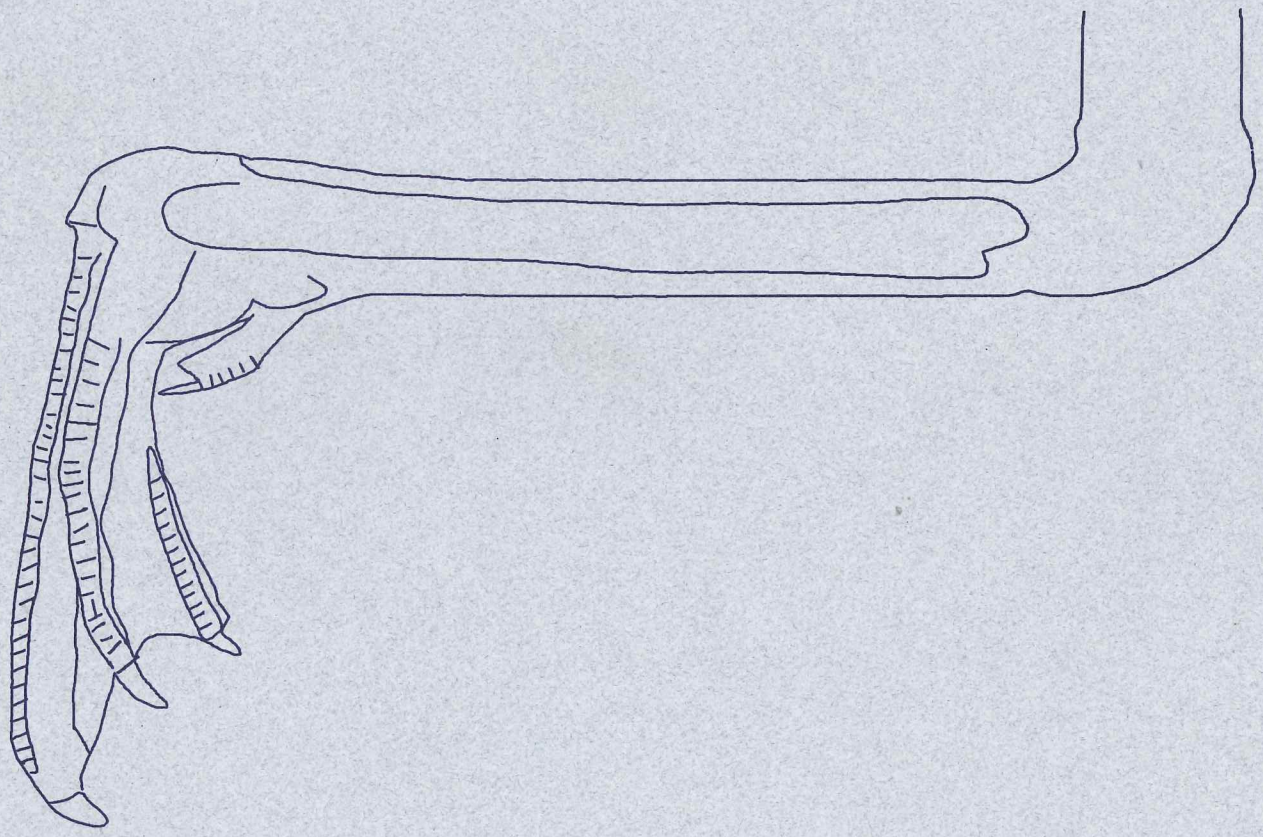
Measurements of Geese

General Field Methods



By Alex Dzubin & Evan Cooch

Measurements of Geese

General Field Methods

Morphological measurements of birds have been used for many purposes. They have been used to characterize differences among individuals, family groups, and closely related species. Differences in body size have been related to differences in mating and reproductive success, and in condition and survival. Identification and classification using morphological measurements are also frequently essential to wildlife enforcement personnel during court cases.

Despite the importance of morphological measurements to many studies, there has been little attempt in the literature to standardize the particular measurements that are frequently made. As a result, there is often considerable variation in the method and definition of certain measurements, and the detail with which they are reported. This often makes comparison of reported values difficult to interpret: Do differences reflect interesting biological variation or differences in definition and technique?

In this short field guide, we attempt to clearly describe and standardize the terminology and methodology for several of the various external linear measurements that may be taken from live geese under field conditions. The myriad skeletal measurements that can be taken from museum specimens are beyond the scope of this guide and are not discussed. The problems of comparing external linear measurements taken from live birds with those taken from dead birds are often significant, and the reader is directed to Rogers *et al.* (1989) for a lucid discussion of this subject. In general, plumage development and plumage morphometrics are often excellent metrics to characterize differences in growth, development, and condition. However, because of the very large number of different plumage characters which can be measured and, in particular, the often significant differences among species in plumage coloration, we present only a select few plumage morphometrics. Rogers *et al.* (1989) describe various techniques for assessing and recording molt and plumage characters.

Previously, the standard references for linear morphometric measurements of birds, including geese, have been Baldwin *et al.* (1931), Palmer (1962), Hanson (1965), and Owen (1980). However, many of the measurements described in these references (particularly Baldwin *et al.* 1931) are appropriate for museum specimens and either cannot be taken or are very difficult to take in the field. Several are also of little value for geese, or waterfowl in general. In this guide, we have attempted to define and illustrate those measurements which have proven useful and practical for geese in the wild. With practice, all of the measurements in this guide can be taken from live geese in the field, with a minimum of stress to either the bird or the investigator.

Although a great many of the measurements described in this guide are useful for waterfowl in general, several of them, particularly those involving linear measurements of the head, are specific for geese and may not be equally useful for ducks.

What measurements to take?

While it is not our intention to categorically state which measurements should be taken in the field, we do offer some suggestions.

First, and foremost, the investigator must decide how the morphometric data are to be used. This is fundamental for morphometric analyses in all ecological research. The measurements which might be useful for a study attempting to differentiate sub-species within a genus might be different from those needed to characterize the overall condition of a bird.

Unfortunately, it is not always possible to anticipate what use will be made of data that are collected in the field. Under such circumstances, the aim should be to take a sufficient number of different measurements from each individual bird to characterize its overall structural size.

There is continuing debate over precisely how many measurements, and which ones, are needed to adequately characterize the structural size of a bird. However, at a minimum, 3 *hard* measurements (see below) should be taken, since 3 dimensions are the minimum needed to define a "geometric space" (Bookstein *et al.* 1985). In most instances, individual (univariate) characters alone should not be used as measures of the structural size of a bird (Willig *et al.* 1986, Rising & Somers 1989, Freeman & Jackson 1990). Interested readers are directed to Marcus (1990) and Rohlf (1990) for further details and discussion of basic morphometric analysis.

Second, the investigator must be aware of the distinction between what we refer to as *hard* and *soft* characters. Among physically mature adult birds (most geese reach asymptotic physical size after their first year), *hard* characters are those which do not change in magnitude within individuals as a function of age, length of time a bird is held, or when during the annual cycle the bird is measured. Typically, skeletal bones, such as tarsus (page 10), are *hard* characters. In contrast, *soft* characters can change significantly due to a variety of factors. For example, the mass of the bird is significantly affected by when during the annual cycle it is measured: A bird weighed immediately after breeding may be significantly lighter than one caught immediately prior to spring migration. Length of primary feathers is another character which may vary significantly as a function of the time of the annual cycle during which it is measured. Meaningful use of *soft* characters requires standardizing time or circumstances of measurement.

Two characters deserve special mention: culmen length and body mass. Culmen length is frequently measured from the distal tip of the bill to the feather line. Unfortunately, since the feather line in several goose species may recede with age due to wear (particularly in species which grub heavily), culmen length measured to the feather line may increase systematically with age of the bird. Therefore, measured in this way, culmen length is a *soft* character, and is a poor character for most purposes. However, there are alternative techniques for measuring culmen length which minimize the softness of the character (Culmen 1 and Culmen 2—pages 6 and 7).

Body mass is undoubtedly the most widely measured *soft* character, since it is easily measured in the field and provides useful information in a number of contexts. However, 2 points need to be made. First, body mass alone should not be used as a measure of body size, even though structurally larger birds will, on average, have greater mass (Piersma & Davidson 1991). Second, body mass is more susceptible to short-term variation than any other character, *soft* or *hard*, and special care must be taken to consider all confounding sources of variation in body mass (e.g., time bird is held before being weighed, time of last feeding, etc.).

For birds measured during their first year, all characters are *soft*, since in most species there is significant growth of all characters during this time. This is especially true when birds are meas-

ured as goslings prior to fledging. Thus, certain comparisons of measurements among studies or populations are meaningful only if the age of the bird (in days) is known. Since there is strong evidence that growth rates of goslings are significantly influenced by a number of environmental factors independent of age (Cooch *et al.* 1991, Larsson & Forslund 1991, Sedinger & Flint 1991), we suggest that investigators use magnitude of individual characters as a substitute for true age only as a last resort, and with considerable caution.

Of the various measurements we describe in this guide, we suggest that investigators attempt to measure at least the following characters:

minimum measurement set {
- culmen length (1 or 2)
- tarsus length (total)
- flat wing length
- ninth primary
- head length
- body mass

If time permits, these basic measurements should be supplemented with as many other measurements as possible, particularly tail length (page 15), which has historically been used to differentiate races and species, and mid-toe length (page 12). This *minimum measurement set* contains both *hard* and *soft* measurements. If there is insufficient time to measure this minimum set, then we suggest reducing the list to *hard* characters only, which can typically be measured more quickly, with a minimum of added error. With practice, the minimum set of measurements can be made on a bird in 2 to 3 minutes. Of course, individual investigators must ultimately decide what trade-off between completeness and efficiency of data collection is optimal.

Finally, it is essential that investigators carefully document the magnitude of variation introduced to their data due to differences in technique within and among measurers. Where possible, comparisons should be made by having individuals measure a set of birds in a randomized order on the same day in the same field location to reduce the additional variation due to either variable. A variety of analytical techniques are available to aid the investigator in assessing the degree of error in univariate and multivariate measures of structural size (e.g., Bailey & Byrnes 1990, Loughheed *et al.* 1991).

In general, the *hard* characters are significantly more repeatable than the *soft* characters (with the exception of body mass, which is typically highly repeatable). This is due to the fact that not only are *soft* characters more variable over time in and of themselves, but they are also softer (more malleable) in the hands. Thus, subtle variations in caliper pressure, or the degree to which a wing is stretched or articulated, can cause considerable variation in the measurement. For example, wing lengths, whether unflattened, flattened, or flattened and straightened, are difficult to measure reproducibly (reviewed in Jenni & Winkler 1989; see also Rogers *et al.* 1989).

However, despite the problems associated with measuring *soft* characters, there is considerable value in taking such measurements. *Soft* characters are often the most sensitive indicators of variation in the condition of a bird (e.g., Owen & Cook 1977, King & Murphy 1985, Cooch *et al.* 1991).

Basic Equipment

Very little equipment is needed to take most of the measurements described in this guide. For the *minimum measurement set*, we recommend a set of dial or Vernier calipers and a steel rule (long enough to at least measure the length of the ninth primary) for the linear measurements, and either a Pesola® or Chattillon® scale for body mass. A measurement board is useful for measurement of

total length and flat wing (see photographs of either for an example of an easily constructed measurement board). All equipment should be checked and calibrated against known standards prior to use in the field.

Acknowledgments

The first version of this guide was drafted in response to a suggestion made in 1989 by Doug Slack that a "measurement guide might be useful for goose biologists." Various comments and suggestions made by the participants of the Morphometrics Workshop at the 7th North American Arctic Goose Meeting and Workshop (January 1992, Vallejo, California) have significantly improved the guide. Any errors or omissions are entirely the fault of the authors. We extend special thanks to meeting organizers John Takekawa and Bob McLandress for facilitating the workshop, and to Bob McLandress for arranging publication of the guide through the California Waterfowl Association. Branimir Gjetvaj took the photographs and Becky Fuchs handled the final layout. We thank them both for their efforts.

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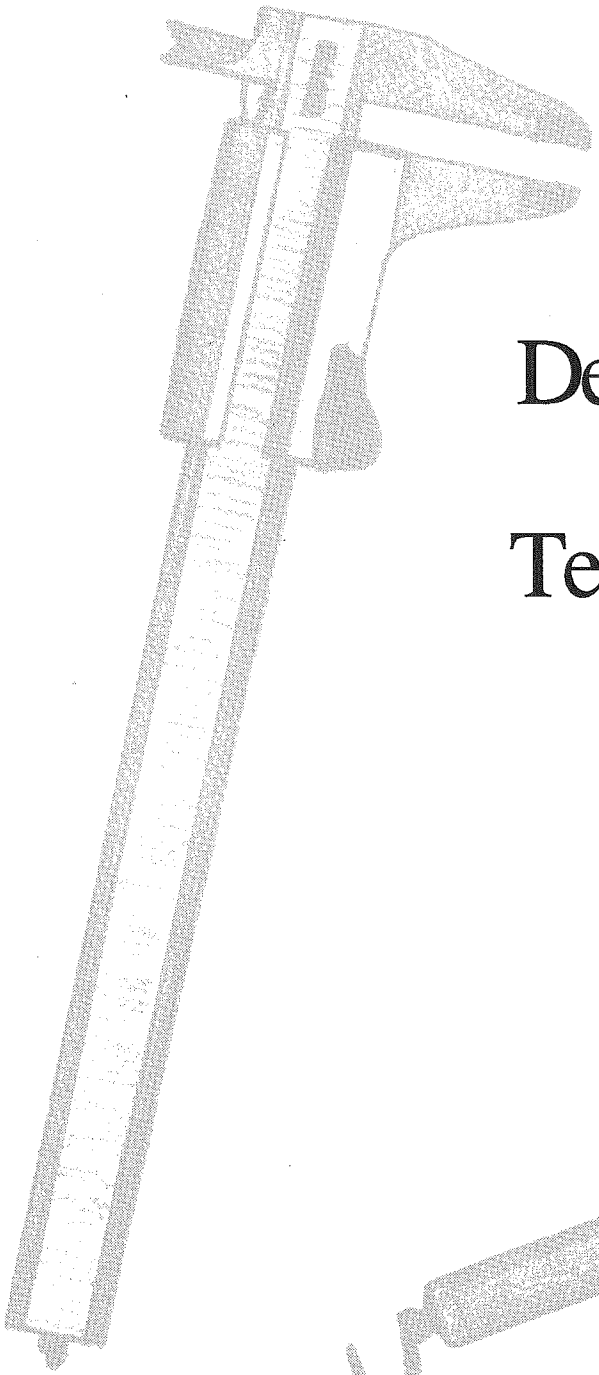
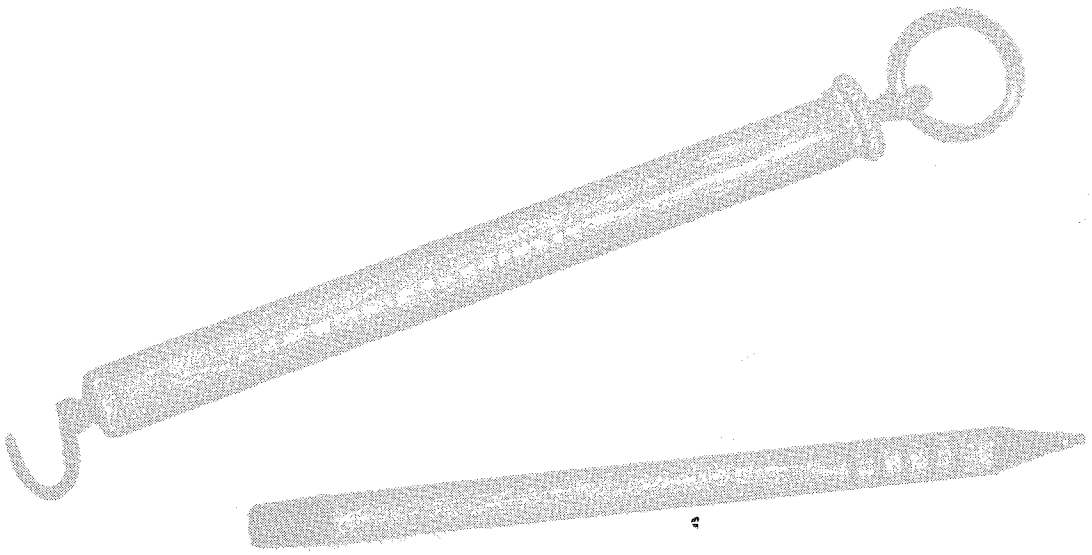
Measurements of Geese

General Field Methods

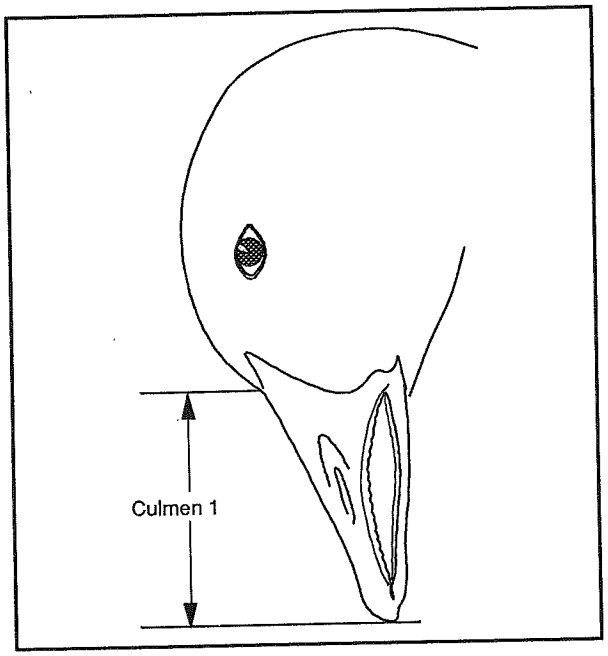


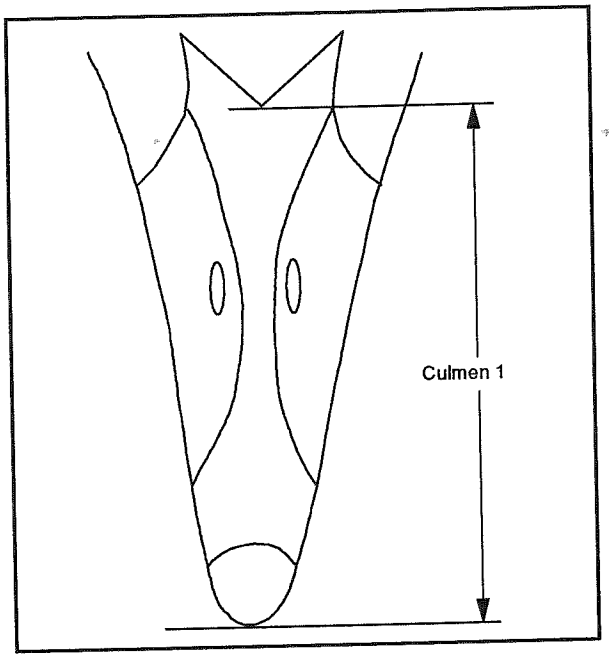
Definitions and Techniques

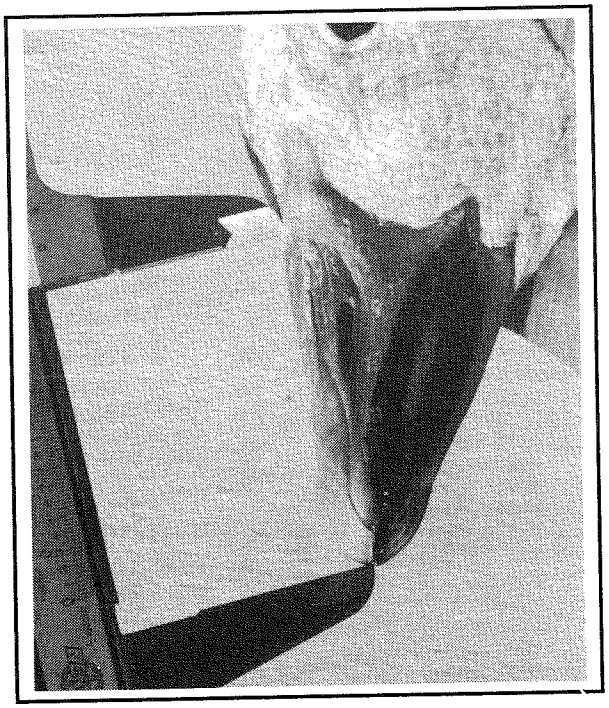


Culmen 1

The chord of the upper mandible length, measured medially from the bottom of the **V**-point where the integument meets the horny portion of the mandible to the distal tip of the bill nail (because of wear, NOT to the first feathers). In goslings, from the lowest point of the **U**, at the interface of the first feathers of the mid-mandible to the distal tip of the bill.

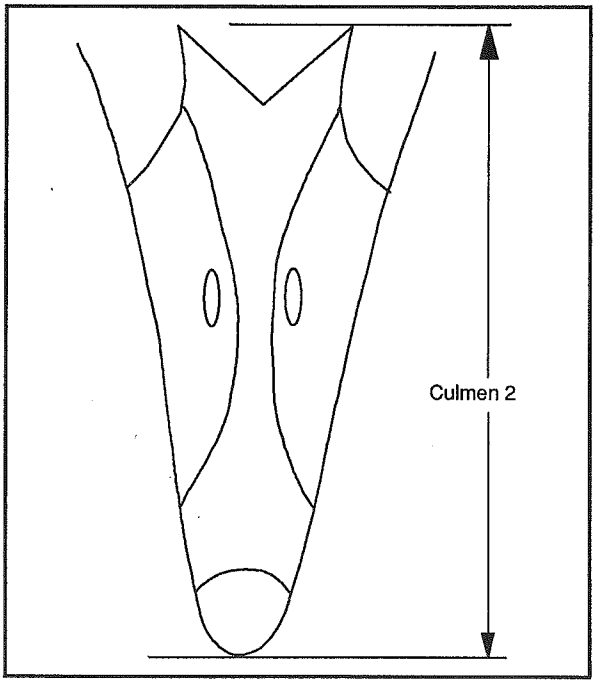


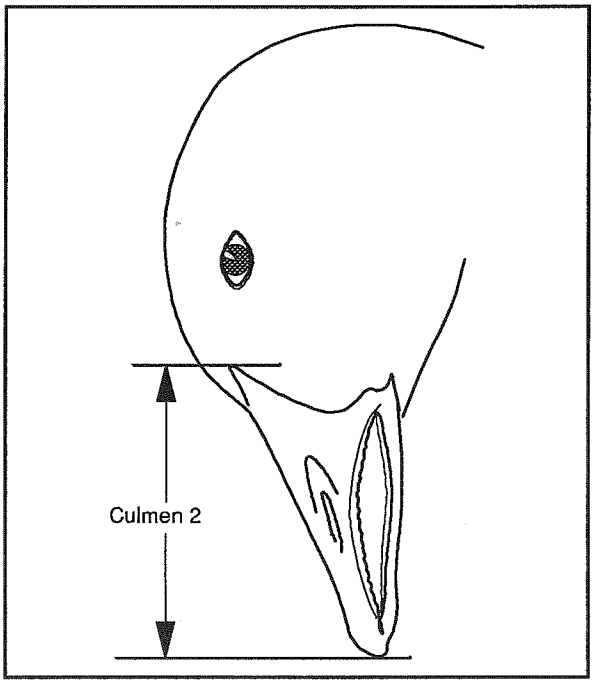


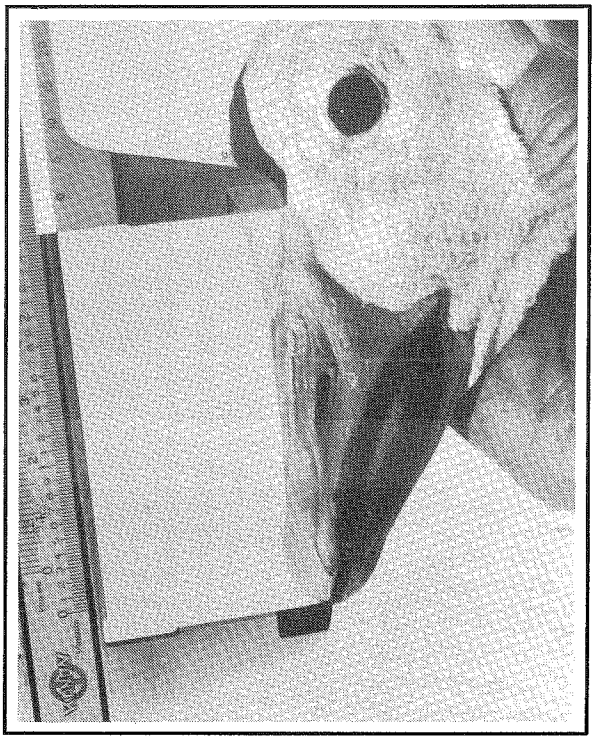


Culmen 2

The diagonal length of the upper mandible from the bill nail to the proximal tip of the posterior lateral extension of the upper mandible, in front of the eyes (*sensu* Würdinger 1975).

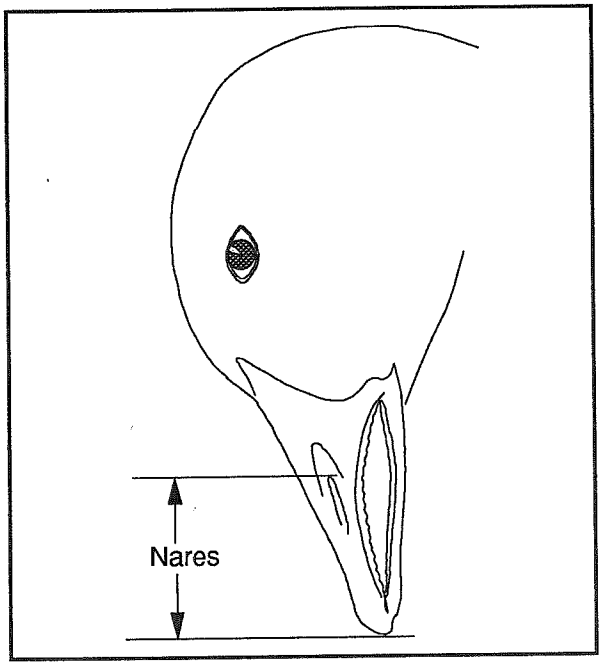


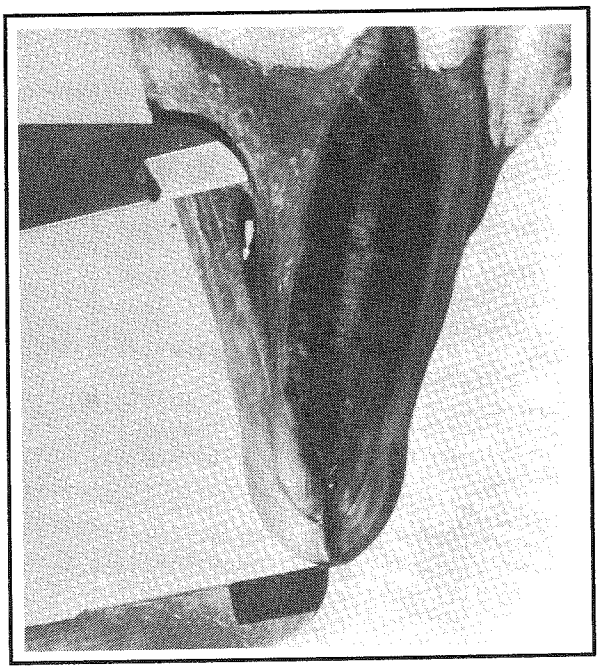




Bill-Nares

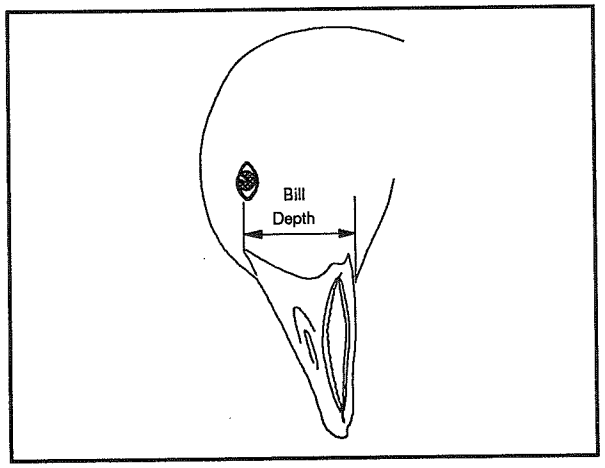
Diagonal length of the upper bill measured from the (1) anterior edge of the nostril to the distal tip of the upper mandible, or (2) the posterior edge of the nostril to the distal tip of the upper mandible.





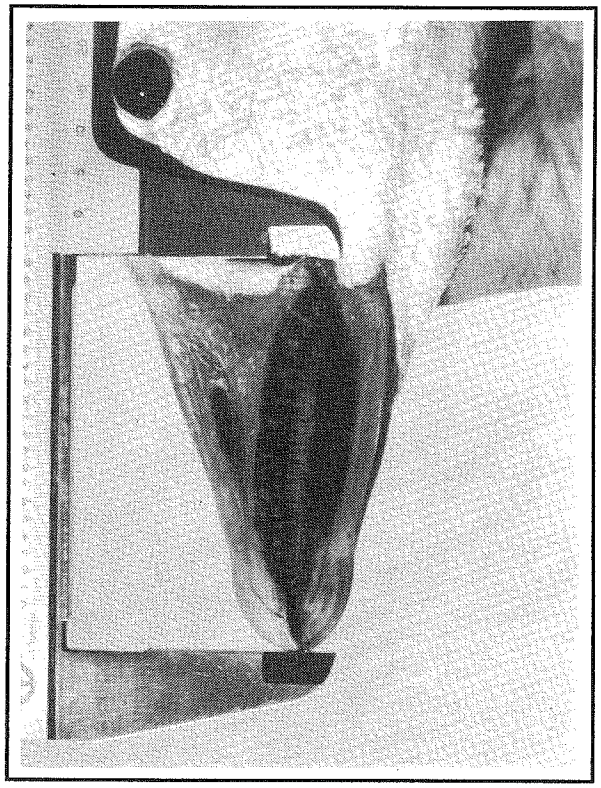
Bill Depth

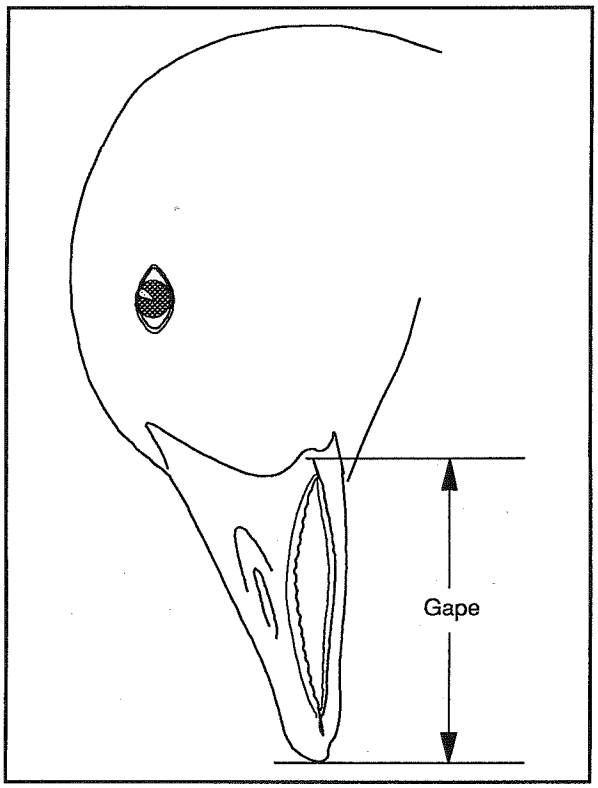
Upper mandible. (1) Depth of the upper mandible from the posterior lateral extension (in front of the eyes) to the base at the commissural point (pictured). (2) The distance perpendicular to the long axis of the bill from the Culmen 2 point to the lower edge of the bottom mandible. **Nostrils.** Depth of the upper bill at the mid-point of the nostril.



Gape

Also known as maxilla length, smile, or upper bill length. The length of the upper mandible from the posterior end of the gape to the distal tip of the nail, along the mouth line (*sensu* Würdinger 1975).



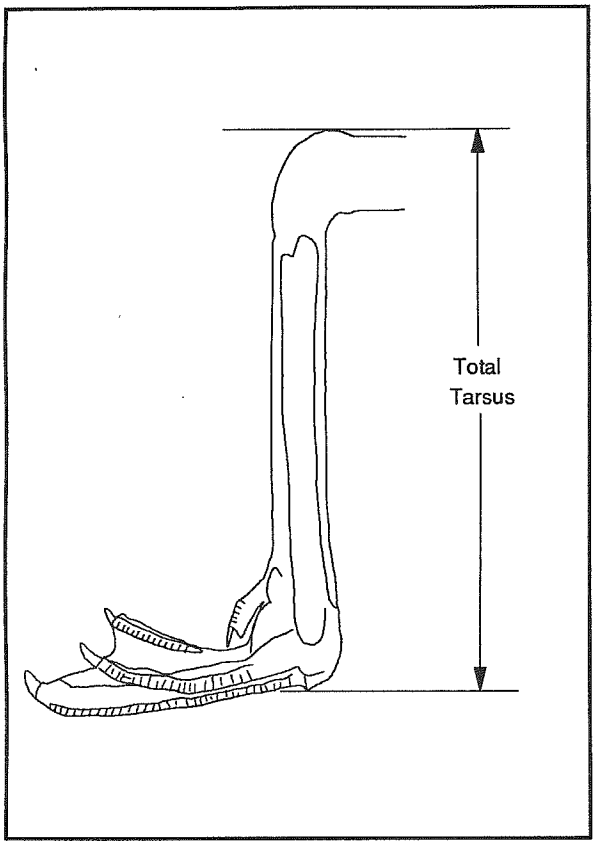


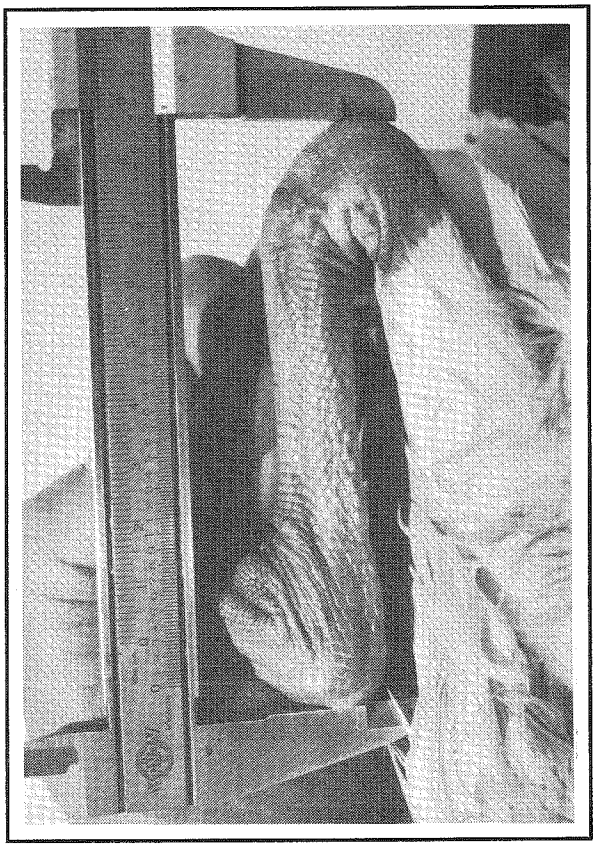
Mandible Width

Maximum width at commissural point, in front of the eyes (Anonymous 1963, Würdinger 1975).

Total Tarsus

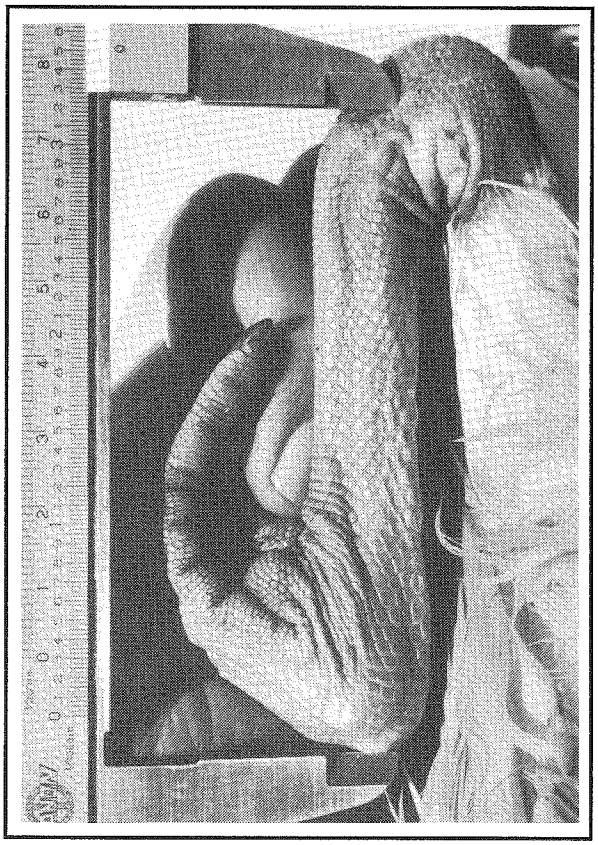
(1) The diagonal length from the most medial condyle of the tarsus where it articulates with the mid-toe to the rounded exterior portion of the distal condyles of the tibia (where this bone is nearly at right angles to the tarsus). The tarsometatarsus is to be articulated to show the position of the condyle (pictured). (2) The diagonal distance from the posterior junction of the tibiotarsus and tarsometatarsus to the distal junction of the tarsometatarsus at the base of the middle toe.

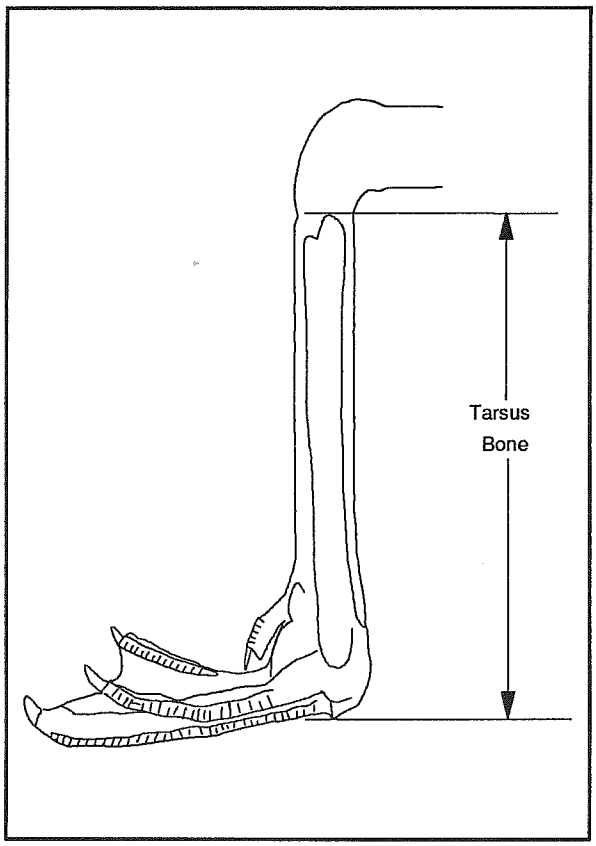




Tarsus Bone

The diagonal length of the tarsometatarsus bone only, along the outside edge.



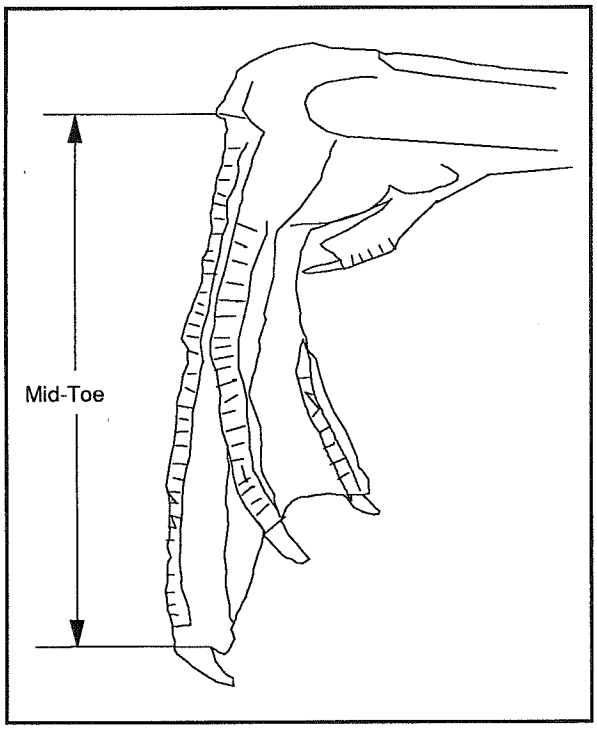


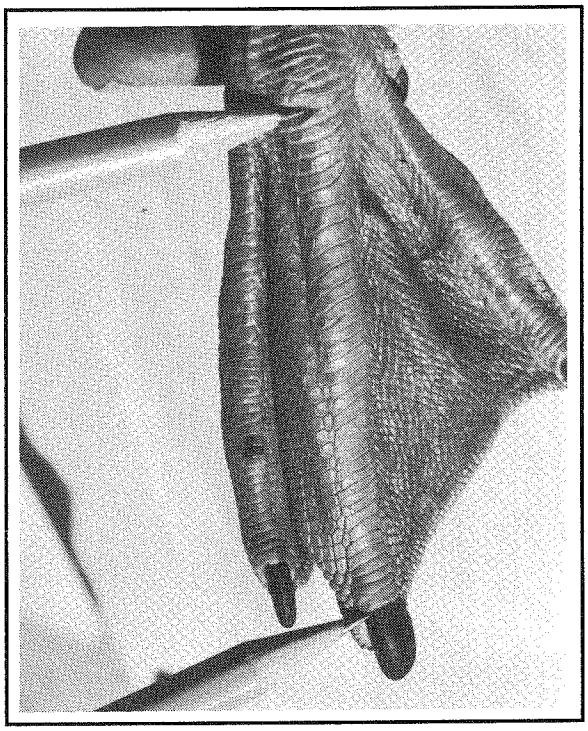
Tarsus Width

Minimum tarsus width along tarsometatarsus.

Mid-Toe

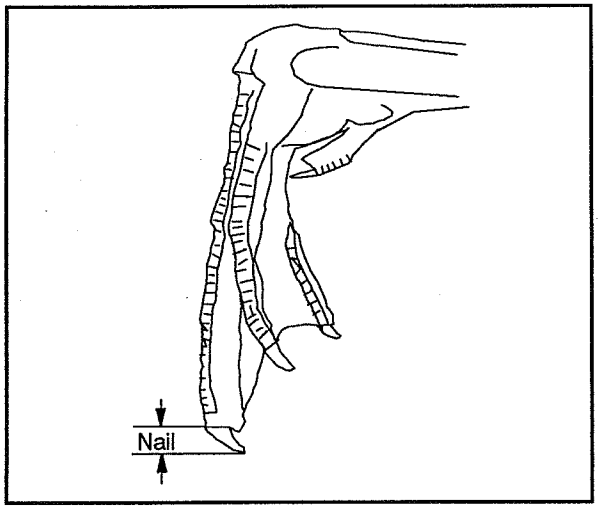
The length of the middle phalanx along its dorsal surface from the proximal articular surface at the juncture of the tarsometatarsus to the distal end of the toe at the base of the claw.





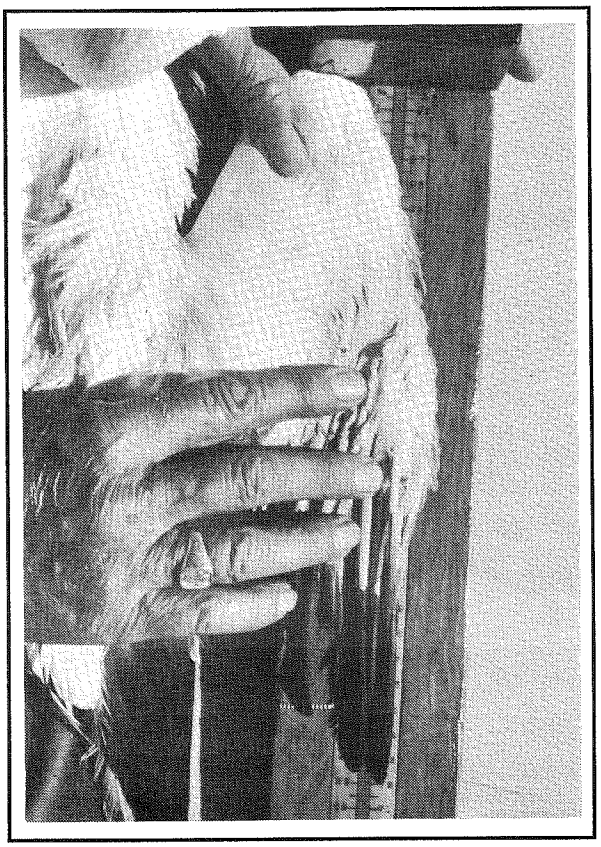
Nail

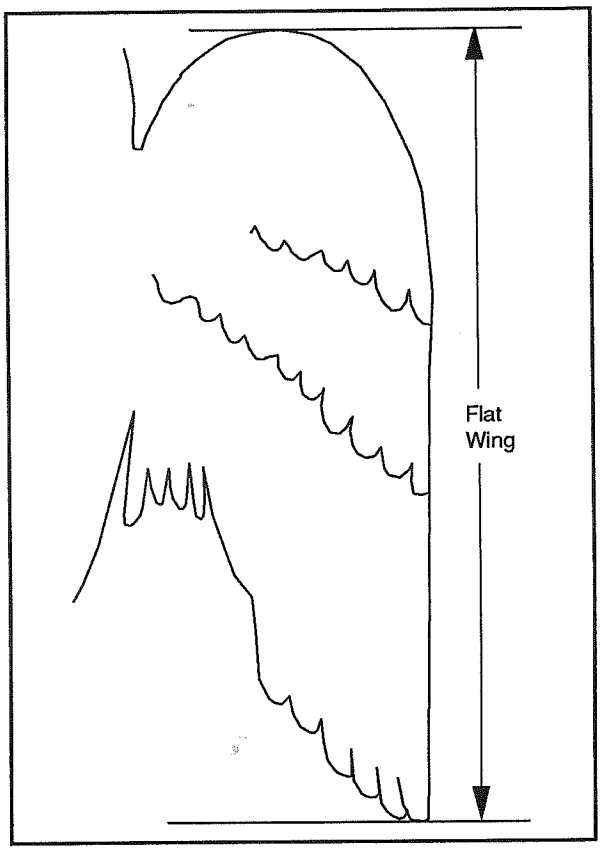
Also known as claw. The length of the chord of the claw from its base to its tip.



Flat Wing

(1) The distance from the blunt end of the wrist joint (flesh at the bend of the folded wing) to the distal tip of the longest primary, with the wing flattened against a measuring board and the longest primary extended upward to lie perpendicular to the bend of the wing. (2) The maximum measurement from the bend of the closed wing to the longest primary, with the wing flattened and the primary straightened against a vertical border attached to the edge of the measuring surface.





Wing Arc

The length from the anterior edge of the wing at the wrist joint to the end of the longest primary—taken with a flexible ruler or tape over the outside middle of the wing while it is in a naturally folded position.

Wing Chord

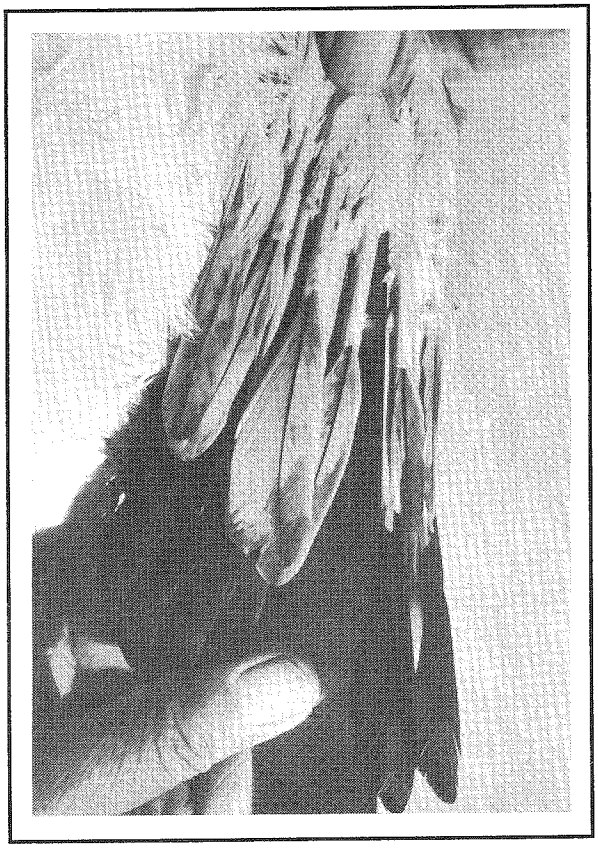
(1) The maximum length from the anterior edge of the wing at the wrist joint to the end of the longest primary, with the wing closed in a naturally folded position. (2) The maximum chord of the unflattened wing.

Mid-Wing

The length from the proximal end of the ulna to the distal end of the radius (proximal to the spur), measured ventrally with the humeral-ulnar joint at 90 degrees (*sensu* Moser & Rusch 1988).

Ninth Primary

The total length of the feather from the insertion of the remige calamus at the skin surface to the distal end of the feather (with the ruler or divider placed between the 8th and 9th primaries). For goslings and molting adults, length of the feather—the length of the growing feather from the edge of the blue sheath to the tip of the feather is a second metric.

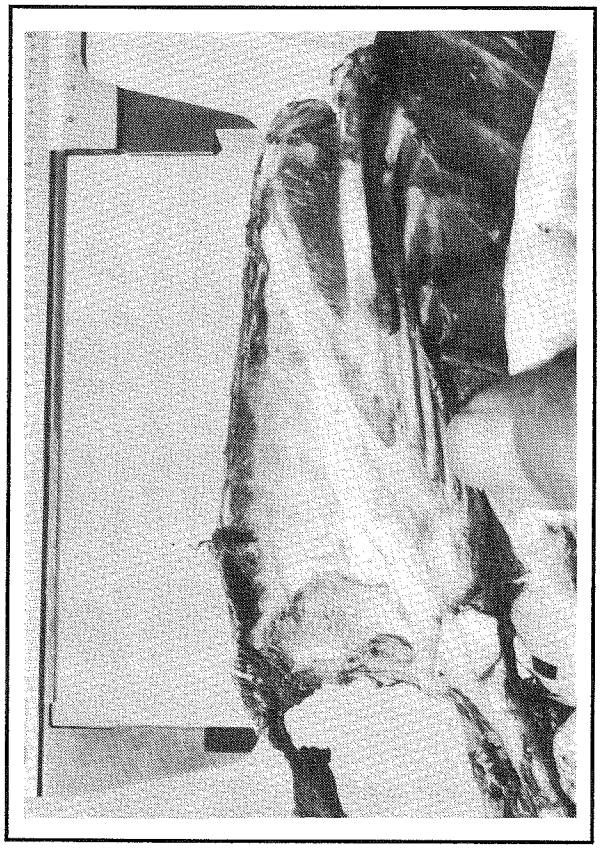


Alula

The length of the longest feather on the second digit, including the digit itself, to its articular surface with the fused carpometacarpus.

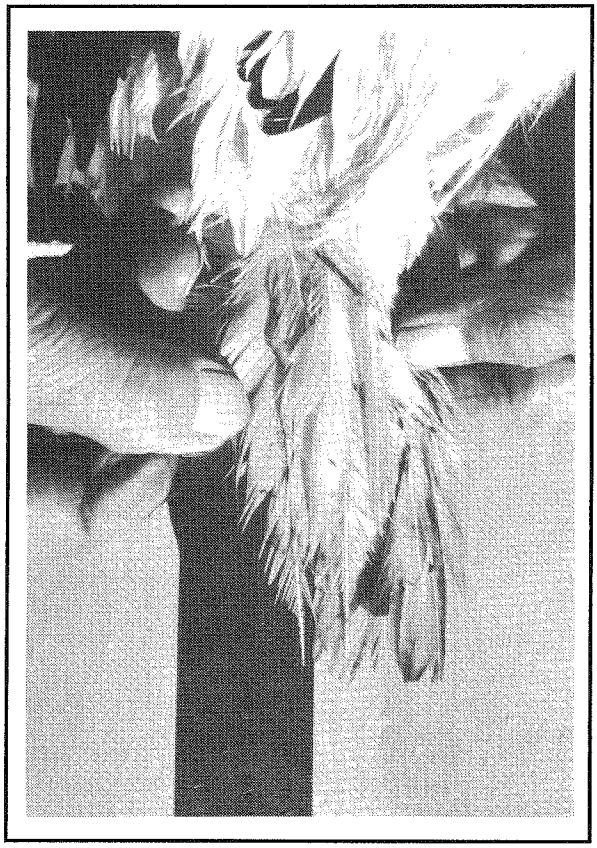
Sternum

Also known as keel or sternal-ridge. (1) The length from the distal to proximal end of the defleshed and dried sternum (remove all the cartilaginous tissue on the distal and proximal ends of the carcass). (2) The length of the sternal ridge nearest the skin, including the skin and feathers (on a live bird). May be flexible in immatures.



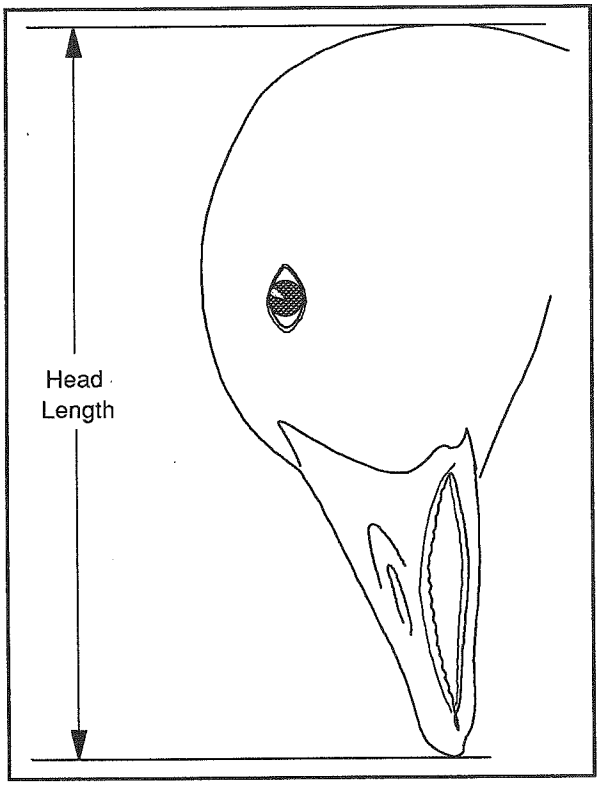
Tail Length

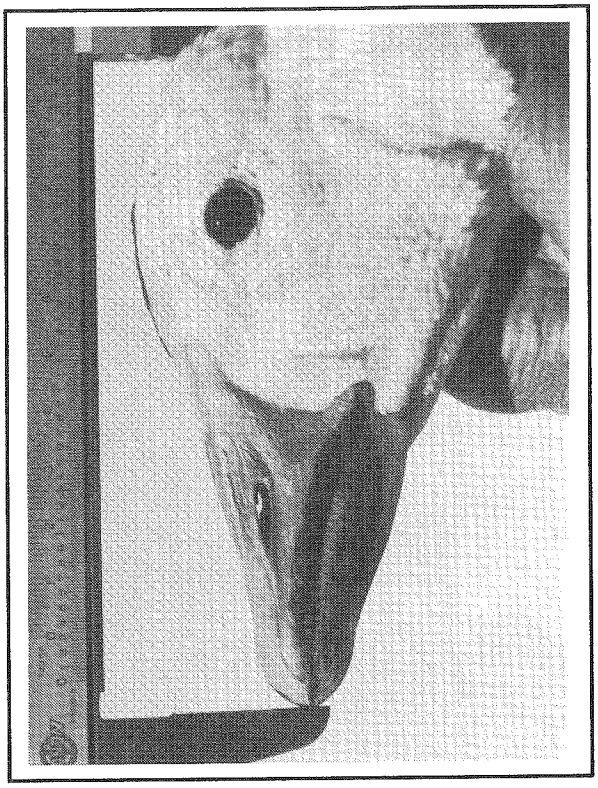
Center. (1) The length of 1 of the 2 center rectrices from the point of insertion of the calamus on the skin of the coccyx to the distal tip of the feather, or (2) the arc length of center rectrix. **Longest.** The maximum diagonal length of the entire tail fan from the point of insertion of the calamus on the skin of the center rectrix to the tip of the longest rectrix (usually the 3rd or 4th inward from the most lateral rectrix).



Head Length

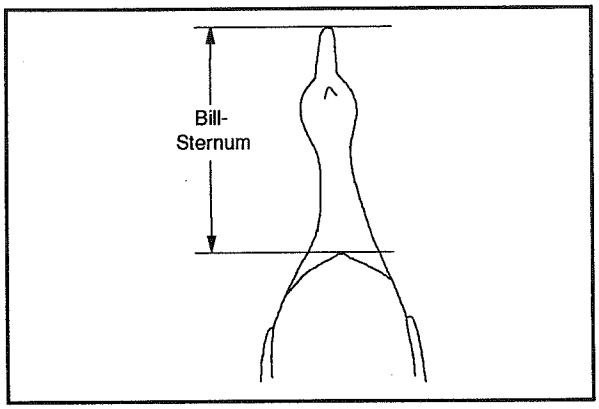
(1) The length of the skull from the external occipital ridge (at the back of the head) to the distal tip of the bill nail (including skin and feathers—pictured). (2) The longest dimension of the head—with tips of the calipers anchored on the ridge and nail at right angles to the head.





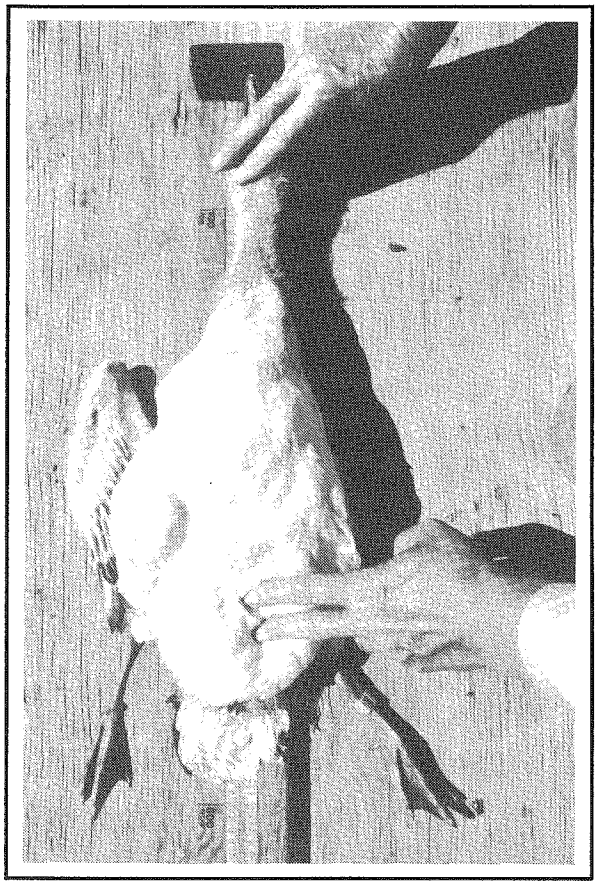
Bill-Sternum

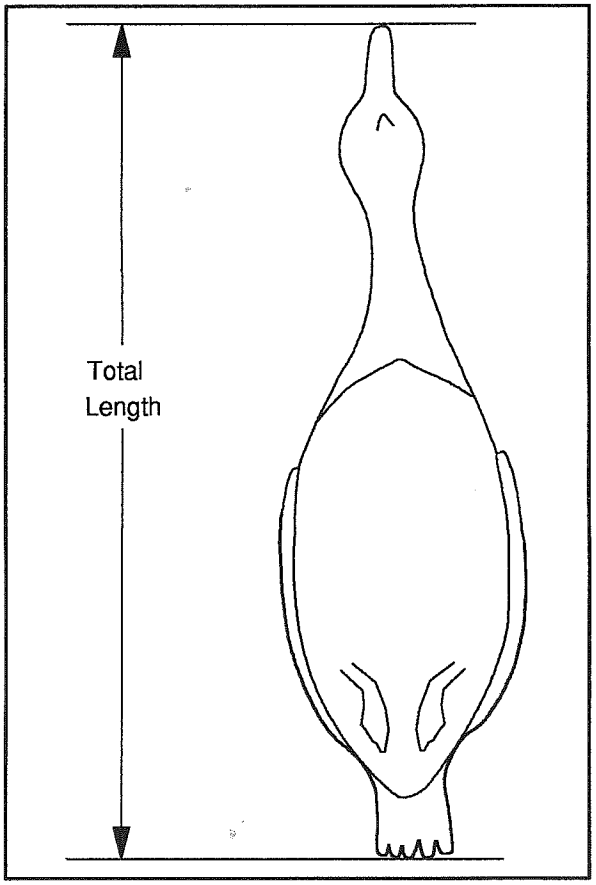
The diagonal length from the tip of the bill to the forward tip of the sternum (including the feathers and the skin).



Total Length

Measure with bird laid on its back on a flat surface. (1) The length of the bird from the tip of the bill to the distal end of the longest tail feather—usually the 3rd or 4th from the most lateral feather (pictured). (2) Body length measurement plus extended but not stretched head and neck (*sensu* Owen & Montgomery 1978).





Body Length

(1) The length of the bird from the tip of the bill to the skin at the end of the coccyx (add tail length at its longest point for total length—above). (2) Distance from the tip of the tail to the shoulders (*sensu* Owen & Montgomery 1978).

Body Mass

(1) Mass in grams (10 grams) of the entire carcass or live bird. (2) Mass in grams of the entire goose minus the digestive tract contents (i.e., minus the esophagus and proventriculus contents).

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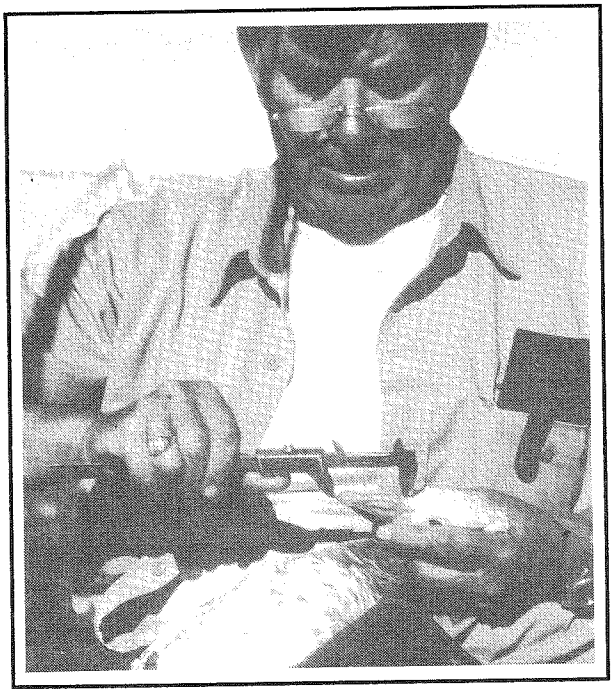
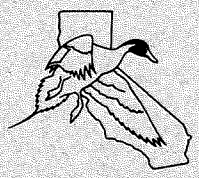


Alex Dzubin

Alex Dzubin has studied the ecology and population dynamics of several species of waterfowl over the past 40 years, principally for the Canadian Wildlife Service. Many of these studies have involved the field measurement of large numbers of many species of geese. Alex Dzubin has been instrumental in developing and teaching many of the techniques presented in this guide, which are currently in use by many goose researchers throughout the world. Although now retired, he maintains an active interest in continuing goose research and frequently collaborates with several current projects.

Evan Cooch

Evan Cooch has extensively investigated aspects of the demography of the Lesser Snow Goose, primarily in association with Fred Cooke and Robert Rockwell and their long-term study of the species at La Pérouse Bay. Some of this continuing work has involved assessing the genetic and environmental sources of variation in growth rates and body size of Snow Geese. He is currently pursuing the theoretical implications of variation in body size on the evolution of reproductive and behavioral strategies in geese.



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