Wildlife Society Bulletin; DOI: 10.1002/wsb.517

*Tools And Technology*

# Age and Sex Identification From Wings of Sage-Grouse

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**ABSTRACT** We redefine and clarify procedures to classify sex and age (juveniles, yearlings, adults, and breeding-age) of greater (*Centrocercus urophasianus*) and Gunnison sage-grouse (*C. minimus*) from wings. Existing keys for greater sage-grouse age and sex classification do not incorporate more recent information on timing and sequence of molt or regional variation. We evaluated keys with the aid of gonadally inspected, hunter-harvested sage-grouse in Colorado (1973–1990) and with birds captured and measured in Washington (1992–1997) and Oregon (2008–2012). The technique is accurate and transferable among biologists who have basic training in reading a key and examining wings (primaries, secondaries, tertials, and coverts). Accurate information on sex and age of grouse, particularly during harvest, is a fundamental component of our understanding of population dynamics, which ultimately enables improved management.


**KEY WORDS** age determination, *Centrocercus minimus*, *Centrocercus urophasianus*, greater sage-grouse, Gunnison sage-grouse, molt, sex-age composition, sex determination, techniques, wing data.

Greater (*Centrocercus urophasianus*) and Gunnison sage-grouse (*C. minimus*) are important indicator species of health of the ecosystems dominated by sagebrush (*Artemisia* spp.) in western North America (Knick et al. 2003, Connelly et al. 2011*b*). Sage-grouse are hunted in Montana, Wyoming, Colorado, Utah, Nevada, California, Oregon, and Idaho (USA); biologists in most of these states collect wings from hunter-harvested grouse to ascertain sex and age composition of the harvest. These data are used to monitor trends in productivity and overall reproductive health of populations by local area, region, and state (Connelly and Braun 1997, Connelly et al. 2003*a*, Hagen and Loughin 2008, Reese and Connelly 2011). Even in states without hunting, wings are regularly used to identify age within each sex.

The earliest published reference for separation of sex and age classes of greater sage-grouse (Patterson 1952) considered the flexibility of the sternum (juvenal sternums more flexible than sternums of older birds), the breaking strength of the lower mandible (juvenal mandibles weaker than older mandibles), toe color (toes of juveniles greenish-yellow and toes of older birds greenish-black), size and shape of the head (males bulkier and longer than females), length of the middle toe (longer in males than females), and texture and character of plumage (remnant juvenal feathers distinctly contrast with appearance of newly molted feathers). Eng (1955) described a method for obtaining sex ratios from sage-grouse wings in Montana based on measurements of primary feathers (but mis-numbered 1 through 10, distal to proximal). Eng classified age based on the appearance of the tips of primaries 10 and 9 as demonstrated by Wright and Hiatt (1943) for gallinaceous birds. Only two age classes were described by Eng, juvenile (hatch year = HY) and adult (after hatch year = AHY). The technique for describing age class was developed by Petrides (1942) for all galliforms. Eng (1955) based his key on birds of known sex (gonads) and age (bursa of Fabricious), although the usefulness of this latter characteristic for sage-grouse is not always clear (Dalke et al. 1963). Later descriptions of size, gonads, and plumage characteristics (such as undertail coverts and primary measurements; Dalke et al. 1963) and a key developed by Crunden (1963) were not especially clear, and the primaries were mis-numbered from 1 through 10, distal to proximal. Crunden only distinguished between two age classes, juvenile and adult, and had at least one mistake in his key (inaccurate comparison of complete primary lengths for juveniles and adults). Because the Dalke et al. (1963) description was not a key, it was not very simple to use or regionally inclusive. Similarly, Beck et al. (1975) summarized the general knowledge useful in identification of sage-grouse sex and age from wings in Colorado, Connelly et al. (2003*b*) provided a simple key for Idaho, and Ottomeier and Crawford (1996) recommended measurement of primary 4 for identification of sex and age in Oregon.

Available sources of information on sex and age of sage-grouse have limitations, including incorrect terminology, limitation to two age classes, lack of sufficiently descriptive photographs, inaccuracies, and unaddressed regional variation (Eng 1955, Crunden 1963, Dalke et al. 1963, Beck et al. 1975, Connelly et al. 2003*b*). Sage-grouse are sexually

Received: 14 July 2013; Accepted: 22 September 2014

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dimorphic (Schroeder et al. 1999); and identification of sex of sage-grouse is relatively simple with intact birds, but may not be as clear with only wings (Beck et al. 1975). The first objective of our paper is to present a key to separate sex and three age classes of sage-grouse from wings collected through mail surveys, volunteer wing-collection stations (Hoffman and Braun 1975), and hunter-check stations during the autumn harvest accounting for some of the variation found throughout their range. The more precise differentiation of age classes offers opportunities for improved assessments of population dynamics and management. This is particularly important for sage-grouse, because of the observed differences in productivity between yearlings and adults (Connelly et al. 2011*a*). A second objective is to test the key with wings that are identifiable with the additional examination of intact birds and/or internal sexual organs. A comprehensive key is needed, especially one that incorporates correct terminology with descriptive photos to clarify ambiguities not dealt with in previous keys.

## METHODS

Measurements of primaries from approximately 500 intact hunter-harvested sage-grouse were initially obtained at check stations in Jackson County, Colorado, in 1973–1974. This effort was expanded to all hunted populations in Colorado starting in 1975. Sex class was ascertained based on size (males are as much as twice the size of females) and strong sexual dimorphism in plumage (Dalke et al. 1963, Beck and Braun 1978, Hupp and Braun 1991, Schroeder et al. 1999). Sex was further verified with gonadal inspection of 938 individuals collected at check stations in Jackson and Moffat counties, Colorado from 1973 through 1990. Measurements of primaries and sex from an additional 94 individuals were obtained as the result of trapping casualties, traffic accidents, predator kills, drowning, or collisions with power lines. These wings, especially those from hunter-harvested sage-grouse of known sex, were used to initially develop and refine measurement criteria for males and females in each age class. Additional spring measurements were obtained from 277 sage-grouse captured in Oregon (2008–2012) and 122 in Washington (1992–1997). Birds were captured in Oregon with the aid of spotlights (Giesen et al. 1982, Wakkinen et al. 1992) and in Washington with the aid of walk-in traps (Schroeder and Braun 1991). The strong sexual dimorphism of sage-grouse makes identification of sex of a captured bird extremely accurate, particularly in spring (Beck and Braun 1978, Hupp and Braun 1991, Schroeder et al. 1999).

Primaries were numbered from P1 (proximal) to P10 (distal), with the first secondary (S1) being adjacent to P1. Age categories are juveniles or chicks (HY), yearlings (second year = SY), and adults (after second year = ASY). Birds are grouped into a single breeding-age class (AHY) in situations where yearlings cannot be distinguished from adults because of advanced primary molt. Following hatch, juveniles progressively grow primaries P1 through P10. Juvenal primaries 9 and 10 emerge at about 21–24 days of age, at approximately the same time that juvenal primary one is replaced (molted; Pyrah 1963). As juveniles mature, they replace their juvenal primaries starting with P1. Because juveniles grow rapidly, juvenal primaries 9 and 10 will be fully grown about the time juvenal P6 is being replaced. A key feature of the juvenal molt is that juvenal primaries 9 and 10 are normally not replaced and retain the characteristics of a juvenal primary (relatively pointed) until replaced in August or September of the next year. The last secondary to molt in juveniles is S1 and its pointed appearance is diagnostic if it is still present; juvenal S1 is normally replaced when P8 is about 25%–50% grown. The molt in yearlings and adults is simpler because they replace all 10 primaries in sequence from P1 to P10 and they would not have a pointed S1.

Measurements were taken with a flexible millimeter ruler of fully grown primaries from the proximal side of the insertion point from the bases of primary feathers (skin) to the tip of the target primary. Thus, length of P10 was measured from the base of the feather between P10 and P9 to the top of P10, P9 was measured by placing the ruler between P9 and P8, etc. In Colorado (both greater and Gunnison sage-grouse), P1 was measured by placing the ruler between P1 and P2, rather than between P1 and S1. Comparison of these two methods with measurements of 42 birds in Oregon showed that the former method produced measurements that averaged 6.8 mm shorter (SD = 2.6 mm) than the latter method. In these situations, it is important to compare measurements that were obtained using the same technique. All feather measurements were examined and compared with simple statistics (means, SDs, and ranges; Fig. 1 and Fig. 2). Data from multiple studies were brought into this key to make it more applicable across the range.

## USE OF THE KEY

The key (Fig. 1) is designed for classification of sex and three age classes of wings. Although the key is primarily designed for wings collected during autumn harvest, it can also be used for intact birds or wings at other seasons. Wings in spring are simpler because of the lack of complexities associated with molt. For example, in spring there would only be two age classes—adults and yearlings—because juveniles would not be present in the population at that time of year. In spring, the presence of a pointed P9 and P10 in most cases, or at least a pointed P10, would be indicative of a yearling (Dalke et al. 1963, Schroeder et al. 1999).

Wings can be frozen, dried, or fresh (unfrozen) but are easiest to use if they have been thawed or are fresh. Although sex and age for most wings can be ascertained without measurement, a flexible millimeter ruler with a minimum length of 240 mm can aid the process and clarify wings that are ambiguous. Primary feathers should be examined for relative degree of fading, wear, and pointedness (Fig. 1). Measurements need only be taken for a feather or feathers to clarify sex and age. Identification of males and females is relatively simple because of the size difference in all age categories (females are markedly smaller than males). Sage-grouse captured in Oregon and Washington exhibited

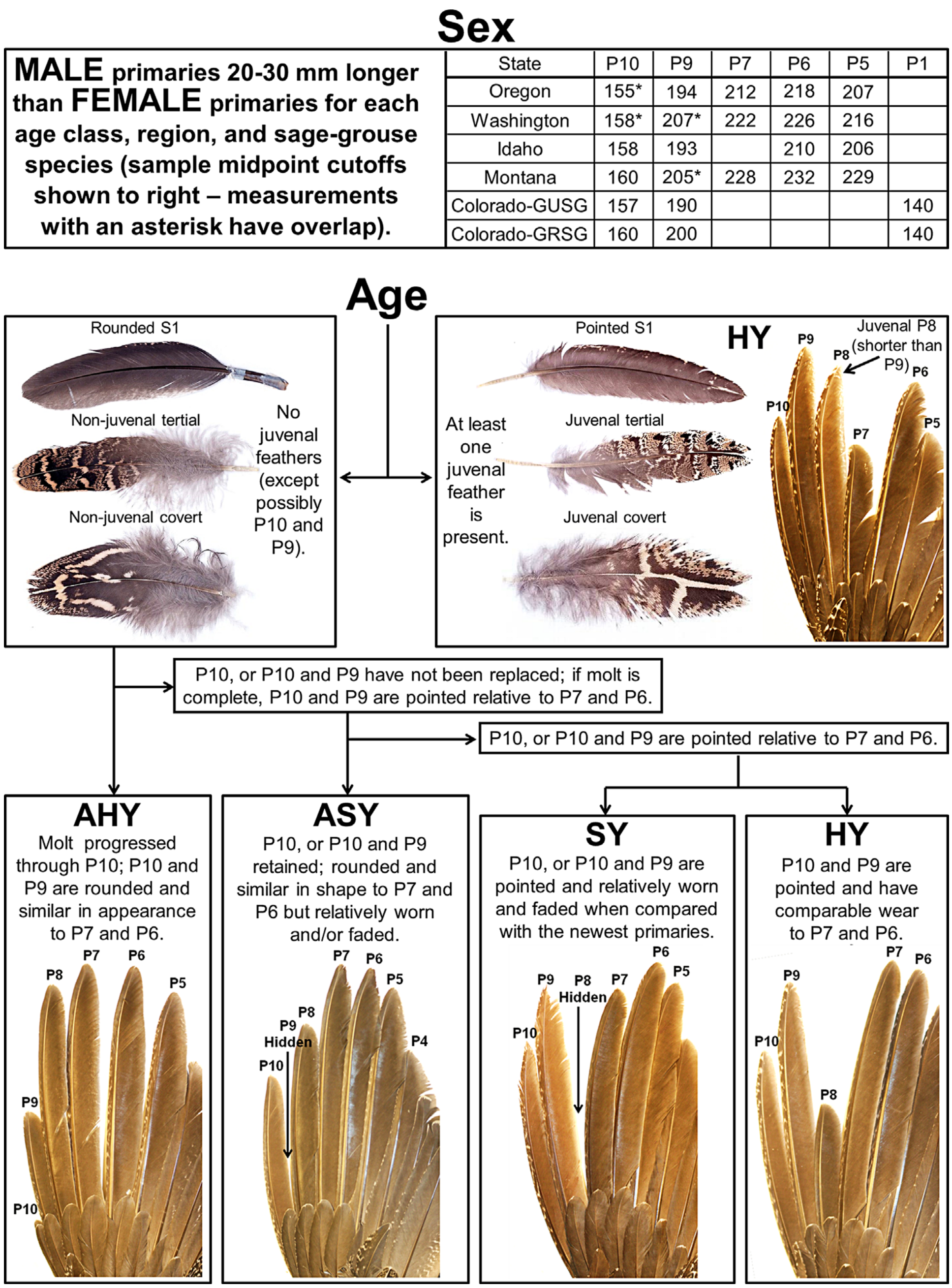


**Figure 1.** Flowchart for identification of sex and age of sage-grouse based on appearance and measurements of wings. Sample measurements for cutoff points for sex were obtained from Oregon (2008–2012), Washington (1992–1997), Idaho (Dalke et al. 1963), Montana (Eng 1955), and Colorado (Beck et al. 1975; 1973–1990) in the United States. Multiple measurements are provided in case some feathers are being molted. Primaries were not flattened and straightened in Idaho; and primaries were measured by placing the ruler between the measured feather and the next proximal feather except for P1 in Colorado, which was measured by placing the ruler between P1 and P2. GUSG refers to Gunnison sage-grouse, GRSG refers to greater sage-grouse.

no overlap in measurements of P5, P6, P7, and P8 (minimal overlap in P9 and P10), regardless of age (Fig. 2). Primary measurements also differed by age within each sex (Fig. 2), but there was some overlap for most primaries (least amount of overlap for P1 and P2). In Washington, only 1 of 38 measured males had an overlapping primary measurement for P2 (adults >157 mm, yearlings ≤157 mm); there was no overlap for P1 in males (adults >151 mm, yearlings ≤151 mm), or P2 (adults >136 mm, yearlings ≤136 mm) and P1 (adults >131 mm, yearlings ≤131 mm) in 84 females. Care must be taken to identify primaries that are missing, shot, or being molted (identifiable by a sheathed base), and therefore difficult to count and unreliable to measure.

The key can be used to differentiate between age classes and molt situations that are somewhat ambiguous. Some difficulties may arise when separating juveniles from yearlings. These difficulties are minimal if unambiguous juvenal feathers are retained (pointed S1, pointed P8, and juvenal tertials and/or coverts; Fig. 1). Even if diagnostic

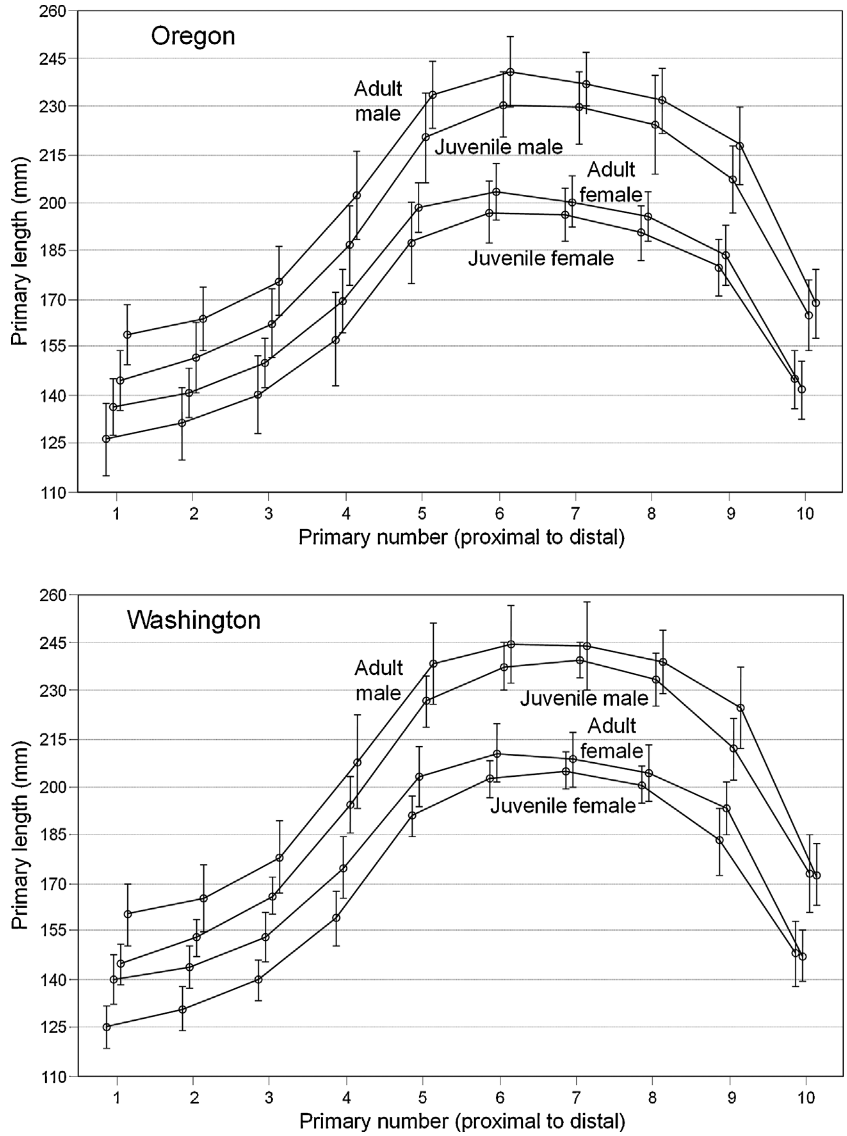


**Figure 2.** Length of fully grown primaries by sex and age for spring-captured greater sage-grouse in southeastern Oregon, USA (top, $n = 277$ wings, 2008–2012 fewer measurements available for some primaries) and north-central Washington, USA (bottom, $n = 122$ wings, 1992–1997, fewer measurements available for some primaries). Juvenal feathers are from a yearling wing prior to molt (spring following hatch). The small circles represent the means for each category and the vertical bars represent the 95% confidence interval for measurements (not the CI for the means, which would be smaller).

feathers are present, they are often present with non-diagnostic feathers (Fig. 3). There is also little ambiguity once a juvenile has almost completely replaced P8 without replacement of juvenal P9, as would normally happen with a yearling. The difficulties occur in the transition period between the previous two examples. Care must be taken in these cases to examine the appearance of P9 and P10 (not as worn and faded for juveniles as year-old feathers would be for yearlings). When the appearance of P9 and P10 are ambiguous, measurements of primaries can be used. For example, the average difference in length of P1 was about 12 mm in Oregon and 15 mm in Washington (yearlings longer within each sex; Fig. 2). It is also possible for juveniles to occasionally molt through juvenal P9, as opposed to P8. This issue appears to be minimal, but has not been quantified. The opposite situation can occur with SY and ASY females when they do not molt through P10 (Fig. 4). It is not clear why this situation (molt suspension) occurs, but it may be related to late nesting. Biologists should pay attention to these ambiguities because they can influence sex and age identification. Sample sizes in each category should be recorded along with molt schedules and, depending on data requirements (i.e., estimation of hatching dates), length of the most recently replaced (molted) growing adult primary (usually P8 or P7) for juveniles.

# DISCUSSION

Accurate identification of age classes improves the opportunities for the study of population dynamics. This is particularly important for sage-grouse because of differences in productivity and survival between yearling and adult age classes (Connelly et al. 2011*a*). Use of the appearance of P9 and P10 to separate age classes of prairie grouse was reported by Petrides (1942), Wright and Hiatt (1943), and Ammann

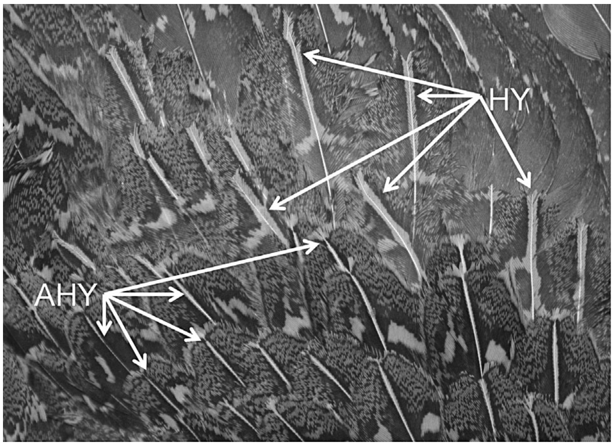


**Figure 3.** During the molt it is common to see HY (juvenile) and AHY (breeding-age) coverts on the same wing. Juvenile coverts are often notched at the tip.

(1944); and specifically for sage-grouse by Patterson (1952) and Eng (1955). However, these authors made no attempt to separate yearling and adult age classes. In previous research in Nevada, Oregon, and Utah, and in low-elevation areas of Colorado, few yearlings could be identified in harvest samples after mid-September. This is because replacement of primary feathers follows completion of breeding activities for males and nesting activities of females. Yearling males cease breeding activities prior to adults (Eng 1963) and initiate molt of primaries 7–14 days before adult males. Thus, in areas where breeding activities peak in March, few yearling males will be identifiable in the harvest after 7–10 September. Regardless of whether a bird is a yearling or adult, once birds have completed their molt, or P10 is in the process of being replaced, yearlings and adults will be indistinguishable from each other. In these cases, birds should be combined into a breeding-age category (AHY) as indicated in the key. Although some may consider all of these birds to be adults (ASY), this is technically incorrect because some of these birds are yearlings (SY). From a management perspective, it is important to be both accurate and consistent with identification of age. For example, comparison of yearlings and adults requires that the adult category actually be adults (ASY) and not adults and yearlings combined (AHY).


**Figure 4.** Appearance of unmolted (suspended molt) outer primaries of an autumn-harvested adult female greater sage-grouse that only molted through P5. Note the faded appearance of the outer 5 primaries. The frequency of this type of molt is unknown, but is clearly uncommon.

Replacement of primary feathers usually begins in adult females following termination of nesting effort. Because yearling females may be less successful in nesting than adults (Connelly et al. 2011*a*), many yearlings have advanced primary molt schedules when compared with adults harvested at the same time. Successfully nesting yearling and adult females have similar primary molt schedules. One possibility that has been suggested (C. E. Braun, unpublished data) is that, depending upon timing of nesting activities (which is related to amount of snow cover, elevation, etc.), females in which the newest growing primary is P9, or more proximal, can be considered as successful in hatching their clutch; whereas, females with a more advanced molt can be considered as unsuccessful in hatching their clutch. This suggestion has not been validated for a sufficient sample of females with a known reproductive history.

There has been little quantification of anomalies in patterns of molt in sage-grouse. From the work we have done, molts through P9 in HY birds and incomplete molts in ASY females appear to be the most common. Unfortunately, these have not been quantified, in part because biologists are not recording these data. It is possible that some of these situations are missed because biologists do not know what to examine and describe. It is likely that other types of anomalies occur. For example, it is possible for sage-grouse to lose feathers and/or be injured during interactions with predators; these interactions most certainly would result in variations in molt schedules.

The key we have developed is useful for identifying sex and age from wings of sage-grouse throughout the range of the species with one minor adjustment. There is regional variation in size, and identification of sex should be adjusted for minor amounts of regional variation in primary lengths. Although our key does not have exact measurements for every region, in fact they are not needed. The size differences are so substantial that males and females can easily be separated with little risk of error. This risk can be further minimized by separation of age categories first and then separation by sex (large birds vs. small birds). In addition, if the sample size guideline of ≥100 wings in Connelly et al. (2003*b*) is followed, there should be no risk of confusing a male with a female, regardless of age. Even with the smaller size of Gunnison sage-grouse, this key has been useful.

The fundamental components of the key have been used since the late 1970s and have been tested by examination of hunter-harvested and intact sage-grouse in California, Nevada, Oregon, Utah, and Wyoming. It is reliable for classifying sex and age because <3% of the wings examined (≥60,000 since development) have been unclassifiable because of condition of the wing. It is useful for wings under most conditions (dried, partially disintegrated, frozen, stained, etc.), and it is easily understood and applied by relatively inexperienced personnel.

## ACKNOWLEDGMENTS

We thank the many hunters who allowed examination and collection of data from sage-grouse they harvested. Collection of wings was facilitated by Area and Regional personnel of the Colorado Division of Wildlife. We especially thank T. D. I. Beck for help in the developmental stages of the sage-grouse harvest data-collection system in Colorado, and R. W. Hoffman for help throughout. Many different individuals assisted with operation of check stations, collection of wings, and data tabulation. We thank all who have been involved since 1973–1974. This manuscript was improved by the reviews of T. D. I. Beck, J. R. Young, J. W. Connelly, two anonymous reviewers, and the Associate Editor. The cooperation of wildlife agencies in California, Nevada, Oregon, Utah, and Wyoming is appreciated. This is a contribution from Colorado Federal Aid in Wildlife Restoration projects W-37-R and W-167-R and Washington Federal Aid in Wildlife Restoration project W-96-R.

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*Associate Editor: M. Peterson.*