Reliability of Established Aging and Sexing Methods in Ruffed Grouse

Peter I. Kalla,[1] *Department of Forestry, Wildlife, and Fisheries, The University of Tennessee, Knoxville, TN 37901*

Ralph W. Dimmick, *Department of Forestry, Wildlife, and Fisheries, The University of Tennessee, Knoxville, TN 37901*

Abstract: Published methods for aging and sexing ruffed grouse (*Bonasa umbellus*) have not been tested on a large sample of birds from the Southeast. We evaluated several methods in a hunter-donated sample of 268 birds from eastern Tennessee. Age and sex determined by individual techniques were compared to necropsy findings. Results of aging techniques ranged from 3.3% to 39% error. Sexing error ranged from 1.3% to 24%. Results were generally not as accurate as those reported from the northern United States due largely to juveniles with adult traits and females with male traits. Use of most traditional methods may lead to underestimates of juveniles and females. The sample was classified 39% juvenile and 45% female.

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Methods to determine age and sex of ruffed grouse were developed using birds in the northern United States and Canada. There have been few studies of the reliability of these techniques for birds inhabiting southern portions of the species' range. Harris (1981) aged grouse from Georgia using feather measurements developed by Dorney and Holzer (1957) in Wisconsin and by Davis (1969) in Ohio. Servello (1985) sexed grouse from Virginia using techniques based on plumage characteristics developed by Hale et al. (1954) in Wisconsin and by Roussel and Ouellet (1975) in Quebec. Sample sizes were small in both investigations. These authors recommended further study to assess validity of these methods for ruffed grouse from the southeastern United States.

The southern Appalachian region is the southeastern periphery of ruffed grouse range (Johnsgard 1983:253). There the brood-rearing season begins a month earlier than in the northern United States and Canada (Longwitz 1985).

[1] Present address: U.S. Environmental Protection Agency, WMD-WS, 100 Alabama St., Atlanta, GA 30303.

Moreover, most southern grouse hunting occurs in winter (January and February). Consequently, juveniles are older when harvested. This difference may affect reliability of criteria used for aging and consequently accuracy of age ratios and productivity estimates of southern ruffed grouse populations. In this paper we evaluate the reliability in the Southeast of several techniques for aging and sexing ruffed grouse, by applying them to a sample of hunter-harvested birds in Tennessee.

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Methods

Grouse carcasses were contributed by hunters in eastern Tennessee. Birds which could not be examined immediately were frozen in sealed plastic bags.

Age was assigned initially by plumage characters, consisting of the ratio of calamus diameters of the eighth and ninth primaries (Rodgers 1979), length of a central tail feather within the sexes (Davis 1969), length of the longest ruff feather within sexes, shape of the ninth and tenth primaries (Bump et al. 1947:84), and amount of basal sheathing on those feathers (Hale et al. 1954).

Sex was assigned initially according to length of a central tail feather (Hale et al. 1954, Davis 1969), length of the longest ruff feather, completeness of the tail band (Hale et al. 1954), and number of spots on the rump feathers (Roussel and Ouellet 1975).

To evaluate the above techniques, each was used independently to ascribe age or sex. Three other external methods, aging by probing the cloaca for presence or absence of the bursa (Gower 1939, Hale et al. 1954) and sexing by color of the eye patch (Palmer 1959) and length of the central toe (Gullion 1989), also were tested independently.

Quantitative Techniques for Determining Age

Ratio of Calamus Diameters.—The eighth and ninth primaries (P8 and P9) were collected from both wings, dried at 50 C for 24 hours, and scraped free of sheathing with a fingernail. Calamus diameter was then measured to the nearest 0.025 mm with a dial caliper immediately proximal to the first barbs in a plane parallel to the vane. Ratios for each wing were calculated as P9/P8 and then averaged (if all 4 primaries were available). Many carcasses were missing 1 or both primaries on 1 side. To maximize sample size, a pooled data set was created to use data from the 1 wing available on these damaged birds. The data set consisted of averaged ratios from intact grouse combined with ratios for individ-

ual wings taken from damaged carcasses. Using the pooled data set yielded greater accuracy when evaluated as an aging technique than subsets comprised of only the average, left wing, or right wing. The ratio derived as a separation point between age classes was identical for all subsets.

Length of a Central Tail Feather.—The left member of the central pair of rectrices was measured because it consistently overlaid all others, simplifying its removal.

Length of the Longest Ruff Feather.—Total length was acquired by straightening the feather on a ruler.

Qualitative Techniques for Determining Age

Shape of P9.—In difficult specimens, degree of curvature of the trailing edge proximal to the feather tip was used as a corollate of tip shape; nearly straight, worn edges were associated with the pointed tips of unmolted juvenal feathers. In the most difficult cases, P9 was compared to P8 from the same wing under a dissecting microscope to ascertain if P9 was more worn than P8, indicating that P9 was not recently molted. The tenth primary was disregarded because of the heavy wear incurred on this feather in all birds.

Amount of Basal Sheathing on P9.—P9 was compared to P8. Birds with less sheathing on P9 were considered juveniles. No specimens were completely devoid of sheathing on P9; those with <2 mm remaining were arbitrarily classified as juveniles.

Presence or Absence of the Bursa.—The cloaca was probed with a 1-mm diameter glass rod to detect existence of a bursa. When present, this organ was discernible as a dorsal evagination of the cloacal wall. Any grouse with a bursa was considered juvenile.

Quantitative Techniques for Determining Sex

The tail and ruff length methods are discussed above.

Length of the Central Toe.—Lengths were taken from both feet and averaged. The foot was pressed down on a hard, flat surface so that the toes were in a plane perpendicular to the long axis of the tarso-metatarsus. A ruler was placed along the top of the toe with the zero mark abutting the angle formed by toe and tarso-metatarsus. The claw was excluded from the measurement.

Qualitative Techniques for Determining Sex

Completeness of the Tail Band.—Both central tail feathers were examined to categorize the tail band. Any band not clearly complete or incomplete was classified intermediate.

Number of Spots on the Rump Feathers.—Feathers immediately anterior to the upper tail coverts were used to count spots. Indistinct spots were considered not countable. Because atypical spot patterns were observed occasionally on individual feathers, several feathers were examined to avoid sampling error.

Color of the Eye Patch.—The patch of bare skin over each eye was in-

spected to characterize presence and intensity of orange pigment. All grouse with a slight to moderate amount of color were considered intermediate between Palmer's (1959) "vivid" and "no color" categories.

Analysis

After applying all external methods, birds were necropsied to determine actual age and sex by internal anatomy. Age class could not be known with certainty for any of the birds, but presence or absence of a bursa (Gower 1939) was accepted as the best evidence of age in either sex. In females, condition of the ovary (Lofts and Murton 1973) was used as an additional means of confirming age. Results of each external method were then compared to necropsy findings. Percentage of birds classified in error was calculated for each method.

Separation points and error rates for measured variables were derived from discriminant analysis procedures in PC-SAS (SAS Inst. 1985). Most other data analyses were done with microcomputer programs in the Statgraphics package (STSC 1987). Normality and homoscedasticity of numeric data were evaluated using skewness and kurtosis, chi-square goodness-of-fit, Kolmogorov D, Cochran's C, Bartlett's and Hartley's tests. Analysis of variance or the Mann-Whitney U test (as an alternative nonparametric method) was used to detect differences between sex and age class means and to allow pooling of some data. Qualitative characters were tested with Chi-square contingency analysis.

Because there was no statistically significant difference between sexes for the ratio of calamus diameters ($F = 0.32$, $P = 0.58$), sexes were pooled for analysis of that method. Though there were differences between age groups within sex for tail and ruff length, distributions for pooled ages within sex were normal. This consideration allowed using discriminant analysis to study these sexing methods with ages pooled (SAS Inst. 1985). Ages also could be pooled for analysis of toe length (Mann-Whitney $U = -0.11$, $P = 0.91$).

Results

We obtained 268 carcasses from October 1983 to February 1988. Not all age and sex characters were available on every grouse because many birds were damaged by gunshot or hunting dogs. Most of the birds (229, 85% of the sample) were shot in the 1983–84 hunting season. Though grouse were taken in all 5 months of the season, 160 (69%) of the 230 birds whose date of harvest was known were shot in January and February. Average weights for the 75 specimens from the 1983–84 season were 592 g for females and 715 g for males (overall range 500–835 g). All birds were the red color phase.

Aging

Actual age was determined by internal anatomy for 118 grouse (44% of the sample). Initial age was assigned incorrectly in 8 grouse (7%) whose actual age was available. Seven of these were juveniles aged as adults.

Table 1. Measurements, accuracy, and separation points for quantitative age determination methods applied to ruffed grouse collected in eastern Tennessee from October 1983 through February 1988.

Method	Min.–Max. (mm)[a]	Overlap (mm)[a]	Error (%)	Separation point[b] (mm)[a]
P9:P8 Calamus diameters		.12	20	.89
Adult	0.80–1.04			
Juvenile	0.80–0.91			
Tail length				
Males		24	21	175
Adult	164–204			
Juvenile	150–187			
Females		21	32	148
Adult	134–166			
Juvenile	135–154			
Ruff length				
Males		24	39	81
Adult	72–103			
Juvenile	59–95			
Females		42	38	58
Adult	48–77			
Juvenile	54–89			

[a]P9:P8 Calamus diameters is a ratio. [b]Adults measure ≥ number shown.

We measured 58 bursae upon excision. Through the season, these measurements ranged from 14 mm in a bird taken in early November to 1 mm in early January. The highly atrophied bursae found in January indicated that presence or absence of this organ was usable for aging grouse conclusively only through December. Similarly, the virgin ovary of juvenile females remained consistently distinguishable from that of regressed adults only through December.

Based on plumage, the age ratio of the sample was 64 juveniles:100 adults. Monthly age ratios were 79:100 in the pooled fall months, 64:100 in January, and 56:100 in February. The January ($X^2 = 4.26$, $P < 0.05$) and February ($X^2 = 7.68$, $P < .01$) ratios differed from 1:1.

Quantitative methods produced error rates of 20% for calamus diameter ratio, 21% and 32% for tail length among males and females, respectively, and 39% and 38% for ruff length among males and females, respectively (Table 1). Error was high despite significant differences ($P < 0.01$) between age-sex group means (Table 2), because group frequency distributions overlapped broadly (as exemplified by calamus diameter ratio, Fig. 1). We used actual age to sort the tail and ruff length data sets for a second analysis of these characters, which were sorted originally by initial age to maximize sample sizes, but saw no appreciable improvement in error rates.

Qualitative techniques yielded greater accuracy, but were frequently unusable. For example, only 31% of the sample was obtained in fall, and only 38

Table 2. Statistics for quantitative age determination methods applied to ruffed grouse collected in eastern Tennessee from October 1983 through February 1988.

Method	Mean (mm)[a]	Standard deviation	Coefficient of variation	Sample size[b]
P9:P8 Calamus diameters[c]				
Adult	.91	.04	4.4	30
Juvenile	.85	.03	3.5	53
Tail length				
Males[c]				
Adult	184	8	4.3	73
Juvenile	172	8	4.7	42
Females[c]				
Adult	149	7	4.7	52
Juvenile	145	4	2.8	41
Ruff length				
Males[c]				
Adult	89	6	6.8	93
Juvenile	84	6	7.2	49
Females[d]				
Adult	63	4	7.0	61
Juvenile	61	5	8.9	47

[a]P9:P8 Calamus diameters is a ratio.
[b]Tail and ruff based on preliminary age and confirmed sex.
[c]Means different between age classes (ANOVA; $P < .001$).
[d]Means different between age classes (Mann-Whitney U; $P < .01$).

grouse collected in January and February had a bursa. Consequently, presence or absence of the bursa could not be used to classify 53% of the available birds (those having an intact cloaca and a known date of harvest) (Table 3). However, the bursal probing technique was the most accurate aging method overall, generating a misclassification rate of 3.3%.

Many grouse had the adult trait for primary shape or primary sheathing on one wing and the corresponding juvenile trait on the other. These equivocal birds were considered unclassifiable and comprised 19% and 7% of the grouse on which these characters were available, respectively (Table 3). Juveniles outnumbered adults among these birds by ratios of 3:1 for shape and 9:1 for sheathing. Despite significant associations between age class and corresponding class trait ($P < 0.001$), 9.4% and 13% of the classifiable birds of confirmed age were misclassified by shape and sheathing, respectively.

Sexing

Actual sex was determined by necropsy for 264 grouse (99% of the sample). Less than 1% of those birds were sexed incorrectly using plumage.

Based on plumage, the sex ratio was 81 females:100 males. Monthly sex ratios were 92:100 in the fall, 93:100 in January, and 73:100 in February. No ratio departed significantly from 1:1.

Tail and ruff length produced error rates ranging from 1.3% to 6% (Table

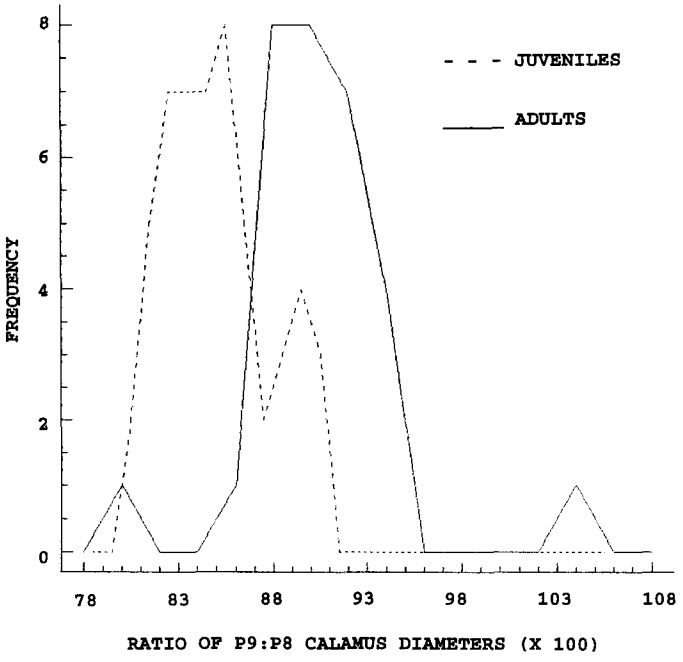

Figure 1. Frequency polygons for the ratio of calamus diameters of the eighth and ninth primaries (P9/P8) of juvenile and adult ruffed grouse collected in eastern Tennessee from October 1982 through February 1988.

Table 3. Utility and accuracy of qualitative age determination methods applied to ruffed grouse collected in eastern Tennessee from October 1983 through February 1988.

Method	Available sample size	Unclassifiable (%)	Uncl. ratio (J:A)	Test sample size[a]	Misclassified (%)
Presence/absence of bursa (by probing)	224[b]	53	—	60	3.3
Primary shape	254	19	3:1	85	9.4
Primary sheathing	262	7	9:1	106	13

[a]From classifiable birds of confirmed age. [b]Date of harvest known, cloaca intact.

4). Error was low because age-sex group frequency distributions overlapped little (as exemplified by tail length within adults, Fig. 2). Pooling ages for males expanded the range of male tail lengths, causing increased overlap and reduced accuracy. Outliers in the juvenile data sets for ruff length expanded their ranges without appreciably increasing overlap. Age-sex group means differed significantly ($P < 0.001$) in all cases (Table 5).

Table 4. Measurements, accuracy, and separation points for quantitative sex determination methods applied to ruffed grouse collected in eastern Tennessee from October 1983 through February 1988.

Method	Min.–Max. (mm)	Overlap (mm)	Error (%)	Separation point[a] (mm)
Tail length				
Adults		3	2.4	165
Male	164–204			
Female	134–166			
Juveniles		5	2.4	155
Male	150–187			
Female	135–154			
Pooled		17	6.0	160
Male	150–204			
Female	134–166			
Ruff length				
Adults		6	1.3	74
Male	72–103			
Female	48–77			
Juveniles		31	4.2	73
Male	59–95			
Female	54–89			
Pooled		31	2.4	73
Male	59–103			
Female	48–89			
Toe length		16	24	40
Male	36–54			
Female	36–51			

[a]Males are ≥ measurement shown.

Mean central toe lengths did not differ between sexes ($P = 0.14$). Due to broad overlap, 24% of the observations were classified erroneously.

Accuracy and utility of qualitative techniques were variable. Indistinct rump spots, intermediate eye patch coloration, and intermediate tail bands rendered 2.5%, 27%, and 27% of the birds, respectively, unclassifiable by these methods (Table 6). Among these grouse, females outnumbered males by 5:1 for rump spots and 6:1 for tail band. Females comprised 42% of birds with intermediate eye patch coloration. Significant associations between sex and sexual trait existed for all methods ($P < 0.001$), but rates of misclassification ranged from 2.6% for rump spots to 7.5% for eye patch and 13% for tail band.

Discussion

Aging Methods

The 0.89-mm separation point for calamus diameter ratio of Tennessee grouse was identical to that reported by Rodgers (1979) for Wisconsin grouse. However, Rodgers (1979) found an error rate of only 5%.

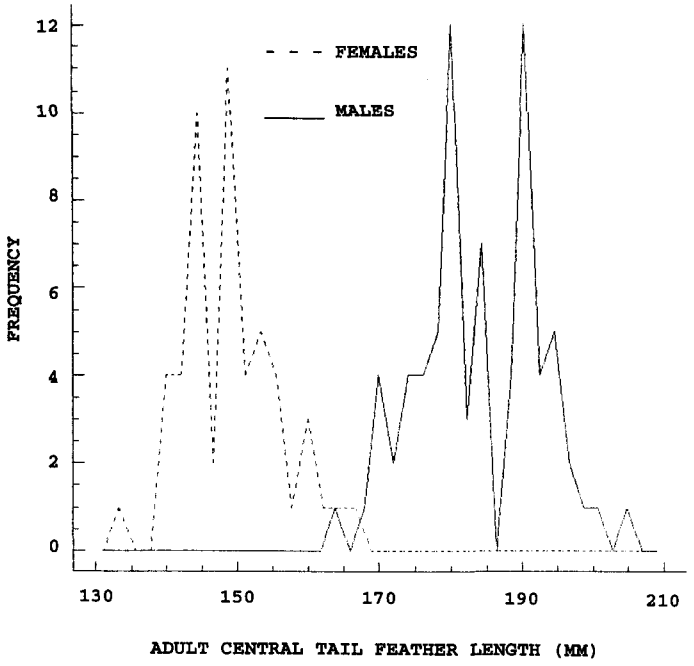

Figure 2. Frequency polygons for total length of the left member of the pair of central tail feathers of adult male and adult female ruffed grouse collected in eastern Tennessee from October 1983 through February 1988.

Feather sheath remnants indicated that 13 of 69 (19%) confirmed juveniles molted their P9s as if they were adults. The post-nuptial molt of P9 produces an adult feather reported to have a calumus diameter larger relative to P8 than does the corresponding juvenile feather (Caldwell 1980). In only 3 of these 13 juveniles, however, did the calamus diameter ratio exceed the separation point. In total, 5 of the 69 (7%) had a ratio greater than the separation point. Two juveniles with a large P9 appeared not to have molted. In contrast, 9 of 39 (23%) confirmed adults that molted had ratios less than the separation point. One adult did not molt and had a small (juvenile ?) P9 from the previous year. These results, particularly the high percentage of molted adults with low ratios, indicate that despite their tendency to molt, juveniles did not contribute proportionally to the error observed for this method. Though adults comprised only 36% of the test group, adults erroneously classified as juveniles accounted for 67% of the errors.

Analysis of Davis' (1969) data for central tail feather length in Ohio shows that he would have obtained misclassification rates similar to ours if he had derived a single separation point for each sex. If we presume that the frequency distributions of his tail lengths by age-sex group were normal and of equal sample size, Davis' points would have occurred midway between age class means.

Table 5. Statistics for quantitative sex determination methods applied to ruffed grouse collected in eastern Tennessee from October 1983 through February 1988.

Method	Mean (mm)	Standard deviation	Coefficient of variation	Sample size
Tail length[a]				
Adults				
Male	184	8	4.3	73
Female	149	7	4.7	52
Juveniles				
Male	172	8	4.7	42
Female	145	4	2.8	41
Pooled				
Male	180	10	5.6	115
Female	147	6	4.1	93
Ruff length[a]				
Adults				
Male	89	6	6.8	93
Female	63	4	7.0	61
Juveniles				
Male	84	6	7.2	49
Female	61	5	8.9	47
Pooled				
Male	87	6	7.4	142
Female	62	5	8.1	108
Toe length				
Male	42	4	9.6	29
Female	40	5	11.3	25

[a]Means different between sex classes (ANOVA; $P < .0001$). Sample size based on preliminary age and confirmed sex.

Table 6. Utility and accuracy of qualitative sex determination methods applied to ruffed grouse collected in eastern Tennessee from October 1983 through February 1988.

Method	Available sample size	Unclassifiable (%)	Uncl. ratio (F:M)	Test sample size[a]	Misclassified (%)
Rump spots	245	2.5	5:1	235	2.6
Eye patch	243	27	0.4:1	173	7.5
Tail band	217	27	6:1	154	13

[a]From classifiable birds of confirmed sex.

For males, our point is slightly shorter than his 178 mm; for females our point is slightly longer than his 146 mm. Average lengths of Tennessee birds were shorter than those reported by Harris (1981) from Georgia (particularly in adult males, for which his mean was 195 mm), suggesting that separation points there might be longer than the ones given here for Tennessee. Harris (1981) would have misclassified 2 of 3 known-aged males using either our point or the one inferred from Davis (1969).

The apparent effect of juveniles on accuracy of the tail length method varied by sex. Among males, juveniles misclassified as adults accounted for 63% of observed error. As juveniles comprised only 37% of males, they caused a disproportionately large share of the error. Among females, 67% of the misclassified birds were adults with tails as short as any juvenile. The distribution of juvenile female tail lengths was tighter, having a range, standard deviation, and coefficient of variation approximately half those of all other age-sex groups.

Our interpretation of bursal presence and depth agrees with that of Gower (1939) and Glick (1983), who maintained that this structure is characteristic of juveniles and that it regresses before sexual maturity. In most of our juveniles, the bursa was completely regressed long before the hunting season ended. Accordingly, unlike Hale et al. (1954) in Wisconsin, we regarded any grouse with a bursa as juvenile, and any bird harvested in the fall lacking this organ as adult. Thus there was an unknown-aged segment of the sample consisting of grouse taken in January and February that had no bursa. Only 1 bird shot in winter and lacking a bursa was classified as juvenile on the basis of condition of the ovary.

Hale et al. (1954) used the bursa's depth as a criterion of age. Though we did not, we found their cloacal probing technique usable to demonstrate the bursa's presence or absence.

Our misclassification rate for aging grouse by primary feather shape was considerably higher than the 1% rate reported from Wisconsin by Hale et al. (1954). Half of our error was from adults which had incurred heavy wear on P9 and P10 that is usually associated with unmolted juvenile feathers. Of the 4 juveniles misclassified as adults because their feathers appeared unworn, 2 had sheath remnants indicating they had molted.

Hale et al. (1954) considered presence of sheath scales on P8 combined with absence of such scales on P9 and P10 as conclusive that a bird was juvenile. Of 14 grouse that we misclassified using this method, 13 were juveniles with sheathing present on P9 and P10 characteristic of adults. This finding suggests that in Tennessee many young of the year molt their outermost primaries prior to conclusion of the long-running hunting season.

Implications for Productivity Estimates

The apparent tendancy of many juveniles to molt their primaries like adults may result in these young of the year being classified as adults, particularly if the more accurate qualitative aging methods are used. This systematic error in age determination would lead to underestimates of productivity in the population when such estimates are based on proportion of juveniles.

In addition, harvest was disproportionately greater late in the hunting season. Combined with monthly age ratios that declined through the season, this uneven harvest may bias the age ratio in hunter returns in favor of adults. This bias would compound underestimates of productivity.

Juveniles comprised 39% of our total sample, but even our fall sub-sample

was only 44% juveniles by plumage. This age ratio was less than that reported from the harvest in northern states, e.g., 50%–58% in New York (Bump et al. 1947:513), 53% in Ohio (Davis and Stoll 1973), 50%–61% in Indiana (Major and Olson 1980), and 77% in Wisconsin (Dorney 1963). Our ratio was low enough, even if corrected for potential bias against juveniles, to suggest lower productivity than that of northern populations.

Sexing Methods

Our separation points for tail length yielded only slightly greater accuracy than Servello (1985) obtained in Virginia. He misclassified 6.5% of his sample employing the point developed by Hale et al. (1954) in Wisconsin. They misclassified <1% using 15 cm for both ages. Servello implied that his accuracy would have improved had he used the points recommended by Davis (1969) for Ohio. Davis obtained approximately 1% and 2% misclassification for adults and juveniles, respectively, using a different measurement for each sex within age classes. Combined separation points for each class, estimated from his work (164 mm for adults and 156 mm for juveniles), are nearly identical to ours.

For adults and for pooled age classes, determining sex by ruff length gave us the best results of any method for determining sex or age that we studied. Discriminant analysis of ruff length may have been compromised by outliers in the distributions for juveniles. However, results for juveniles were similar to those of adults, suggesting that the juvenile data sets met the condition of being approximately normal.

Our results for determining sex by rump feather spots are comparable to the high accuracy reported by other authors. Servello (1985) regarded none of the 62 grouse in his sample from Virginia as ambiguous for rump feather spots, and correctly classified all of them using this method. Roussel and Ouellet (1975) misclassified only 1 bird out of 366 (0.27%) in Quebec.

Our error rate for determining sex by eye patch coloration is comparable to the 5.4% obtained by Palmer (1959) in Michigan. Most of his misclassified birds were females with "some pigmentation." All of our error came from 13 hens (17%) that had a vividly colored eye patch.

Our view that grouse with an intermediate tail band are unclassifiable by the tail band method is in accord with the judgement of several authors (Bump et al. 1947:43, Amman 1948 *in* Hale et al. 1954, Hale et al. 1954) who evaluated this technique in northern states. Hale and his co-workers determined that 15% of their sample of 768 birds from Wisconsin had an intermediate band. In their study, females were only twice as likely to have this trait as males.

Hale et al. (1954) classified the remainder of their sample (complete and incomplete tail bands) with 5.2% error. Our error rate was greater because 39% of our hens had a complete band. Contrary to male grouse in New York (Bump et al. 1947:43) and Michigan (Amman 1948), few (2.7%) of the cocks in Tennessee had an incomplete band. Bump et al. (1947:43) and Amman (1948) considered the method unusable because intermediates and males with an incomplete

band were too abundant in their samples. In Tennessee, it is not useful because a high proportion of hens possess intermediate or complete bands.

Conclusions and Recommendations

Even with locally derived separation points for tail length, none of the quantitative methods analyzed in this study were very accurate for aging Tennessee grouse. Probably because of their advanced age, juveniles affected some techniques by appearing as adults. Qualitative age characters also performed poorly. The bursa gave accurate results, but its useability was limited to birds harvested prior to January.

Tail length, ruff length, and rump spots were accurate for sexing Tennessee grouse. To minimize error when using tail length in other southern Appalachian states, it may be necessary to use separation points different than those reported here. Tail band and eye patch were unreliable, and toe length was invalid.

Using accuracy as the primary criterion while considering objectivity and convenience, we ranked the methods in a fixed sequence of integrated steps for application to Southern grouse. A unified hierarchical protocol is recommended particularly for determining age.

Though a bird's age and sex may be determined in as little as 2 steps, the entire sequence may be necessary for the most difficult individuals. Error rates approximating 5% can be obtained efficiently in this manner, but caution is suggested when estimating productivity from age ratios.

The recommended hierarchy of methods is as follows: Determine age by (1) bursa (acceptable in fall, or if present in winter). If the bursa cannot be used, age by (2) primary shape or (3) primary sheathing. If neither of these characters can be used, age by (4) calamus diameter ratio. Determine sex by (5) rump spots. If rump spots cannot be used and age has been determined, sex by (6) tail length or (7) ruff length. If age could not be determined, sex by (8) ruff length or (9) tail length. If neither length is available, sex by (10) eye patch coloration. If the eye patch cannot be used, sex by (11) tail band. If sex can be determined but none of the above aging methods were usable, determine age by (12) tail length or (13) ruff length.

If the best technique can be employed, any accuracy gained by going through additional steps may be too slight to justify the time expended. However, a suite of characters does give better results than even the best single character, as shown by the accuracy of our initial assignment of sex. This contrast applies equally to aging when the bursa cannot be used.

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