

MINIMUM SURVEY EFFORT FOR DETERMINING SEX RATIO OF WINTERING AMERICAN KESTRELS IN A LARGE AREA

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Abstract.—Winter roadside surveys of American Kestrels in middle Tennessee revealed that 18 surveys (involving 196 sexed birds) conducted in 1985–1986 provided as precise sex ratio data as 48 surveys (involving 543 birds) and 38 surveys (involving 397 birds) conducted in the same region in 1986–1987 and 1987–1988, respectively; no statistically significant difference among the sex ratios resulting from data collected during the three survey seasons was detected. Furthermore, randomly selected pools of data from the 1985–1986 surveys, when analyzed, showed that precise sex ratio information can probably be generated by as few as 14 surveys (involving at least 176 sexed birds) in an area comparable in size to middle Tennessee.

ESFUERZO MÍNIMO PARA DETERMINAR LA PROPORCIÓN DE SEXOS EN INDIVIDUOS INVERNALES DEL FALCÓN AMERICANO (*FALCO SPARVERIUS*)

Resumen.—Censos de caminos llevados a cabo durante el invierno, sobre poblaciones del falcón americano (*Falco sparverius*) en Tennessee, revelaron que 18 censos (en donde se determinó el sexo de 196 aves) efectuados durante 1985–1986 arrojaron una proporción por sexo tan precisa como 48 (que involucraron 543 aves) y otros 38 censos (que involucraron 397 aves) que se llevaron a cabo en la misma región durante 1986–1987 y 1987–1988, respectivamente. No se encontraron diferencias significativas en las proporciones de sexos de estos falcones durante los tres periodos de estudio. Al analizarse data tomada al azar del periodo de 1985–1986, se encontró además, que se podía generar información apropiada sobre la proporción de sexos de estas aves con tan solo tomar los datos de 14 censos (envolviendo al menos 176 falcones) en un área comparable en tamaño a la estudiada.

Roadside raptor surveys have been conducted for at least 50 years (Nice 1934). Their primary purposes have been to provide an index of the abundance of wintering raptors (Craighead and Craighead 1956, Leopold 1942), to estimate the total populations of birds of prey (Andersen et al. 1985, Woffinden and Murphy 1977), and to analyze habitat and perch

TABLE 1. Middle Tennessee American Kestrel sex ratio data on raptor surveys for 1985–1986, 1986–1987, and 1987–1988.

Winter season	No. of surveys	No. of male (%)	No. of female (%)	No. of unknown	Total
1985–1986	18	111 (56.6)	85 (43.4)	66	262
1986–1987	48	315 (58.0)	228 (42.0)	139	682
1987–1988	38	222 (55.9)	175 (44.1)	119	516

TABLE 2. Three replicates of sex ratio estimates of American Kestrels using randomly selected survey pools compared to the sex ratio obtained for 1985-1986.

No. of randomly selected samples in survey pool	No. of males	No. of females	Total	% Male
1 1st replicate	4	2	6	66.7
2nd replicate	11	8	19	57.9
3rd replicate	4	2	6	66.7
2	5	3	8	62.5
	22	20	42	52.4
	10	3	13	76.9
3	17	9	26	65.4
	11	9	20	55.0
	20	6	26	76.9
4	22	28	50	44.0
	30	25	55	54.5
	21	19	40	52.5
5	49	46	95	51.6
	40	44	84	47.6
	21	17	38	55.3
6	41	43	84	48.8
	34	15	48	70.8
	51	53	104	49.0
7	38	30	68	55.9
	43	29	72	59.7
	50	34	84	59.5
8	36	27	63	57.1
	37	22	59	62.7
	44	21	65	67.7
9	54	49	103	52.4
	74	58	132	56.1
	41	24	65	63.1
10	70	66	136	51.8
	63	51	114	55.3
	67	61	128	52.3
11	59	43	102	57.8
	85	71	156	54.5
	58	38	96	60.4
12	76	62	138	55.1
	74	41	115	64.3
	76	67	143	53.1
13	70	48	118	54.7
	70	48	118	59.3
	82	65	147	55.8
14	96	75	171	56.1
	101	76	177	57.0
	93	70	163	57.0
15	96	80	176	54.5
	103	83	186	55.3
	88	67	155	56.8

TABLE 2. Continued.

No. of randomly selected samples in survey pool	No. of males	No. of females	Total	% Male
16	90	64	154	58.4
	107	81	188	56.9
	104	84	188	55.3
17	100	77	177	56.5
	101	84	185	54.0
	105	82	187	56.1
18 (actual count)	111	85	196	56.6

preferences of raptors (Koplin 1973, Preston 1980). Use of this method to provide sex ratio data is not frequent. During the present study, winter roadside raptor surveys were conducted with a primary goal of determining the sex ratio of wintering American Kestrels (*Falco sparverius*) in middle Tennessee. A secondary result of the study was to suggest the minimum survey effort needed to determine the sex ratio of kestrels wintering in an area the size of middle Tennessee.

METHODS

During the winters of 1985–1986, 1986–1987, and 1987–1988, roadside surveys of diurnal raptor populations were conducted in Tennessee. Eighteen surveys (averaging 127.1 km; range 100–172 km) were conducted during the first winter (Stedman 1986) in middle Tennessee (i.e., between the Kentucky and Alabama borders on the north and south, respectively, and between the Tennessee River and the western escarpment of the Cumberland Plateau on the west and east, respectively). This region, as defined for the purposes of the winter roadside raptor surveys, includes 37 counties and covers 40,600 km². The second season included 48 surveys (averaging 116.3 km; range 100–166 km) (Stedman 1988), and the third field season included 38 surveys (averaging 112.7 km; range 100–151 km) (Stedman, unpublished data).

To conduct a survey, cooperators drove a motor vehicle along 100+ km of unpaved, secondary, and little used primary roads within one county, taking 3–6 h (though they were requested to average about one hour/25 km in the third winter) to cover the route. As part of their duties, cooperators recorded the survey route on a county map, so that replication of the route could occur in later winters. The route chosen was to be continuous and to include as little backtracking as possible, with any backtracked km not included in the total distance. The location and sex of all kestrels was marked on the route map. On a prepared form, cooperators recorded the number of male, female, and unknown-sex kestrels encountered along the route, as well as weather, habitat, time, and distance

data. The map and form were then submitted for analysis, while a copy of each was retained by the cooperator.

RESULTS AND DISCUSSION

During the 18 surveys conducted in the first winter, 262 American Kestrels were recorded, of which 66 were of unknown sex. Of the sexed individuals, 111 (56.6%) were male and 85 (43.4%) female. This winter sex ratio is similar to those reported in many other regions of North America (Palmer 1988), though regions with a predominantly female composition in winter have been reported (Mills 1975). Furthermore, no significant difference was found in the sex ratio of American Kestrels in middle Tennessee during the three survey seasons (Table 1; $X^2 = 0.426$, $df = 2$, $P = 0.05$). Thus, the smaller sample obtained during the first field season (involving less than half the number of surveys conducted during either of the two later seasons and less than half the number of sexed individuals) resulted in sex ratio data about wintering American Kestrels in middle Tennessee for that winter which were nearly identical to sex ratio data resulting from larger samples in later winters.

As a result of my analysis of the sex ratio data, one question arose: exactly how much less effort (i.e., number of surveys conducted or number of birds sexed) could be expended and still acquire precise sex ratio data for wintering American Kestrels in an area the size of middle Tennessee? I analyzed samples of American Kestrel sex ratio data based on information from one survey randomly selected from the 1985–1986 middle Tennessee pool of surveys, then two surveys, then three surveys, etc., up to 17 surveys. This simulation was conducted three times. Interpretation of this analysis (Table 2) showed that sex ratio data for randomly selected groups of surveys began to consistently approximate the data for all 18 surveys at the level of 14 surveys (involving an average of 170 sexed birds). Although this method of analysis provides no more than an “eyeball” estimate of the minimum effort required, it appears possible to determine accurately the wintering sex ratio of American Kestrels in a geographic area approximately the size of middle Tennessee by conducting 14 surveys of 100+ km each. Alternatively, the same results could probably be obtained by sexing about 176 kestrels, the average of the number sexed in randomly selected pools of 14–17 surveys. The integrity of the data would be enhanced if the surveys/birds sexed were evenly distributed throughout the area being surveyed (in the current study surveys were fairly evenly distributed throughout the region in the first and second field seasons and very evenly distributed in the third season).

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