip of p5 was larger in the left wing than the right.

Consistency of wing tip patterns between moults Of the seven colour-marked birds examined in the hand in 1996 and 1997, primary type of p5-p10 remained consistent from one year to the next. One bird had an "all white" p5 in 1996 and a "black spot(s)" p5 in 1997. Another had a "black spot(s)" p5 in 1996 and an "all white" p5 in 1997. In another, p6 was categorised as a "black bar" in 1996 and a "white spot" in 1997. Viewed another way, of the 42 (7 birds by 6 primaries categorised) possible opportunities for a primary to change type in the two years, they did so on only three occasions (7%).

DISCUSSION

Patterns of black and white at the tip of some primaries varied substantially between individual Black-legged Kittiwakes in this study. Such variation was readily observable in the field with a spotting scope or binoculars, and could be used to differentiate between members of the pair at the nest-site. Once partners were distinguished in this manner, it was a relatively straightforward matter to determine the sex of the birds through observations of courtship feeding or copulation, and then follow the activities of individual, known-sex birds at the nest. Clearly, it would be preferable to capture and mark birds for individual recognition if disruption to breeding activities was minimal; however, observation of wing tip patterns provides a reasonable and practical alternative in many situations. The method does not work well when several birds are visiting a nest-site and nest-site "ownership" has not been established. In these cases, birds may not visit the site long enough to be able to observe wing tip patterns, or there may be too many birds visiting a nest-site to keep track of individuals. However, these cases are relatively rare compared with the usual pattern where only two birds are ever seen at a particular nest-site from the point at which the site becomes occupied.

Rather than categorise and sketch every primary of those individual birds of interest, a more efficient method would be to record the minimum information necessary to distinguish mates. Ideally this would involve identifying one key difference in the wing tip pattern that could be used "at a glance" to identify mates. Based on the diversity and evenness of types seen in each of the classified primaries, and other patterns of inter-individual variation, I recommend the following procedure:

- Record the type of p5 and p6 based on the classification system described here; in particular, look for "white spot" vs. "black bar" on p6 and the presence of any black on p5;
- Sketch the shape of the black patch(es) in p5 and p6; look for asymmetry between feather vanes, the shape of the demarcation between black and white, and the number and position of any black spots;
- Record the outermost primary showing an apical white spot; this will usually be p7 or p8; and
- Note the relative size (between mates) of apical white spots on p6-p8.

The system of individual identification described here relies on the relative differences in wing tip patterns between mates at the nest. As such, it is not analogous to the use of human fingerprints or the ventral fluke patterns of humpbacks to uniquely identify individuals. It is likely that because of the degrees of freedom available for variation, a full description would yield a unique wing tip pattern for each bird. However, some birds may be separable only through careful measurements of birds in the hand, rather than at a distance. How consistent these patterns might be over the lifetime of a bird is not known; the data presented here suggest some degree of consistency at least across two successive moults. Bretagnolle *et al.* (1994) found that the unique pattern of head markings in Ospreys was similar in four individuals observed over two successive years, but that the dark markings were larger in the second year than in the first. The authors suggested that there may be an age effect whereby the dark head markings increase in size with age. There also may be an age effect with Black-legged Kittiwake wing tip patterns; Black-legged Kittiwake chicks and fledglings show more black in the wing tips than adults (*pers. obs.)* and Coulson (1959) found that immature Black-legged Kittiwakes could be distinguished from breeders by the more extensive black on the outer vane of the outermost primaries. Perhaps in Black-legged Kittiwakes, wing tip patterns change as the bird matures, then stabilise for the remainder of the bird's lifetime.

Several other species of gulls have black-tipped outer primaries with various amounts of white within the black ("mirrors") and/or at the extreme primary tips. It is reasonable to expect inter-individual variation in wing tip patterns of these species, and it may be fruitful for investigators to inspect wing tip patterns closely if they need to identify individual birds in situations where alternatives to capture and colour marking are sought.

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HERKENNING VAN DRIETEENMEEUWEN *RISSA TRIDACTYLA* OP DE NESTPLAATS MET BEHULP VAN HET PATROON OP DE VLEUGELPUNT

Bij Drieteenmeeuwen *Rissa tridactyla* in arctisch Canada en Newfoundland werden individuele verschillen in het zwart-witpatroon op de punten van de buitenste handpennen (P) vastgesteld. Aan de hand van de hoeveelheid wit op de punt werden vijf typen onderscheiden. Afhankelijk van de locatie vertoonden P5 en P6 de meeste, individuele variatie. In vergelijking met P9 en P10 die vrijwel alle tot één type behoorden, waren P5 en P6 gelijkmatiger over de vijf typen verdeeld (tabel 1). De beschreven variatie werd gekwantificeerd met de Shannon-Weaverindex. Vorm, aantal en positie van de zwarte vlekken op de punt van P5 en P6 vertoonden ook individuele variatie, evenals de relatieve grootte van de apicale vlekken op P6 t/m 10. De beschreven verschillen konden in het veld gebruikt worden om beide partners van een paar op de nestplaats met 100% zekerheid van elkaar te onderscheiden. Het patroon op de linker- en rechtervleugel was vrijwel gelijk. Ook het patroon na twee opeenvolgende ruicycli was vrijwel altijd gelijk. In situaties waarbij het ongewenst

of onmogelijk is om vogels op de nestplaats te vangen en te merken maakt de combinatie van waarnemingen van *courtship feeding* of copulatie en individuele variatie in het patroon van de vleugelpunt studie van vogels met bekend geslacht mogelijk. Andere meeuwensoorten vertonen mogelijk een vergelijkbare, individuele variatie in patroon op de vleugelpunt.

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