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Source: *The Journal of Wildlife Management*, Vol. 45, No. 1 (Jan., 1981), pp. 227-230
Published by: Wiley on behalf of the Wildlife Society
Stable URL: http://www.jstor.org/stable/3807891
Accessed: 13-04-2016 04:51 UTC

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Received 30 December 1977.
Accepted 10 February 1979.

ABDOMINAL PROFILE—A CONDITION INDEX FOR WILD GEESE IN THE FIELD

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Knowledge of the body condition of birds is essential in studies of energetics, but no technique of estimating condition in the field has yet been developed. Most condition indices are derived from body weight, corrected either for body size in live birds (Harris 1970, Owen and Cook 1977) or carcass analysis (Ankney and MacInnes 1978, Woodall 1978). Trapping samples of waterfowl without baiting (which would itself affect condition) is difficult, and large samples of dead birds are usually obtainable only in the hunting season.

The definition of condition used here is "the fitness of a bird to cope with its present and future needs" (Owen and Cook 1977). The ability to survive periods of bad weather or food shortage, to make long migrations, and to breed successfully (Harvey 1971) is related to fat reserves, and fat content gives a good indication of condition as defined above. Fat is deposited in various sites, and the abdominal (omental) depot is an important one (Hanson 1962). Although omental fat comprised only 10% of the total body fat in red-billed teal (*Anas erythrorhyncha*), there was a close correlation ($r = 0.955$) between abdominal fat and total fat content (Woodall 1978). Hanson (1962) commented that the abdomen of Canada geese (*Branta canadensis*) enlarged when large amounts of fat were present. The degree of abdominal enlargement was examined in this study as a possible measure of condition.

This work was part of a population dynamics and energetics study of barnacle geese (*Branta leucopsis*) wintering on the Solway Firth in northern Britain and breeding in Spitsbergen (Svalbard). The population in 1977–78 had 6,800 individuals, of which some 1,900 (28%) were individually marked with coded plastic leg bands.

METHODS

Observations were made at Caerlaverock during autumn and winter, at Rockcliffe in spring (both on the Solway), and on staging islands in Helgeland, Norway. Three catches were made by using rocket-propelled nets in the 1977–78 season, and profiles were compared with mean body weight. Because 1977 was a poor breeding season, all the data refer to adult geese.

Geese were observed through telescopes, through which the codes could be read at 200 m, and the abdominal profile was classified as straight (1), convex (2), rounded (3), or sagging (4), or as intermediate between classes (1.5, 2.5, 3.5) (Fig. 1). With no requirement for individual recognition, profiles could be assessed at much greater distances. Because the profile changed slightly

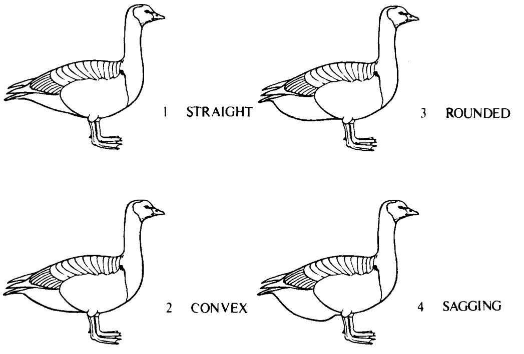

Fig. 1. Classification point values (1–4) of abdominal profiles of barnacle geese.

depending on the bird's posture and behavior, each individual was observed for at least 15 seconds before being classified. Because the line of the sternal ridge is used as a guide in assessing abdominal profile, the main requirement is that this should be horizontal. Thus birds should not be assessed while in extreme alert or when the body is tilted downward, for example while grubbing. All observations were on recognized, marked birds so that repeat sightings gave a check on the reliability of classification. Six observers collected the data examined here; each was given drawings, and their classifications were occasionally checked against those made by the author.

Geese arriving on the feeding grounds in the morning were empty of food, and their profiles were less rounded. Sixty-two birds indexed before 0915 (1 hour after arrival on the feeding grounds) in January 1978 were compared with 75 geese assessed later the same day. The early sample had a median index 0.5 points lower than the late one. Of 10 individuals assessed both early and late, 3 were placed in the same category, 6 had each increased 0.5 points, and 1 had increased a full index point. The gut is filled within about 1 hour after arrival on a feeding ground (Owen 1975); assessments made before then were not included in our comparisons.

RESULTS AND DISCUSSION

Classifications of the same individual geese by the same and different observers were similar (Table 1). Two-thirds of the allocations of the same observer within 2 days were in the same category, and only 4% differed by a full index point. The classifications of different observers were only slightly less reliable. Individuals classified 6 or more days apart during a period when geese were gaining weight showed the expected increase in profile index 64% of the time; only 7% were placed in lower categories. This level of consistency justifies the use of intermediate categories in addition to the 4 classes (Fig. 1).

Unfortunately, few individuals caught were classified within a few days of any catch. The mean condition index of other marked geese at the time of trapping was

Table 1. Differences between abdominal profile classifications (Fig. 1) of the same geese by the same or different observers, and at different intervals between classifications.

	Classifications within 2 days						Reclassification after 2 days					
	Same observer			Different observer			3–5 days			5+ days		
	0[a]	±0.5	±1.0	0	±0.5	±1.0	0	+	−	0	+	−
N	138	60	8	84	55	6	125	115	44	139	301	32
%	67	29	4	58	38	4	44	41	16	29	64	7

[a] Zero = no difference between point values (1–4) of 2 different classifications of the same geese.

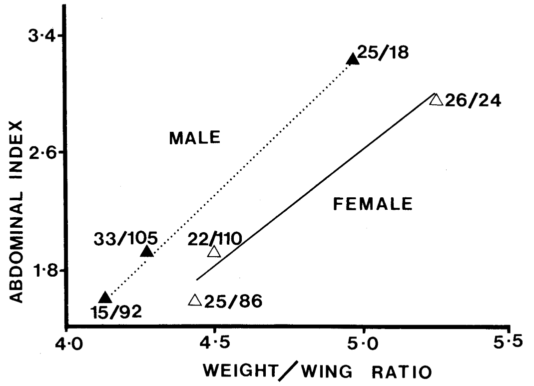

Fig. 2. Relationship between mean abdominal profile index of geese in the field and condition index [body weight (g)/wing length (mm)] of birds caught at the same time of year. Catches were on 4 October 1977 and 11 January and 6 April 1978. Fractional numbers show the numbers of geese indexed/caught.

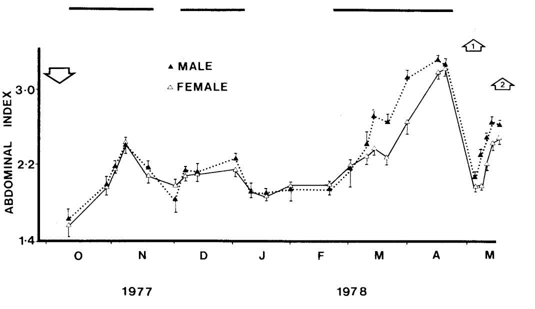

Fig. 3. Abdominal profile index of barnacle geese, October 1977–May 1978. Vertical bars are standard errors. Horizontal bars at top of figure indicate when maximum daytime temperature was above 6 C, the threshold temperature for grass growth. Also shown are times of major migratory movements (arrows): (1) Britain to Norway = 1,600 km, and (2) Norway to Spitsbergen = 1,500 km.

plotted (Fig. 2) against the weight/wing length, a condition index used for mallards (*Anas platyrhynchos*) by Owen and Cook (1977). Woodall (1978) found that weight/wing ratio in red-billed teal correlated better with total body fat ($r = 0.857$) than did body weight ($r = 0.748$). The correlations I found (Fig. 2) were extremely close; although there were too few catches to calibrate the relationship accurately, these correlations do indicate a close linear relationship. The slope of the line for females is steeper than that for males, reflecting the more rapid weight gain for females in spring (mean weight of females in October was 88% of that of males, compared with 91% in April).

Classifications of male and female barnacle geese throughout the 1977–78 season document the value of the index (Fig. 3). The index increased rapidly in autumn when the birds were feeding on high-energy foods such as white clover (*Trifolium repens*) stolons and seeds. It decreased to a slightly fluctuating winter level in November, and responded when vegetation was growing in December. As soon as spring growth commenced, the index increased and the lines for male and female diverged. This corresponded to the time when paired males began actively defending feeding areas around the females, enabling the latter to gain weight more quickly (Owen, Gullestad, and St. Joseph, unpubl. rep., Wildfowl Trust, 1977). By the time the geese had completed the 1,600-km migration to the staging area in Norway, the index had decreased. It was calculated that this journey had an energy cost equivalent to 160 g of fat (Owen and Ogilvie 1979). When geese were feeding for >17 hours per day on the staging area (unpubl. data), the index increased at a faster rate than at any other time.

The abdominal profile thus varies predictably with changes in environmental conditions, and fits well with known facts about the feeding and energy budget of the geese. I conclude that the index gives a good guide to the condition of geese in winter and spring. The technique makes it possible to study the effect of condition on breeding success in goose populations, and to monitor the breeding performance of marked individuals in relation to their winter and spring condition, without having to catch or kill them. My study involved the assessment of marked individuals only, but the technique could be used to estimate the breeding potential of unmarked populations or to examine the performance of geese on different habitats or sites. For example, a group of greater snow geese (*Anser caerulescens atlanticus*) in an area where much of the feeding was on agricultural land had higher indices (median test $P < 0.01$) than those that had, on the same day, fed exclusively on *Scirpus* marsh.

Acknowledgments.—I thank A. Dekker, N. Gullestad, M. Nugent, P. Reynolds, and A. K. M. St. Joseph for help in collecting data on abdominal profiles. J. Blossom and C. Prentice drew the figures, and G. V. T. Matthews made useful criticisms on a draft of the manuscript. The overseas work was aided by grants from the North Atlantic Treaty Organization and The Royal Society.

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Received 11 September 1978.
Accepted 29 March 1980.

WING-FEATHER CRITERIA FOR AGE SEPARATION OF AMERICAN WIGEON

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Evidence for many bird species shows that factors such as social status, productivity, and feeding efficiency are age-related (Coulsen and White 1958). Therefore, to interpret accurately the results of a year-around ecological study of American wigeon (*Anas americana*), it was necessary to distinguish age-classes of individuals.

In the fall, Northern Hemisphere ducks may be identified as <1 year old (HY = hatching year) or older (AHY = after hatching year) by tertial-feather wear (Carney 1964). Due to molt, this may not be possible by early winter (Palmer 1976). However, Weller (1957) and Oring (1968) found that juvenile remiges and their coverts (excluding tertials) persist for about 1 year, until the prebasic II molt. Likewise, adults replace these feathers only once a year, during the prebasic molt. Several workers (Dane 1968, Dane and Johnson 1975, Blohm 1977, Krapu et al. 1979) have found the color