SUBSPECIFIC DISCRIMINATION OF CANADA GEESE HARVESTED IN SOUTH DAKOTA

Jeffrey S. Gleason, Scott A. Stolz, and
Jonathan A. Jenks
Wildlife and Fisheries Sciences Department
Box 2140B
South Dakota State University
Brookings, South Dakota 57007

ABSTRACT

Nineteen morphological characters were measured on Canada geese *(Branta canadensis)* (n = 66) obtained opportunistically from hunters during October-December, 1995. We used principle components analysis (PCA) to evaluate 19 separate morphological characters on a model data set of Canada geese (n = 47) harvested in South Dakota. Principle components loadings identified which characters best discriminated between the subspecies and these characters were used to identify a model for discriminant function analysis (DFA). Seven characters were found to be most important by both PCA and DFA. A univariate F-test was significant ($P \leq 0.073$) for all 7 variables tested for the multivariate model (DFA). Classification rate for the model data was 100%; giant (n = 36), interior (n = 4), *B.c. parvipes* (n = 1), and *B.c. hutchinsii* (n = 2). An additional 19 geese were measured as test data for the model. Classification rate for the test data was 89%.

INTRODUCTION

Canada geese are one of the most commonly harvested waterfowl species in North America, comprising 63% (1969-88) of the total goose harvest (Trost et al., 1990). Canada goose harvest estimates have continued to increase in South Dakota peaking in 1995 (n = 73,377), the highest estimated total since the surveys inception (Sharp, 1995). The Central Flyway, of which South Dakota is a part, generally ranks second among the 4 flyways in the number of wintering geese and their harvest (Kraft and Funk, 1990). Four management populations (Eastern Prairie Population, Western Prairie Population, Tallgrass Prairie Population, and Shortgrass Prairie Population) of Canada geese migrate through South Dakota enroute to southern wintering areas (Fowler, 1972; Bellrose, 1976). The 5 Canada goose subspecies that comprise these management populations are the giant *(B. c. maxima)*, interior *(B. c. interior)*, great basin *(B. c. moffitti)*, lesser *(B. c. parvipes)*, and Richardson's *(B. c. hutchinsii)* (Fowler, 1972; Bellrose, 1976).

According to Pettingill (1985), measurements of birds have 3 general purposes; first, to aid in systematic studies, second, to determine differences between sexes, and third, to measure the growth of young. Numerous studies have been conducted to determine the best method of aging and differentiating subspecies of Canada geese (Johnson et al., 1979; Tacha et al., 1987; Tacha et al., 1989; Moser and Rolley, 1990; Merendino et al., 1994). Fowler (1972; 1974; 1975) determined yearly trends in size-class composition, and sex and age ratios for Canada geese harvested in 12 counties (Campbell, Walworth, Dewey, Potter, Sully, Stanley, Hughes, Lyman, Buffalo, Brule, Gregory, and Charles Mix) along the Missouri River, South Dakota. Measurements taken to separate ratios of large to small Canada geese were culmen, tarsus, body weight, and middle tail feather length. Proportion of large Canadas varied for all years of the study ($\bar{x}$ = 61%, range 29% - 94%). The author also noted a geographical difference in size ratios, with a decreasing proportion of large geese from north to south.

Currently, harvest estimates of Canada geese are obtained from tail fans as a component of the U.S. Fish and Wildlife Service's Parts Collection Survey. The middle rectrix is measured (adult large ≥ 156 mm, adult small ≤ 155 mm) and the individual is classified as either large or small based on this measurement. Our objective was to determine if length and shaft diameters of the 8th, 9th, and 10th primaries, as well as the middle rectrix could be used as accurate morphological characters for discrimination of Canada goose subspecies.

METHODS

Canada geese were collected (2 October–10 December 1995) opportunistically from hunters in 9 counties in eastern and central South Dakota (Brookings, Brown, Clark, Deuel, Haakon, Kingsbury, Lake, Stanley, and Sully). Announcements describing the study were strategically placed around Brookings, South Dakota. The whole bird was preferred; however, in cases where the whole bird could not be obtained the head, left foot, left wing, and tail were collected. We used visual cues (i.e., size and breast and neck feather coloration) as a preliminary method of Canada goose subspecies separation. We determined sex by cloacal (Hanson, 1962) and/or internal examination (Pettingill, 1985) and age by external characteristics such as breast and neck feather coloration, primary feather shape and wear, rectrix notching, and presence or absence of wing spurs (Hanson, 1962; Marquardt, 1962; Higgins and Schoonover, 1969; Caithamer et al., 1993).

We measured 19 morphological characters using an electronic digital caliper (± 0.1 mm) and a metric tape (± 1.0 mm). In an attempt to reduce observer bias, only the second author took measurements on all geese. Culmen 1 (distance from the distal tip of the bill to the V-point where the integument meets the horny portion of the mandible), culmen 2 (distance from the distal tip of the bill nail to the proximal tip of the posterior lateral extension of the upper mandible), bill width, skull length, total tarsus length, tarsus bone length, mid-toe length, mid-toe nail length, body length and flat wing length were measured following guidelines of Dzubin and Cooch (1992). In addition, we measured 9 other characters. These included skull width (distance across the head including skin and feathers at the temporal canthus) (Pettingill, 1985), the length of the 8th, 9th, and 10th primaries and the middle rectrix (proximal end of the calamus to the distal end of the vanes), and the shaft diameter of these same feathers at a point 25 mm from the proximal end of the calamus.

We used principle component analysis (PCA) (SYSTAT, Wilkinson, 1990) to evaluate morphological characters for Canada geese harvested in South Dakota (Johnson, 1981). Loadings on the first canonical axis identified which characters best discriminated between subspecies and these characters were used to identify models for use in discriminant function analysis (DFA) (Merendino et al., 1994).

RESULTS

Age and gender composition of our Canada goose sample (n = 66) was 45 subadults, 21 adults, 38 males, and 28 females. Subspecific composition was 53 *maxima,* 7 *interior,* 5 *hutchinsii,* and 1 *parvipes* (Table 1). Differences in subspecific composition may be attributed to hunter preference, hunting method availability, period of the season, county hunted, and differential vulnerability (Higgins et al., 1969; Fowler 1974; Schultz et al., 1988).

Eigenvalues for the first 5 PCA factors were > 0.900. These five factors explained 82% of the total variance in the data set. DFA was conducted on 7 variables (sex, skull length, skull width, culmen 1, culmen 2, mid-toe length, and mid-toe nail length) (Tables 2-5) identified as important in the PCA. DFA correctly classified (Wilks' Lambda = 0.063, df = 21, 95, P < 0.001) all (100%, n = 43) Canada geese to subspecies: maxima (n = 36), interior (n = 4), hutchinsii (n = 2), and parvipes (n = 1). Four geese were not classified to subspecies due to missing parts and were not included in the analysis. Measurements on an additional 19 geese were collected to evaluate the model; however, information obtained for 2 geese did not allow determination of subspecific status.

Table 1. Number of Canada geese by subspecies, sex, and age.

Subspecies	Number	Sex	Age
Maxima	23	Male	Adult
Maxima	8	Male	Subadult
Maxima	12	Female	Adult
Maxima	10	Female	Subadult
Interior	4	Male	Adult
Interior	2	Male	Subadult
Interior	1	Female	Adult
Hutchinsii	1	Male	Adult
Hutchinsii	3	Female	Adult
Hutchinsii	1	Female	Subadult
Parvipes	1	Female	Adult

Table 2. Mean lengths (mm) of 2 skull and 3 bill characters used to classify Canada geese harvested in South Dakota.

Subspecies	Sex	Age	SkLength			SkWidth			Culmen1			Culmen2			BWidth		
			n	x	SE	n	x	SE	n	x	SE	n	x	SE	n	x	SE
Maxima	M	Ad	23	135.4	1.2	23	41.9	0.4	23	60.9	0.6	23	71.6	0.7	22	28.3	0.2
Maxima	M	Su	8	133.1	1.6	8	40.7	0.6	8	60.5	1.4	8	70.6	1.3	8	27.7	0.4
Maxima	F	Ad	12	128.8	1.5	12	40.5	0.4	12	56.6	0.6	12	65.9	1.0	12	27.0	0.3
Maxima	F	Su	10	128.6	1.6	10	39.2	0.6	10	57.4	0.7	10	67.4	1.1	10	26.4	0.4
Interior	M	Ad	4	119.6	3.0	4	38.8	0.8	4	50.0	1.5	4	61.5	1.2	4	26.3	0.6
Interior	M	Su	2	123.7	0.2	2	38.0	0.1	2	55.1	1.3	2	64.1	0.9	2	25.5	1.3
Interior	F	Ad	1	130.2	*	1	37.5	*	1	59.1	*	1	71.2	*	1	25.2	*
Hutchinsii	F	Ad	3	93.3	3.6	3	32.4	0.3	3	36.2	1.9	3	42.7	2.4	3	20.8	0.8
Hutchinsii	F	Su	1	88.5	*	1	29.9	*	1	37.3	*	1	43.6	*	1	19.3	*
Parvipes	F	Ad	1	108.2	*	1	36.3	*	1	48.3	*	1	55.5	*	1	23.9	*

Definitions:

SkLength= Skull length
SkWidth= Skull width
Culmen1= Measurement for culmen 1
Culmen2= Measurement for culmen 2
BWidth= Bill width

Note: For 1 adult male Hutchinsii only the middle tail feather length and diameter were measured.
* Standard errors could not be calculated

Table 3. Mean lengths (mm) of 2 tarsi and 2 halluces characters used to classify Canada geese harvested in South Dakota.

Subspecies	Sex	Age	TTarsus			TarsusB			MToeL			MToeNL		
			n	x	SE	n	x	SE	n	x	SE	n	x	SE
Maxima	M	Ad	13	119.0	1.2	20	98.0	1.4	20	88.2	0.8	20	15.8	0.3
Maxima	M	Su	5	122.0	3.0	8	98.6	2.2	8	86.8	1.2	8	15.0	0.4
Maxima	F	Ad	6	111.8	2.2	11	92.2	1.5	11	82.7	0.9	11	15.4	0.3
Maxima	F	Su	7	113.4	2.5	10	92.8	0.9	10	83.0	0.7	10	15.5	0.3
Interior	M	Ad	1	116.2	*	4	90.3	1.9	4	76.1	1.7	4	13.5	0.6
Interior	M	Su	NM			2	89.5	1.5	2	77.6	3.2	2	12.8	0.7
Interior	F	Ad	NM			1	93.5	*	1	84.6	*	NM		
Hutchinsii	F	Ad	1	85.9	*	2	68.8	3.6	3	57.9	0.1	3	10.6	0.3
Hutchinsii	F	Su	1	81.1	*	1	68.0	*	1	56.0	*	1	8.0	*
Parvipes	F	Ad	1	98.2	*	1	81.2	*	1	70.7	*	1	2.4	*

Definitions:

TTarsus= Total tarsus
TarsusB= Tarsus bone
MToeL= Mid-toe length
MToeNL= Mid-toe nail length

Note: For 1 adult male Hutchinsii only the middle tail feather length and diameter were measured.
* Standard errors could not be calculated
NM No measurements were taken

Table 4. Mean lengths (mm) of 6 primary feather characters used to classify Canada geese harvested in South Dakota.

Subspecies	Sex	Age	P8L			P8D			P9L			P9D			P10L			P10D		
			n	$\bar{x}$	SE	n	$\bar{x}$	SE	n	$\bar{x}$	SE	n	$\bar{x}$	SE	n	$\bar{x}$	SE	n	$\bar{x}$	SE
Maxima	M	Ad	20	389.4	2.9	20	6.4	0.1	20	380.2	2.9	20	6.3	0.1	19	352.1	2.7	20	8.6	2.7
Maxima	M	Su	8	383.4	4.1	8	6.3	0.2	8	371.1	4.2	7	6.1	0.2	8	343.3	4.3	7	5.7	0.1
Maxima	F	Ad	11	376.9	3.8	11	6.5	0.1	11	366.0	4.1	11	6.3	0.1	11	340.0	4.4	11	5.9	0.1
Maxima	F	Su	10	375.1	3.6	10	5.8	0.3	10	365.4	3.6	9	5.9	0.1	10	339.1	3.7	10	5.7	0.1
Interior	M	Ad	4	364.0	9.1	4	6.2	0.2	4	357.5	8.5	4	6.0	0.2	4	331.0	9.3	4	5.6	0.2
Interior	M	Su	2	358.0	6.0	2	6.1	0.1	2	349.5	4.5	2	5.9	0.1	2	306.0	26.0	2	5.7	0.0
Interior	F	Ad	1	371.0	*	1	6.5	*	1	362.0	*	1	6.4	*	1	332.0	*	1	5.7	*
Hutchinsii	F	Ad	3	311.7	6.8	3	5.3	0.1	3	305.3	6.2	3	5.2	0.1	3	284.3	6.3	3	4.9	0.1
Hutchinsii	F	Su	NM			1	5.0	*	1	281.0	*	1	4.9	*	1	257.0	*	1	4.5	*
Parvipes	F	Ad	1	355.0	*	1	5.8	*	1	380.0	*	1	6.0	*	1	350.0	*	1	5.8	*

Definitions:

P8L= 8th primary length
P8D= 8th primary diameter
P9L= 9th primary length
P9D= 9th primary diameter
P10L= 10th primary length
P10D= 10th primary diameter

Note: For 1 adult male Hutchinsii only the middle tail feather length and diameter were measured.
* Standard errors could not be calculated
NM No measurements were taken

True classification rate for the model was 89%; 15 of 17 geese were correctly classified (1 giant and 1 interior were incorrectly classified).

DISCUSSION

Most studies concerning taxonomic separation of Canada geese have been conducted on the breeding grounds (Johnson et al., 1979; Moser and Rolley, 1990; Merendino et al., 1994). The advantage of measuring Canada geese on their breeding grounds versus measuring harvested birds in the fall are twofold; first, a large sample of available birds, and second, the philopatric nature of the species enables separation of subspecific breeding areas (Johnson et al., 1979). In their study conducted in Alaska, Johnson et al. (1979) accurately described 82.9% of 1,156 Canada geese *(B. c. minima, B. c. leucoparia, B. c. taverneri, B. c. parvipes, B. c. occidentalis,* and *B. c. fulva)* using culmen, tarsus, and total tarsus. Merendino et al. (1994) were able to accurately separate (> 99%) breeding interior and giant Canada geese on Akimiski Island, Northwest Territories.

Management of subspecies of Canada geese is often difficult due to mixing on the wintering grounds (Kraft and Funk, 1990). Analysis of tail fans sent in by a random sample of hunters provides an estimate of harvest, age ratios, and ratio of large to small Canada geese (Sorenson et al., 1987). The accuracy of tail fans as an estimator for age ratios has been questioned (Tacha et al., 1987) and these ratios (immatures/adult) are generally considered to be biased low (Caithamer et al., 1993).

Neither PCA nor DFA selected feather characters (i.e., shaft diameters and lengths of the 8th, 9th, and 10th primaries, as well as the middle rectrix) as reliable variables for subspecies discrimination. The variables we used to discriminate subspecies in the DFA were "hard" characters (characters which do not change within individuals as a function of age, length of time the bird is held, or time of year the bird is measured) (Dzubin and Cooch 1992). Results indicate that use of these 7 characters in conjunction with principle components analysis and discriminant function analysis should provide an accurate method of subspecific separation of Canada geese harvested in South Dakota.

Accurately estimating composition of mixed subspecies flocks of Canada geese may result in regulations specifically tailored for areas of the country in which geese from many populations breed, migrate, or winter (Moser and Rolley, 1990). As local, urban giant Canada goose populations continue to increase, harvest regulations that allow for harvest of a specific subspecies will maximize recreational opportunities while protecting migratory flocks.

ACKNOWLEDGEMENTS

We thank the many individuals who donated geese. We would like to thank T. Symens, D. Franke, and R. Doorenbos for their computer assistance. Reviews of earlier drafts of this manuscript were done by R. Johnson and K. Higgins. This project was supported by South Dakota State University and the South Dakota Cooperative Fish and Wildlife Research Unit in cooperation with the U.S. Fish and Wildlife Service, South Dakota Department of Game, Fish and Parks, and the Wildlife Management Institute.

LITERATURE CITED

Bellrose, F. C. 1976. *Ducks, geese, and swans of North America,* 3rd edition. Stackpole Books, Harrisburg, PA.

Caithamer, D. F., R. J. Gates, J. D. Hardy, and T. C. Tacha. 1993. Field identification of age and sex of interior Canada geese. *Wildl. Soc. Bull.* 21:480-487.

Dzubin, A., and E. G. Cooch. 1992. Measurements of geese: general field methods. Calif. Water. Assoc. Sacramento, CA.

Fowler, R. M. 1972. Investigation of Canada geese, using Missouri River impoundments in South Dakota: 1971-72. South Dakota Dept. Game, Fish and Parks, Annual Report, Pierre.

Fowler, R. M. 1974. Investigation of Canada geese, using Missouri River impoundments in South Dakota: 1973-74. South Dakota Dept. Game, Fish and Parks, Annual Report, Pierre.

Fowler, R. M. 1975. Investigation of Canada geese, using Missouri River impoundments in South Dakota: 1974-75. South Dakota Dept. Game, Fish and Parks, Annual Report, Pierre.

Hanson, H. C. 1962. Characters of Age, sex, and sexual maturity in Canada geese. Ill. Nat. Hist. Surv. Biol. Notes 49. 15pp.

Hanson, H. C.. 1965. *The giant Canada goose.* Southern Illinois Univ. Press, Carbondale, IL.

Higgins, K. F., and L. J. Schoonover. 1969. Aging small Canada geese by neck plumage. *J. Wildl. Manage.* 33:212-214.

Higgins, K. F., R. L. Linder, and P. F. Springer. 1969. A comparison of methods used to obtain age ratios of snow and Canada geese. J. Wildl. Manage. 33:949-956.

Hochbaum, H. A. 1942. Sex and age determination of waterfowl by cloacal examination. *Trans. N. Am. Wildl. Nat. Resour. Conf.* 7:299-307.

Johnson, D. H. 1981. The use and misuse of statistics in wildlife habitat studies. Pages 11-19 IN D. E. Capen, ed. *The use of multivariate statistics in studies of wildlife habitat.* U.S. Dept. Agric., For. Serv. Den. Tech. Rep. RM-87.

Johnson, D. H., D. E. Timm, P. F. Springer. 1979. Morphological characteristics of Canada geese in the Pacific Flyway. Pages 56-80 IN R. L. Jarvis, and J. C. Bartoneck, eds. Management and biology of Pacific Flyway geese- a symposium. Oregon State Univ. Book Stores, Inc., Corvallis, OR.

Kraft, M. J., and H. D. Funk. 1990. Goose management in the '90s: a central flyway perspective. *Trans. N. Am. Wildl. Nat. Resour. Conf.* 55:321-326.

Marquardt, R. E. 1962. Ecology of the migrating and wintering flocks of the small white-cheeked geese within the south central United States. Ph.D. Thesis. Oklahoma State Univ., Stillwater.

Merendino, T. M., C. D. Ankney, D. G. Dennis, J. O. Leafloor. 1994. Morphometric discrimination of giant and Akimiski Island Canada geese. *Wildl. Soc. Bull.* 22:14-19.

Moser, T. J. and R. E. Rolley. 1990. Discrimination of giant and interior Canada geese of the Mississippi Flyway. *Wildl. Soc. Bull.* 18:381-388.

Pettingill, O. S., Jr. 1985. *Ornithology in laboratory and field.* 5th ed. Academic Press, Inc., New York, NY.

Schultz, D. F., J. A. Cooper, and M. C. Zicus. 1988. Fall flock behavior and harvest of Canada geese. *J. Wildl. Manage.* 52:679-688.

Sharp, D. E. 1995. Central flyway- harvest and population survey data book. U.S. Fish Wildl. Serv., Off. Migr. Bird Manage., Denver, CO.

Sorenson, M. F., S. M. Carney, and E. M. Martin. 1987. Age and sex composition of ducks and geese harvested in the 1986 hunting season in comparison with prior years. U.S. Fish Wildl. Serv. Adm. Rep., Off. Migr. Bird Manage., Laurel, MD.

Tacha, T. C., D. D. Thornburg, and R. A. Williamson. 1987. Bias of tail-fan surveys for estimating Canada goose age ratios. *Wildl. Soc. Bull.* 15:533-534.

Tacha, T. C., D. D. Thornburg, and R. A. Williamson. 1989. Use of wing-tips to estimate age ratios of Canada geese. *Wildl. Soc. Bull.* 17:146-148.

Trost, R. E., K. E. Gamble, and D. J. Nieman. 1990. Goose surveys in North America: current procedures and suggested improvements. *Trans. N. Am. Wildl. Nat. Resour. Conf.* 55:338-349.

Wilkinson, L. 1990. SYSTAT: the system for statistics. SYSTAT, Inc., Evanston, IL. 676pp.