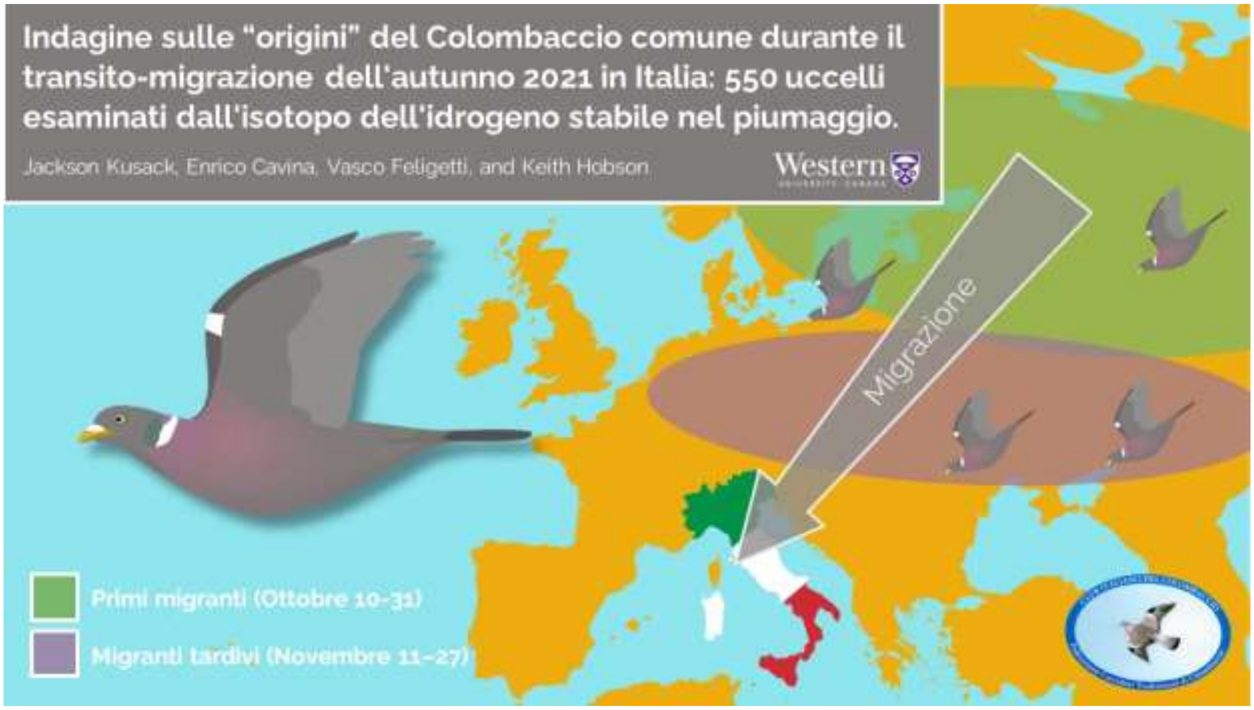

Statistical survey on the "origins" of the common wood pigeon during the transit-migration of autumn 2021 in Italy: 550 birds examined by the stable hydrogen isotope in the plumage.

PRELIMINARY REPORT

Summary

Using stable-hydrogen isotope (δ^2H) measurements of feathers provided by hunters, we determined the likely breeding areas for Common Wood-Pigeon (*Columba palumbus*) harvested in Italy, Corsica, and Sardinia in 2021. Our analyses showed the likely breeding regions were north-central and eastern Europe. Wood-pigeons harvested later in the season showed more positive δ^2H values, indicating a more southern origin (i.e., central Europe) compared to early harvested birds. Isotopic origins of the Cinnamon-necked subspecies (*C.p. casiotus*) was consistent with their more southeastern range but future sampling of this group is recommended. These results will help inform the management of the wood-pigeon in Italy and elsewhere and assist in evaluating the effects of projected natural and anthropogenic changes on their populations.

We provide a wood-pigeon feather δ^2H map or isoscape that can be used by hunting clubs to look up the likely origins of the birds they harvested and submitted for analysis. We further provide a synthesis of all birds harvested in Italy and Corsica/Sardinia with an emphasis on timing of harvest. Our work shows the value of using hunter-derived feather samples to inform the origins of birds recruited into the autumn harvest.

Below is a brief report for the stable-isotopic assignment using feather stable-hydrogen (δ^2H_f) values from Common Wood-Pigeon harvested in Italy.

Report

Background

For harvested populations, making connections between breeding, non-breeding, and harvest areas is important for their sustainable harvest management and conservation. Previously, much information has been gained from the use of ringing, but most harvested birds are not marked in this way and so an intrinsic marker can be extremely useful in providing estimates of the origin of harvested birds. Stable isotopes of various elements occur in nature and their measurement in wildlife tissues can provide a forensic tool to approximate origin. This is because stable isotopes within animal tissues are influenced by their diet. Tissues that do not continue to grow after they are formed (e.g., feathers) 'lock in' the isotope signatures related to location during tissue growth and retain that signal until the tissue is replaced. For birds, feathers are a useful marker of breeding/moult location, depending on the life history of that species. Many birds, such as the Common Wood-Pigeon, replace their flight feathers on the breeding grounds, making their primary feathers representative isotopically of the location where they bred. Similarly, for hatch-year birds that grew their first flight feathers on their natal sites, their feathers will also represent the breeding location. Not all elements are useful for this purpose but some have been shown to produce large-scale, continental patterns in foodwebs that can be used for tracing the origins of migratory animals (https://www.scientia.global/wp-content/uploads/Keith_Hobson/Dr-Keith-A.-Hobson.pdf).

The stable isotopes of hydrogen are especially useful for assigning origins of wildlife because they show very distinct known patterns of abundance ultimately driven by precipitation and these patterns are faithfully passed on to higher consumers like wood-pigeons. Because of the well-known mechanisms for how the isotopes will behave within the hydrological cycle, we can create predicted maps across large areas (e.g., Figure 1). These maps, which show predicted isotope values on a geographic scale, are referred to as isoscapes (i.e., isotope landscapes).

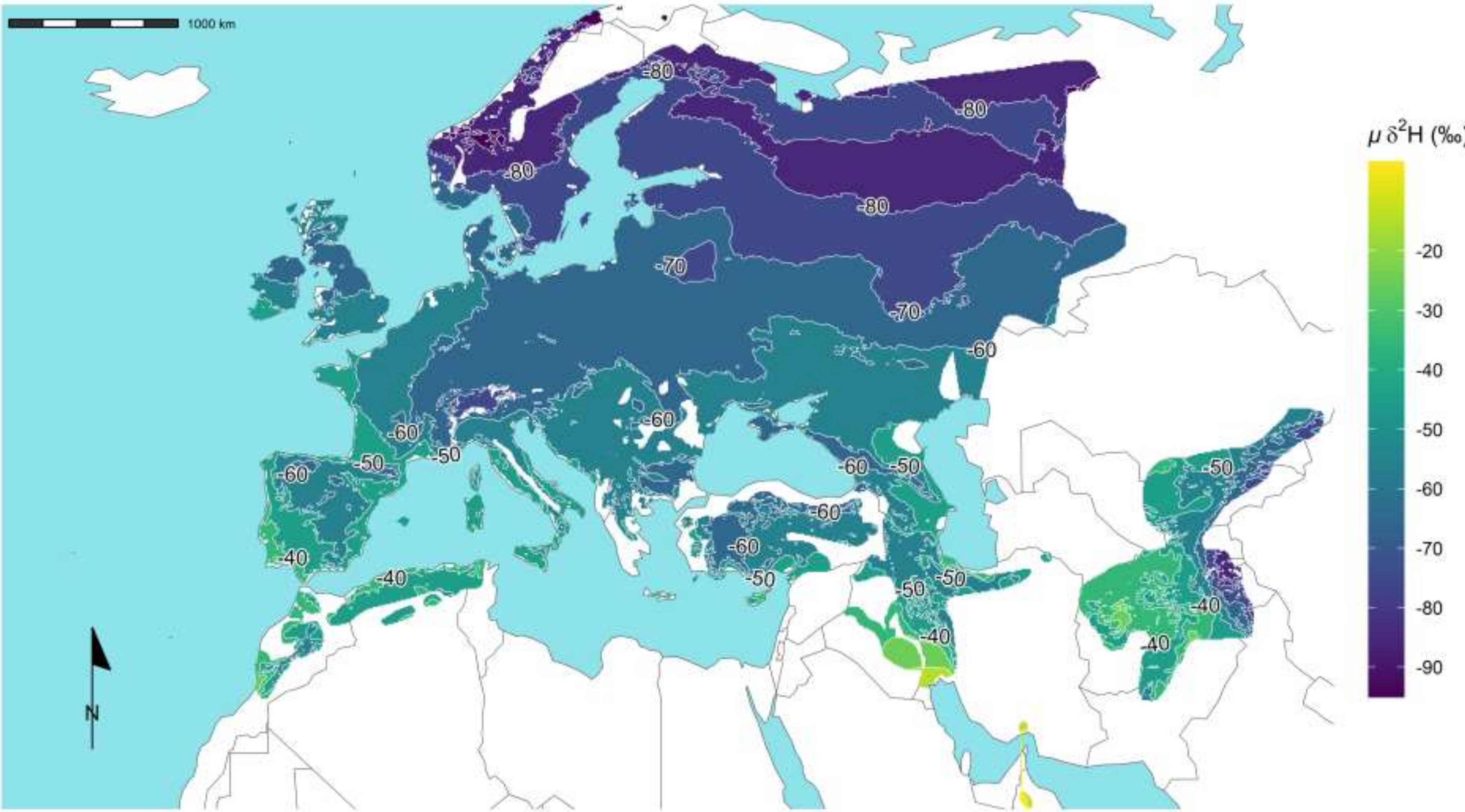

Figure 1 – Expected feather δ^2H isoscape across the wood-pigeon breeding range. The color shows the average δ^2H value and the white contours show incremental changes (10 ‰) in δ^2H values. This figure can be used to "look up" the approximate locations of any bird or group of birds provided by individual hunting clubs (Appendix).

Methods

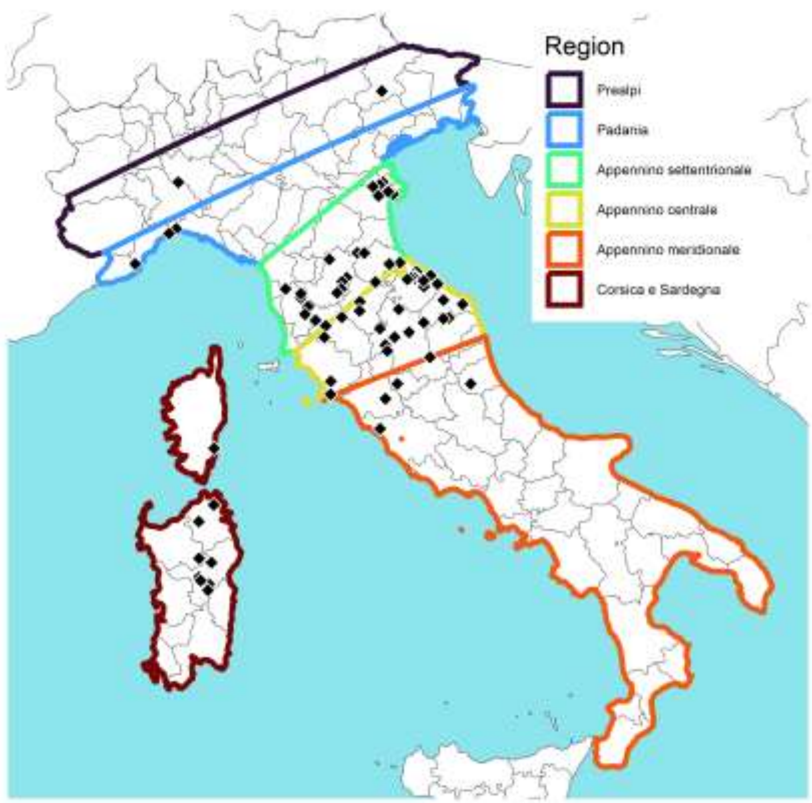

Figure 2 – Map showing the harvest regions and sampling locations for harvested wood-pigeons.

We obtained feathers of harvested wood-pigeons on the Italian Peninsula (n = 503), Sardinia (n = 46) and Corsica (n = 1; Figure 1) from hunters belonging to the Club Italiano del Colombaccio. Wood-pigeons were shot during autumn and early winter 2021. One flight feather was taken from each pigeon, which was then processed for stable-hydrogen isotopes (δ^2H) at the stable isotope laboratory in Trento, Italy.

To determine the breeding region for these harvested wood-pigeons, we used an assignment method where we assessed the probability of each feather being grown at different points of the breeding range based on the expected hydrogen-isotope ratios at those locations. Using this information, we outlined a region of likely origin for each individual and summarized these regions across all individuals. It is worth noting that looking at each individual surface doesn't tell us much about the harvest, as the true breeding location could likely be anywhere within that region, but combining these surfaces across many individuals allows us to get a better idea of the general breeding regions at the population level. For all maps of origin depicted below, the scale is the number of pigeons whose likely breeding region overlaps with that pixel or cell.

Results

Overall, the bulk of the harvest originated from central and eastern Europe (Figure 3). Specifically, the regions where most birds were assigned were western Russia, Finland, Sweden, Estonia, Latvia, Lithuanian Belarus, Poland, as well as Switzerland and eastern France. Very few birds showed more southern origins.

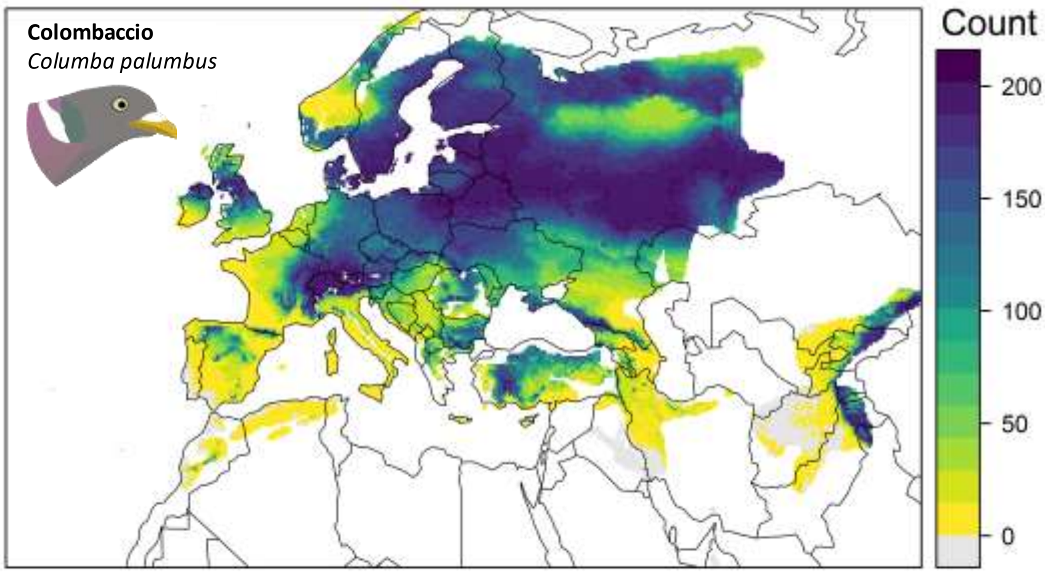

Figure 3 – Likely origins of wood-pigeon (n = 550) harvested in Italy (2021). The scale represents the number of individuals assigned to a given cell. Important to note that these dark regions are consistent with origins but this does not mean birds actually came from all dark areas (i.e. this depiction is the maximum extent of *possible* origins).

To better understand how breeding origin changes over the season, we separated the harvest into waves: October 10-20 (n = 249), October 23-31 (n = 147), and November 11-27 (n = 57). When we analyzed the differences between these waves, we found that stable-hydrogen isotope values in these first two waves differed from the third. Specifically, δ^2H values for November harvested wood-pigeon were relatively more positive, showing more southwestern origin. Wood-pigeon harvested in October, which were the majority of samples showed probable breeding origins predominantly in the boreal and taiga forests of eastern and Northern Europe (e.g., western Russia, Finland, Sweden, Estonia, Latvia, Lithuania, Belarus, Poland, and Switzerland; Figure 4A). Wood-pigeon harvested in November showed more southern breeding origins predominantly in the broadleaf and mixed forests of central and eastern Europe (Figure 4B). This is a broad region that spans from Russia/Ukraine in the east to France/Germany in the west.

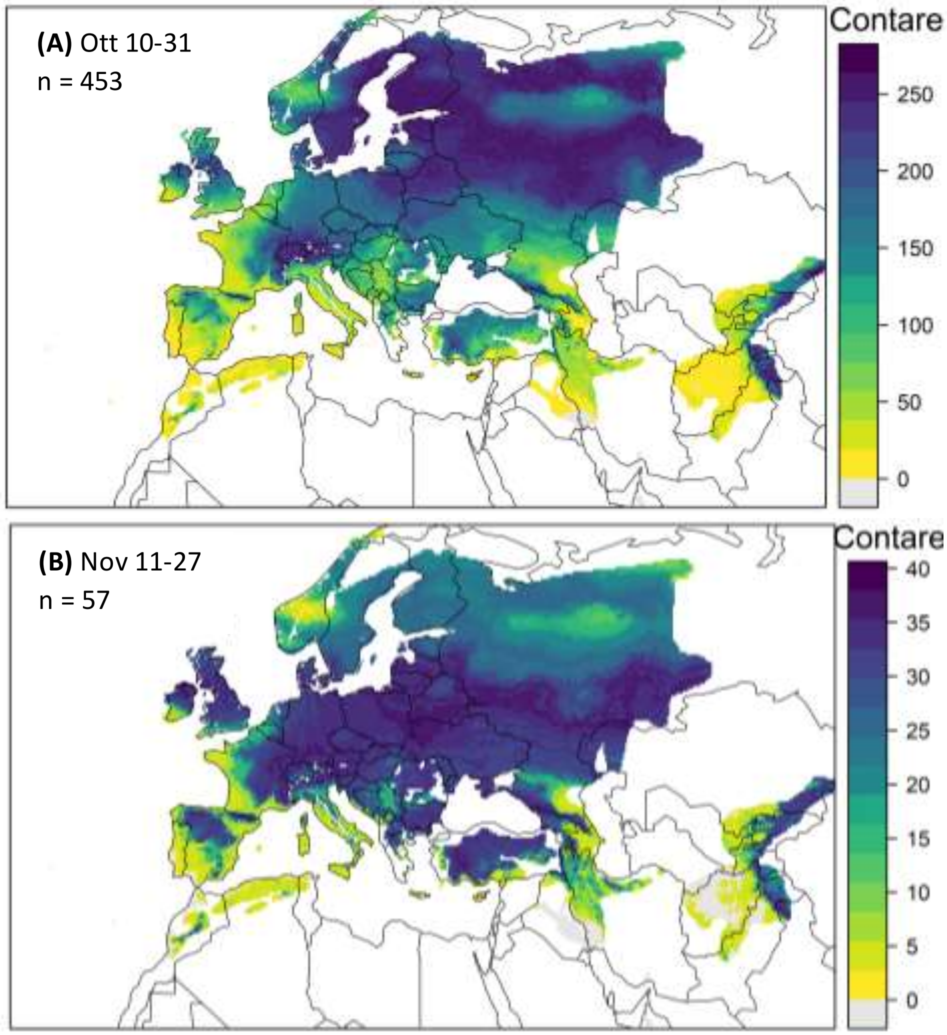

Figure 4 - Likely origins of wood-pigeon harvested in Italy (2021). The three panels show the different periods of harvest: October 10-31 (A) and Nov 11-27 (B). The scale represents the number of individuals assigned to a given cell.

Some harvested individuals were identified as potentially being from the Cinnamon-necked (*Columba palumbus casiotis*) subspecies, which breeds in central Asia. When we assigned these individuals to the breeding range of this subspecies, the majority of birds showed origins in the eastern portion of that range, consistent with Kazakhstan, Kyrgyzstan, Tajikistan, Afghanistan, and Pakistan (Figure 4). Isotopically, the Cinnamon-necked birds were not different from the rest of the harvested birds. Finally, we found no relationship between the wing length and δ^2H values of harvested birds, although wing length was only available for a subset of the birds.

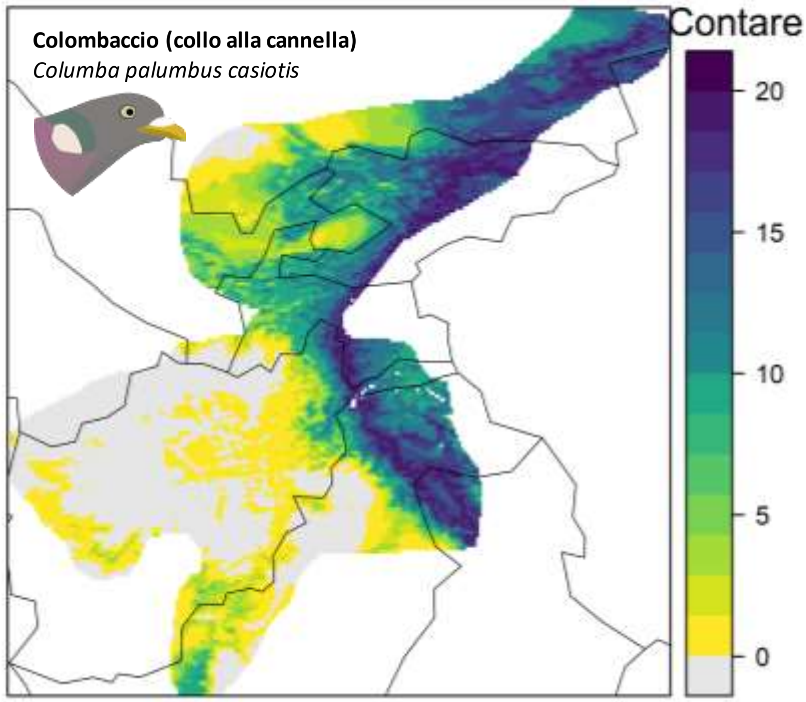

Figure 5 – Likely origins of Cinnamon-necked wood-pigeon (n = 21) harvested in Italy (2021). The scale represents the number of individuals assigned to a given cell.

Although few studies have looked at connectivity for the wood-pigeon in Italy, there are a few studies from France to compare with. Specifically, Hobson et al. (2009) found that the majority of wood-pigeons harvested in France were residents and only 30% of birds were short-distance migrants and 13% were long-distance migrants. Within France, birds harvested in the southern parts of the country were more migratory than those harvested in the north. Our study provides evidence that southern harvested wood-pigeons, such as those harvested in Italy, Corsica, and Sardinia, are primarily longer-distance migrants compared to those harvested in west-central Europe. The Hobson et al. (2009) study also found evidence of a weak relationship between wing length and δ^2H values, where birds with longer wings showed more δ^2H values indicative of more northeastern origins and long-distance migration. That result was especially true for Corsica and Sardinia. In our case for Italian harvested birds in 2021, we found no relationship between feather δ^2H values and wing length. However, wing length was not taken on all birds, and this might be a useful measurement for future work.

References:

Hobson, K. A., H. Lormée, S. L. Van Wilgenburg, L. I. Wassenaar, and J. M. Boutin. 2009. Stable isotopes (δD) delineate the origins and migratory connectivity of harvested animals: the case of European woodpigeons. Journal of Applied Ecology 46:572–581.

Appendix: Regional Summary Data

The table below can be used along with the predicted feather isoscape (Figure 1) to "look up" the approximate locations of any bird or group of birds provided by individual hunting clubs. The mean δ^2H values give an average (center) for the group while the standard deviation values tell us how variable (spread) the δ^2H values were for those birds. For the 56 birds harvested in Genova, the mean value is -71.7‰ and the standard deviation is 9.4. So, the majority of the birds harvested in Genova had isotope values around -71.7‰ but it is common to have values ± 9.4‰ from that center. These isotope values correspond to the northeastern edge of the range near eastern Russia, Finland and Sweden. Note, regions that are isotopically similar on the isoscape map cannot be seperated through isotopes alone.

Table 1. Summary data grouped by region and municipality of harvest. We calculated the mean and standard deviation (SD) of feather stable-hydrogen (δ^2H) isotope values and the sample sizes (n).

Regione	Comune	Media (‰)	SD (‰)	n
Prealpi	SEDICO	-73	9.2	5
	PIOVERA	-67.6	8.2	14
Padania	ALBENGA	-67.5	6.5	15
	GENOVA	-71.7	9.4	56
	VARAZZE	-70.8	17.7	4
Appennino settentrionale	ARIANO	-66.5	12.5	11
	BIENTINA	-67.3	8.5	3
	CASOLE D'ELSA	-65	19.8	2
	CODIGORO	-87	5.7	2
	CORBOLA	-82	NA	1
	DOVADOLA	-71.5	12.3	10
	FIRENZUOLA	-74	13.9	9
	GAMBASSI	-70.4	8.1	11
	GORO	-77	6.2	3
	INCISA V.A.	-72.7	7.4	11
	LONDA	-71.4	11.5	23
	MESOLA	-76.3	6.1	3
	MODIGLIANA	-74.9	9.5	16
	PALAIA	-74	NA	1
	RIGNANO S.A.	-72.9	10.8	17
	RIVA DEL PO	-86	2.8	2
	RONCO FREDDO	-75	10	18
	RUFINA	-70.4	13.4	5
	SAN MINIATO	-52	NA	1
	TAGLIO DI PO	-90	NA	1
	VOLTERRA	-67.4	13.5	15
Appennino centrale	AMELIA	-79.2	8.2	5
	AREZZO	-74.9	8.2	12
	BELVED OSTRENSE	-86.8	9.2	9
	CAPALBIO	-69.5	14.8	6

	CINGOLI	-73	9.4	7
	CORTONA	-70	13.2	11
	FABRIANO	-64.5	9.4	8
	FANO	-72.2	2.2	4
	FILOTTRANO	-72.9	10.8	10
	FONTECORNIALE	-81.6	13.2	7
	M. VIBI. VECCHIO	-64.8	9.8	6
	MAGLIANO	-74	0	2
	MONDAINO	-72	11.1	6
	MONTECICCARDO	-77.3	10.9	9
	MONTICIANO	-66.7	13.9	6
	OFFAGNA	-79.1	10.1	23
	PANICALE	-60.1	10.1	8
	PERUGIA	-61.7	7.9	6
	PESARO	-73.1	11.2	9
	S:GIOVANNI IN M.	-74.4	13.7	5
	SALUDECIO	-74.2	10.2	23
	SELLANO	-81.2	10.6	6
	SOVICILLE	-78.5	13.3	4
	TAVOLETO	-74.5	11.4	13
	TUORO	-59	NA	1
	VALFABBRICA	-62.6	12.4	12
Appennino meridionale	CERVETERI	-64.4	10.7	11
	MONTORIO	-73.7	6.8	14
	VALENTANO	-81	NA	1
Corsica e Sardegna	ARZACHENA	-71	NA	1
	BULTEI	-74.8	17.6	4
	FONNI	-69.4	15.3	13
	FONNI	-75.3	9.5	3
	OLLOLAI	-69.2	4.9	5
	ORUNE	-66.3	10.1	9
	SARI SOLENZARA	-89	NA	1
	SARULE	-70.3	7.2	3
	TEMPIO PAUSANIA	-68.5	9.8	8

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