A method for rapid identification of the murres (Uria lomvia and Uria aalge) based on tibiotarsus and phalanges

F.G. Cook1 and B. Collins2

Abstract

A procedure has been developed using measurements of the tibiotarsus and phalanges to distinguish between Thick-billed Murres (Uria lomvia) and Common Murres (Uria aalge) taken by subsistence hunting in coastal waters off Newfoundland-Labrador. Both discriminant function and manual techniques were tested. The results produced by the former technique led to misidentification of 6.9% of U. aalge and 6.7% of U. lomvia, while the latter yielded misidentification of 6.9 and 11.7% respectively. This procedure is preliminary and requires field testing with an independent sample.

Introduction

Each year an estimated 4 million Thick-billed Murres (Uria lomvia), from the Canadian eastern Arctic and western Greenland, migrate south and winter in the waters around Newfoundland and southern Labrador (Gaston 1980). There they join an estimated 1.5 million Common Murres (Uria aalge) that breed in the region. During winter, the two species are partially sympatric in distribution with a broad zone of overlap off the northeast and southeast coasts of Newfoundland.

Large numbers of the birds are taken in nets during the summer peak of gill-net fishing in Newfoundland, especially Common Murres (Tull et al. 1972) or are killed by oil, or taken by subsistence and recreational hunters (Wendt and Cook 1982). Both species are under increasing pressure from human exploitation, industrial activities such as fishing and hydrocarbon emissions, and perhaps a depleted food resource (Brown and Nettleship, in prep.). Thick-billed Murres in the Canadian arctic colonies have declined by 30-50% (Gaston and Nettleship 1981) while Common Murres have shown significant increases at breeding sites such as Cape St. Mary's and Witless Bay Islands.

According to preliminary field checks of hunting zones and various oil spills in the wintering period, Thick-billed Murres appear to suffer most of the hunting pressure in West Greenland and Newfoundland, as well as oiling during autumn, winter, and spring. The major Common Murre wintering zones appear to be more southerly, perhaps largely confined to the Gulf Stream rather than to the Labrador Current. Because of these factors and increasing pressure on both species, it is important to measure the relative and absolute mortality being suffered by U. lomvia and U. aalge and to know their seasonal changes in distribution along the coast of Newfoundland. The use of recoveries of standard US Fish and Wildlife Service (USFWS) bands was insufficient for this purpose.

Because many of the bands do not survive as long as the birds wearing them, relatively small numbers have been banded in recent years, and recovery and reporting rates are low.

A modified species composition survey (SCS), patterned after that used for ducks and geese, is probably the best way to collect material permitting specific identification on a regular and stratified basis. We considered requesting hunters to send in wings or mandibles for identification, but rejected the first of these proposals when we found that no distinction between the species could be made on the basis of wings. Furthermore, mandibles proved too difficult to remove cleanly from shot birds and, in their shipment by mail, it seemed likely that postal workers would object to blood oozing from the packed mandibles. The only other appendages readily available for easy removal and cheap transport were the tibiotarsi and foot. But, since the number of those parts submitted was likely to be very large, we needed to develop a method of species discrimination which was quick and involved a minimum of precise measurements.

Material and methods

We based this study initially on 98 specimens in the National Museum of Canada, plus 118 fresh feet from Diggles Island, Northwest Territories and coastal Newfoundland. An additional 175 fresh specimens were used to test the methodology in preliminary stages of the investigation. We restricted the use of museum study skins to standard measurement of the tibiotarsus. The bones in the phalanges were measured individually, but the procedure was too time-consuming and subject to considerable error. Thus tibiotarsi and phalanges were measured only on fresh specimens. For these measurements, we abandoned such devices as dial vernier calipers and dividers in favour of a 20-cm standard flanged ruler used by bird banders to record wing lengths.

We made the following measurements (to the nearest millimetre): (1) the total length to the distal tip of the nail, with the posterior edge of the cornual process abraded against the flange, and the tarsus and mid toe pressed flat; (2) the mid, outer, and inner toes from the proximal point of articulation to the distal tip of the nail; (3) the tarsus from the tibial fold to the inner side of the tibiotarsus. In all cases the species involved were known, and 1st-year birds were distinguished from older ones. Sexes were frequently unknown.

Frequency distribution ranges, means, and standard deviations are given in Figures 1 to 6.

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We made the above measurements in the following sequence: (1) total length, (2) mid toe, (3) outer toe, (4) inner toe, and (5) tarsus; and undertook the subsequent analysis at three levels in order to discover the most efficient way to determine the species composition of the kill.

A discriminant function analysis was made to determine the statistical precision of the concept. This required the coding and punching of 500 measurements per 100 parts. We ran a standard discrimination analysis on these data with the SAS program package DISCRIM routine (SAS Institute 1979), which set the prior estimates of population proportions as equal, the resulting error rates for misclassification (4/58 vs. 60) being very nearly equal. We then made a test of the homogeneity of within-species covariance matrices, and found that the hypothesis of equal within-species covariance matrices was rejected (P < 0.10). Our examination of the observed variances and correlations (Table 1) revealed no simple pattern to describe the significance; e.g., variances were substantially higher for either U. alage mid toe or U. lomvia outer toe. Due to the lack of homogeneity of the covariance matrices, we based the discriminant function on the separate covariance matrices.

It is difficult to present the function in a form easy to use in hand calculations, because the procedure requires the calculation of 2 quadratic forms from 5 x 5 matrices, a process involving 10 subtractions, 48 additions, and 60 multiplications. The procedure, however, correctly classified 54 of 58 U. lomvia and 56 of 60 U. alage. Since we had set the prior estimates of population proportions as equal, the resulting error rates for misclassification (4/58 and 4/60) were very nearly equal.

Once the results of the discriminant analysis had indicated that a considerable degree of segregation was possible, we introduced a stepwise discrimination based largely on a synoptic key (Table 2).

In order to reduce the amount of labour in classifying tibiotarsi, we examined several procedures by taking measurements and attempting to classify the individual on the basis of single measurements, with additional measurements only in cases of doubt.

We determined the classification key subjectively through examination of histograms. Table 3 shows several alternative stepwise procedures that are differentiated by stopping after 1, 2, 3, 4, or 5 measurements. Total length alone led to correct classification of 56 of 58 U. lomvia and 49 of 60 U. alage, i.e., with 13 misclassified observations in all. If the discrimination was stopped after 2, 3, or 4 measurements, 10 cases would continue to be misclassified. If the complete 5-step process was used, only 9 (7.6%) observations would be misclassified, compared with the 8 (6.8%) misclassifications for the simplest discrimination procedure. The number of measurements to be taken, however, is much smaller for the stepwise than for the classical discrimination (209 vs. 590). The procedure used was as follows:

*(1)* We measured total lengths as defined, and assigned those falling below 96 mm to *U. lomvia*, and those above 99 mm to *U. alage*. This procedure immediately assigned

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### Table 1

<table>
<thead>
<tr>
<th>Species</th>
<th>Variable</th>
<th>Mean</th>
<th>Variance</th>
</tr>
</thead>
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<tr>
<td></td>
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<td></td>
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<tr>
<td>U. lomvia</td>
<td>Tarsus</td>
<td>36.16</td>
<td>1.747</td>
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<tr>
<td></td>
<td>Mid toe</td>
<td>59.02</td>
<td>3.000</td>
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<tr>
<td></td>
<td>Inner toe</td>
<td>55.31</td>
<td>3.446</td>
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<tr>
<td></td>
<td>Outer toe</td>
<td>43.57</td>
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<tr>
<td></td>
<td>Total</td>
<td>95.09</td>
<td>6.782</td>
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<tr>
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<td>Tarsus</td>
<td>38.38</td>
<td>1.766</td>
</tr>
<tr>
<td></td>
<td>Mid toe</td>
<td>62.85</td>
<td>4.333</td>
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<tr>
<td></td>
<td>Inner toe</td>
<td>58.63</td>
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<tr>
<td></td>
<td>Outer toe</td>
<td>46.03</td>
<td>2.134</td>
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<tr>
<td></td>
<td>Total</td>
<td>100.60</td>
<td>5.905</td>
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### Table 2

<table>
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<th>Species</th>
<th>Mean (mm)</th>
<th>Variance (mm)</th>
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<td>U. lomvia</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>U. alage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total length</td>
<td>&lt; 95</td>
<td>&gt; 99</td>
<td></td>
</tr>
<tr>
<td>Mid toe</td>
<td>58</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Outer toe</td>
<td>43</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Inner toe</td>
<td>54</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>Tarsus</td>
<td>37</td>
<td>38</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3

Results of stepwise discrimination procedures

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68% of the specimens, with an error in identification of 1.5%, and less than 30.5% unclassified.

(2) We then used the 30.5% of material falling between 95 and 100 mm for each of the subsequent measurements, and for each step applied the distribution ranges given in Table 3.

In the classical discrimination procedure, one uses prior estimates of the relative population sizes as an aid to classify the individuals, and this approach is reflected in procedures attempting to force the misclassification rates for the populations to be approximately inversely proportional to their relative sizes. In the present problem, however, the objective is to estimate the relative numbers of U. lomvia and U. aalge in the population, and the classical procedure can be reversed so that known error rates are used to improve estimates of population totals, as follows.

Let N₀ denote the sample size for species i (i = 1, 2; U. lomvia, i = 2, U. aalge) with N₁ + N₂ = N. Assume that a simple random sample of n birds is selected, of which n₁ are species i. Let p₀ denote the probability of classifying a bird of species i as species j, and let p₁ denote the number of birds in the sample classified as species i. The expected value of n₀ given n observations taken from population i is:

\[ E(n₀) = n p₀ + n p₁ \]

and that unconditionally:

\[ E\left(\frac{n}{N}\right) = \frac{n p₁ + (N - N p₀)}{N} \]

which is a biased estimator of the true proportion unless N₁ = N₂. An unbiased estimator of N/k/N is given by:

\[ \frac{n₀}{n} \]

The two main problems with using this adjusted estimator are that: (1) the misclassification rates must be known accurately, and (2) there is a possibility that estimated sizes must be of the same magnitude as the error in the estimate.

Neither procedure permits the identification of males and females within a species. A further complication is that: (1) the misclassification rates must be estimated unless N₁ and N₂ from the first season, we can modify the discrimination procedure so that the condition N₁N₀ is satisfied, thereby reducing the bias in the estimator n/n.

Conclusion

The proposed operational technique permits species designation of 97% adult U. aalge and U. lomvia, but does not provide an accurate assessment of the sex or age ratios in the kill. In addition to the standard measurements of the tarsus, one can do all four additional standard measurements at the rate of more than two specimens per minute. Since not all measurements need be made, 200 identifications an hour are possible once the primary sorting by age and the exclusion of aberrant species have been completed.

We found that material received in Ottawa 5 days after shipping was still sufficiently pliable without further relaxing. Shrinkage of specimens left in a "ziplock" bag was less than 0.5 mm and was not a significant error factor.

We hope that in 1983-84 assemblages of material from Newfoundland-Labrador can be collected at monthly intervals at various locations from 1 September to 31 March. If this is accomplished, it should be possible to apportion the kill between species and gain further insight on geographic and temporal differences in the kill. Although U. aalge may constitute about 30% of the murres found at some time of the year in coastal waters, the numbers taken apparently vary throughout the season, and in our samples appear consistently in the 10-20% range. This technique may well help resolve important questions as to the distribution and kill of the two murre species in the northwest Atlantic.

It would be useful to apply the procedure to a new set of data to verify the expected performance and obtain the rates of error in a more realistic setting. The misclassification rates presented here are perhaps too low, since we used the same set of data to generate and to evaluate the procedure.

The discrimination procedure may require modification after we have studied the results of a trial run, at which time we hope that estimates of the harvest population sizes N₁ and N₂ will be available. The estimates N₁ and N₂ from the first season, we can modify the discrimination procedure so that the condition N₁N₀ is satisfied, thereby reducing the bias in the estimator n/n.
Figure 2
Frequency distribution (mm) of total length of tarsus plus mid toe

Figure 3
Frequency distribution of length of middle toe
Figure 4
Frequency distribution of length of outer toe

Figure 5
Frequency distribution of length of inner toe
Figure 6
Frequency distribution of length of tarsus

![Graph showing frequency distribution of tarsus length for different species.](image-url)