

Mass variation in Northern Saw-whet Owls: implications for current sexing criteria

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ABSTRACT. Currently, a protocol using body mass as the primary criterion for assigning sex of Northern Saw-whet Owls (*Aegolius acadicus*) is being used by banders. We assessed mass variation of owls using paired measurements of those recaptured ($N = 372$) during fall migration along the lower Delmarva Peninsula (1994–2005) to assess the stability of gender assignments resulting from the protocol in current use. Mass variation ranged from 0 to 26.0 g, with a mean of 6.0 g. There was a positive relationship between body mass and the magnitude of the mass change between measurements. Variation in mass between captures caused a considerable shift in gender designations. Changes were most pronounced for birds classified as male ($N = 43$), with 58% remaining either definite or probable male and the remainder changing to either unknown (28%) or female (14%). Female designations ($N = 317$) were more stable, with 76% remaining either definite or probable female. Variation in mass and associated changes in gender assignments caused a two-fold shift in perceived sex ratio from 1:13 to 1:6 (M:F). Given that meals cause variation in mass that is large relative to the differences between sexes, we suggest that mass carries an unacceptably high level of uncertainty to be useful in assigning gender. Sex ratios and other demographic parameters generated using the current technique should be used with caution.

SINOPSIS. Variación en la masa corporal en *Aegolius acadicus*: implicaciones en los criterios utilizados para sexarlo

Al presente se utiliza un protocolo, que usa la masa corporal como criterio principal, para el sexado en *Aegolius acadicus*. Determinamos variación en la masa corporal utilizando medidas pareadas de individuos recapturados ($N = 372$). El estudio se llevó a cabo del 1994–2005, durante la migración otoñal, a lo largo de la parte inferior de la Península Delmarva. El objetivo de este fue determinar la estabilidad de los sexos asignados a individuos, como resultado del protocolo utilizado. Encontramos variación en la masa con un promedio de 6.0 g., y un rango de 0–26 g. Hubo una correlación positiva entre la masa corporal y la magnitud del cambio en masa entre medidas. La variación en la masa entre capturas causó un cambio considerable en el sexado. Los cambios fueron más pronunciados para aves clasificadas como machos ($N = 43$), con un 58% clasificados como probables o definitivamente machos, un 28% sin clara clasificación y un 14% como hembras. La designación de hembras ($N = 317$) resultó ser comparativamente más estable, con un 76% que se clasificaron como probables o definitivamente hembras. La variación en masa asociadas con el cambio en el sexado de los individuos examinados, causó un cambio de doble magnitud en la percepción de la tasa de sexos, esto es de 1:13 a 1:6 (M:H). Dado el caso que la alimentación puede causar variación en la masa de estas aves, que a su vez puede producir diferencias en el sexado, señalamos que el utilizar la masa corporal trae como consecuencia un alto grado de incertidumbre que es inaceptable para asignar el sexo de estas aves. La tasa de sexos generados con el protocolo actual, al igual que otros parámetros demográficos, deben ser utilizados con mucha cautela.

Key words: *Aegolius acadicus*, mass variation, migration, sex ratio, sexing criteria

Reverse sexual size dimorphism is common in North American owl species and has been used as the basis for gender assignment for several species (Earhart and Johnson 1970). However, because smaller species are less dimorphic than larger ones, assigning sex based on body size alone is less reliable. Similar plumage and limited size dimorphism have made sex determination of Northern Saw-whet Owls (*Aegolius acadicus*) particularly problematic.

Since the mid 1970s, several criteria for sexing Northern Saw-whet Owls have been published. Early criteria involved using the distribution of wing chord lengths for known-sex birds to delineate ranges exclusive to males and females, as well as an overlap zone where gender could not be reliably assigned. Sheppard and Klimkiewicz (1976) suggested that males had wing chords <135 mm and females had wing chords >139 mm. In 1980, the Bird Banding Laboratory published wing chord thresholds of <132 mm for males and >142 mm for females (Anon. 1980), and Weir et al. (1980) sexed all owls

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with wing chords ≤ 134 mm as males and those with wing chords ≥ 141 mm as females. In 1984, Buckholtz et al. (1984) incorporated differences in wing chord lengths based on age and published criteria for sexing hatch-year (HY), after-hatch-year (AHY), and unknown-age (U) owls. Buckholtz et al. (1984) recommended the following wing chord measurement for sex determination: AHY male ≤ 134 mm, AHY female ≥ 141 mm, HY male ≤ 132 mm, HY female ≥ 139 , U male ≤ 132 mm, and U female ≥ 139 mm.

Mueller (1990) questioned the need for gender assignment of Northern Saw-whet Owls and the use of sample statistics to establish threshold values, pointing out that previous criteria led to a large percentage of owls classified as unknown gender and an unacceptably high rate of error. Further, Mueller (1990) demonstrated that all previous sexing criteria may have been flawed because of differences in measuring techniques, geographic variation in wing chord lengths, changes in wing chord based on age, decreasing wing chord lengths of dried museum specimens, and biased samples.

In the mid 1990s, a protocol using body mass as the primary criterion for assigning sex was proposed, with wing chord as a secondary criterion (Brinker et al. 1997, Brinker 2000). This protocol has been approved by the Bird Banding Laboratory. Based on this protocol, Northern Saw-whet Owls with masses ≤ 78 g are considered males and those with masses ≥ 93 g are females. For owls with masses between these threshold values, a discriminate function analysis using combinations of both mass and wing chord is used to assign gender.

Unlike wing chord, body mass is highly dynamic, raising questions about its reliability for use in gender assignment. Due to their feeding ecology, many raptors exhibit rapid variation in body mass, particularly small raptors like Northern Saw-whet Owls with a high prey-to-body mass ratio (Graber 1962, Collins 1963). Here, we use measurements from owls captured twice during the same fall migration season to assess the magnitude of mass variation and its implications for gender determination. We use the current protocol (Brinker 2000) to evaluate its consistency in gender assignment.

METHODS

We captured Northern Saw-whet Owls during fall migration from 1994 to 2005 along the lower Delmarva Peninsula in Virginia. We operated three trapping stations located approximately 3–5 km apart. Stations were located on the western bayside, eastern seaside, and the southern tip of the peninsula (Whalen and Watts 1999, 2002). Stations were located within forest patches consisting primarily of loblolly pine (*Pinus taeda*), eastern red cedar (*Juniperus virginiana*), and mixed hardwoods (e.g., *Quercus* spp., *Carya* spp., *Acer rubrum*, and *Prunus serotina*) with moderate understory vegetation.

We used a continuous line of six 12-m mist-nets (60-mm mesh) erected along an east–west axis to capture birds. We positioned an electronic audio-lure at the center of each net line to attract migrating owls and enhance capture rate. Each audio-lure consisted of a portable player, amplifier, 12-v deep-cycle marine battery, and a loud-speaker facing north. We played a continuous-loop broadcast of a Northern Saw-whet Owl advertising call (Cannings 1993, Duffy and Matheny 1997, Erdman and Brinker 1997, Evans 1997) at a volume of about 100 dB.

We initiated trapping each year in late October and continued through mid December. We trapped nightly from approximately 0.5 h after sunset to 0.5 h before sunrise, weather permitting. Nets were checked for captured birds at about 3-h intervals. Captured owls were banded with USGS Bird Banding Laboratory aluminum bands. We measured unflattened wing chord with a wing ruler (± 1 mm) and body mass (± 1 gm) with a Pesola spring scale (prior to 2000) and a digital balance (after 2000). We recorded the band number and measured body mass each time an owl was recaptured.

To evaluate patterns in mass change and their implications for sex determination, we used data from individuals captured two or more times during the same migration season. We used the highest and lowest masses of each individual to determine mass change and evaluated the relationship between mass change and body mass. We assigned gender to individuals based on the maximum and minimum masses recorded for each individual using Brinker's sexing criteria (Brinker 2000) described previously. We used classification results for highest and lowest

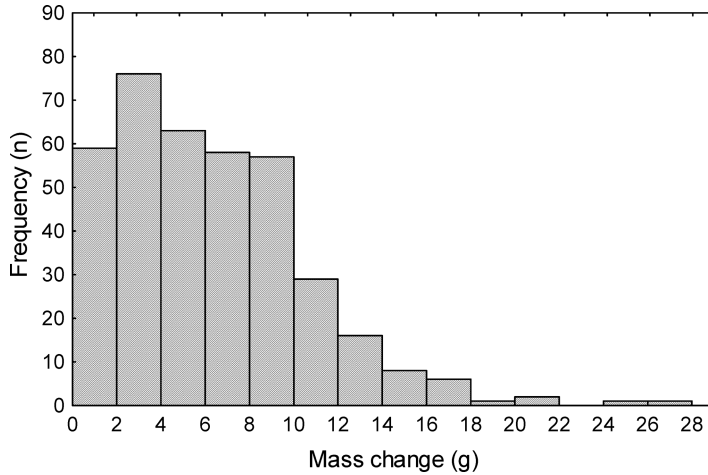


Fig. 1. Frequency distribution of mass changes for recaptured Northern Saw-whet Owls (*Aegolius acadicus*) on the lower Delmarva Peninsula. The distribution is skewed to low mass changes, but with a long tail represented by extreme values.

weights to evaluate the influence of mass changes on the stability of classification results. Values are presented as mean \pm 1 SD.

RESULTS

Northern Saw-whet Owls measured more than once ($N = 376$) during a fall season showed considerable variation in mass between captures (Fig. 1), with a mean difference of 6.0 ± 4.3

g (range: 0–26 g). The mass of most (96%) owls changed between measurements, with 55% changing more than 5 g and 17% more than 10 g. Expressed as a percentage of body mass, the mean change in body mass was $6.9 \pm 5.1\%$ (range: 0–32%). In general, the largest birds exhibited the greatest changes in mass (Fig. 2). The change in mass for 15 (4%) individuals exceeded the 15-g separation between definite males and females.

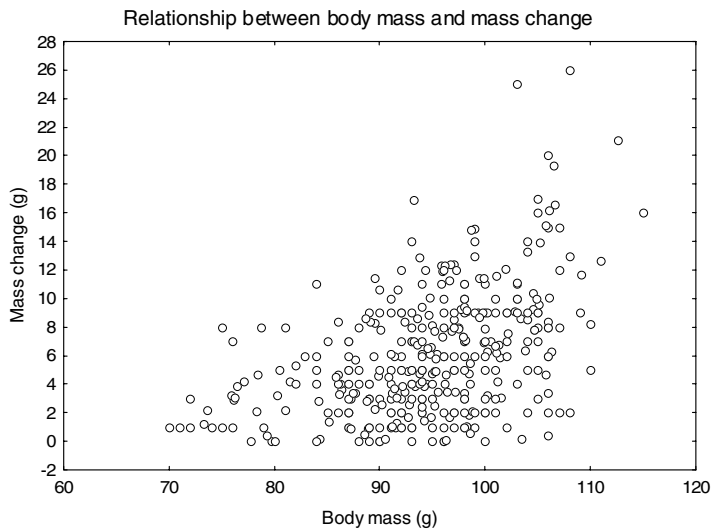


Fig. 2. Relationship between the mass change and body mass for owls recaptured along the lower Delmarva Peninsula. The heaviest mass recorded was used for body mass. Extreme mass changes appeared to be associated with the heaviest owls.

	Definite male	Probable male	Unknown	Probable female	Definite female
Definite male	19	4	9	1	2
Probable male		2	3	2	1
Unknown			22	38	31
Probable female				34	101
Definite female					107

Fig. 3. Matrix of changes in gender assignment for Northern Saw-whet Owls between captures during the same fall season. Numbers are sample sizes for the possible assignment combinations.

The gender designation of most (51%) owls changed between captures (Fig. 3). Changes were most pronounced for birds classified as male ($N = 43$), with 58% remaining either definite or probable male and the rest changing to either unknown (28%) or female (14%). Female designations ($N = 317$) were more consistent, with 76% remaining classified as either definite or probable female and the rest changing to either unknown (22%) or male (2%).

Variation in mass and associated changes in gender assignments caused a two-fold shift in perceived sex ratio. When sexing criteria were applied to the high mass values, sex ratio was 1:13 (M:F), with 34 birds classified as unknown. When applied to the low mass values, sex ratio was 1:6 (M:F), with 91 birds classified as unknown. Nearly 42% more owls were sexed as males using the low values than the high values. Nearly 31% more owls were sexed as females using the high values than the low values.

DISCUSSION

Northern Saw-whet Owls in our study exhibited considerable variation in mass between captures. Although there are several potential reasons for such variation, the most likely is ingestion of prey. Northern Saw-whet Owls consume a variety of prey, with most prey species ranging in mass between 20 and 40 g (Swengel and Swengel 1992, Cannings 1993). As with many small raptors, prey size relative to body mass is relatively high so that eating may cause considerable variation in body mass. Collins (1963) suggested that mass was particularly la-

bile in this species and documented variation in mass of up to 56% in captive birds. In our study, the greatest difference in body mass was 32%.

Northern Saw-whet Owls deal with their high prey-to-body mass ratio by partially consuming prey (Collins 1963, Bondrup-Nielsen 1977, Cannings 1993). For captive owls, Collins (1963) observed that large mice (25–35 g) were eaten in two bouts separated by 5–6 h, and 10–15 g mice were consumed during a single bout. Graber (1962) found that the mass of prey consumed during a single feeding bout ranged from 13.3 to 18.3 g. We found a mean change in mass of 6 g and, given that many of the owls may not have eaten for several hours, this is consistent with previous observations.

The current sexing protocol for Northern Saw-whet Owls uses differences in mass as little as 5 g to assign gender, a difference less than the mean variation observed between captures in our study. In addition, a difference of 15 g is used as the sole criterion to separate definite males from definite females, and this difference is within the range of a normal meal. Variation in mass in our study was sufficient to change gender assignments, with 24.6% of the owls classified as males or females changing to either unknown or to the other gender. These results indicate that mass is too variable to be used to assign gender of Northern Saw-whet Owls, and the only way to determine the definite sex of Northern Saw-whet Owls is either by internal examination or using molecular methods (Griffiths et al. 1998). Clearly, sex ratios and other demographic parameters generated using the current protocol must be viewed with caution.

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