error in determination of direction (unpubl.). Of course, the exact level of error may vary among observers, habitats, and with absolute distance of an observation. Assuming 10% error, errors in distance and direction estimation thus may be viewed as frustrums of wedges that increasé in area with increasing distance from the observer (Fig. 1). Accurate estimation of direction and distance may be difficult in extremely rough terrain, where across-ground direction and distance estimates are desirable. In such cases, however, mapping locations will still indicate general areas of higher use by birds.

Extensive evaluation followed the formal introduction of the VCPM (such as in Ralph and Scott 1981). The use of direction estimates to delineate territories must also be evaluated. We are using the addition of directional data to the VCPM to help assess habitat use; these results will be presented elsewhere.

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Evaluation of the road survey technique in determining flight activity of Red-tailed Hawks.—Road censusing, as described by Craighead and Craighead (Hawks, Owls and Wildlife, Stackpole Co., Harrisburg, Pennsylvania, 1956), has been used extensively in Christmas bird counts to assess raptor population densities. Observations of activity of raptors during such surveys have been used to indicate the overall activity pattern of a species (Craighead and Craighead 1956; Schnell, Auk 84:173–182, 1967; Bildstein, Ph.D. diss., Ohio State Univ., Columbus, Ohio, 1978; Preston, Wilson Bull. 93:350–356, 1981). However, there are no studies that verify that road censusing techniques provide an accurate estimate of the flight activity pattern of raptors. In this report I assess the applicability of the road survey technique for determining the amount of daily flight of the Red-tailed Hawk (*Buteo jamaicensis*) by comparing this method with results obtained from direct long-term observations of individuals. Red-tailed Hawks are good candidates for the census technique (Fuller and Mosher, Stud. Avian Biol. 6:235–248, 1981), since they tend to use open habitat and frequently hunt along roadsides.

In order to obtain an accurate estimate of the actual percentage of the day spent in flight, a bird must be equally visible during all activities. As raptors often change their activity patterns at certain periods of the day, it is also essential that all periods are equally represented in the sample. Seasonal changes in activity patterns and behavior of certain individuals occurring, for example, during breeding, migration, or fledging, should also be taken into account.

Methods.—Road surveys of Red-tailed Hawks were made during winter (5 December 1981–28 February 1982) and during summer (23 June–16 September 1982). Over 4000 km were driven (32–72 kmph [20–45 mph]) each season along roadway transect routes in central Missouri (38°49′N lat.). These intervals were chosen to minimize the possibility of observations of breeding or migratory hawks, but still at such times to enable me to compare activity patterns typical of summer and winter. Routes were travelled repeatedly, but only once per field day, by one to three observers. When a bird was first observed, the time of day and activity (either flying or perched) was recorded. The vehicle was stopped momentarily if a bird could not be identified. Only birds within approx. 0.4 km of either side of a road were included. When driving unfamiliar transects and/or ones along which topography

TABLE 1

ACTIVITY OF RED-TAILED HAWKS THROUGHOUT THE DAY AS DETERMINED BY THE ROAD SURVEY TECHNIQUE

Time period	Summer		Winter	
	Total seen	% perched	Total seen	% perched
06:00–09:00[a]	46	95.6	113	87.6
09:00–12:00	47	89.4	110	84.0
12:00–15:00	28	75.0	50	90.0
15:00–18:00	34	97.1	77	88.3
18:00–21:00	6	100.0	—	—
Total	161	90.7	340	87.1

[a] Times are DST for summer and CST for winter.

or vegetation (particularly in summer) made birds more difficult to detect, the driving speed was reduced and the number of observers increased.

To evaluate the road census technique, individual Red-tailed Hawks were watched for intervals longer than any bird was observed during a transect run. This lengthy observation, done with a 40× telescope, occurred concurrently with transect runs. I conducted 107 observation sessions totalling 113.5 h from 13 December 1981–24 February 1982, and 96 observation sessions totalling 122.7 h from 8 July–14 September 1982. Birds were not marked, therefore the total number of individuals included in the sample is not known, but observation periods often involved what seemed (by behavior, location, and/or plumage) to be the same bird. Activity of a bird was monitored continuously during an observation session. The percentage of time a bird perched at heights above 6.0 m and on the ground were noted during time budget observations.

Results.—As determined by the road survey technique, birds flew 9.3% of the daylight hours in summer and 12.9% of the time in winter. These estimates are nearly twice those

TABLE 2

ACTIVITY OF RED-TAILED HAWKS THROUGHOUT THE DAY AS DETERMINED BY LONG-TERM OBSERVATION

Time period	Summer		Winter	
	Total obs. time (sec)	% perched	Total obs. time (sec)	% perched
06:00–09:00[a]	86,783	97.6	68,986	95.5
09:00–12:00	93,171	92.6	126,809	94.2
12:00–15:00	84,536	89.2	122,686	90.4
15:00–18:00	104,868	97.1	89,972	93.6
18:00–21:00	72,323	98.8	—	—
Total	441,681	95.0	408,453	93.2

[a] Times are DST for summer and CST for winter.

TABLE 3

CHI-SQUARE TESTS FOR GOODNESS-OF-FIT OF DAILY ACTIVITY AS DETERMINED BY ROAD SURVEY DATA COMPARED TO THAT DETERMINED BY LONG-TERM OBSERVATION

Time period	Summer		Winter	
	χ^2	P[b]	χ^2	P
06:00–09:00[a]	0.15	NS	14.58	0.005
09:00–12:00	0.32	NS	17.22	0.005
12:00–15:00	4.48	0.05	0.04	NS
15:00–18:00	0.25	NS	2.77	NS
18:00–21:00	0.47	NS	—	—

[a] Times are DST for summer and CST for winter.
[b] df = 1 in all tests.

measured by long-term visual observations of individual birds (5.0% and 6.8% for summer and winter, respectively; Tables 1, 2). Using the latter data as the expected proportion of flight and perching in a standard Chi-square test, there were no significant differences between road surveys and long-term observation data for different times of the day (Table 3) except during the summer afternoons, and winter early morning and late morning. Lumping all observations regardless of time, the null hypothesis was rejected for summer ($P \leq 0.025$) and for winter ($P < 0.005$).

During long-term observations in summer, perched hawks were on the ground 1% of total perched time and higher than 6.0 m, 8.4% of the time. However, during winter, perched hawks spent 3% of their total perched time on the ground and 35.1% of the time on perches higher than 6.0 m. These seasonal differences in perch height may have influenced the visibility of perched hawks during road surveys.

Discussion.—The over-estimate of flight time using the road census technique probably results from an under-representation of the number of perched birds observed during the census. Although hawks typically used high perches in summer and were seldom on the ground, perched birds were often difficult to detect after foliage growth. Morning and evening times during summer showed close agreement between the census technique and the time budget. I found the largest difference between the two techniques for the afternoon period—25.0% flight time as assessed by surveys compared to 10.8% observed in the time budget. During summer afternoons, hawks soared for long periods. Compared to perched or low flying hawks, a soaring bird is much more obvious, particularly at great distances. This increased detectability may have biased the census, resulting in an inaccurate measure of flight activity.

I expected the census data to provide a more accurate estimate of flight activity in winter than summer, because the leafless condition of deciduous trees would make perched birds more visible. However, the winter road survey total for flight was almost twice as high as that observed during the time budget. Perhaps perched Red-tailed Hawks were difficult to detect because they used lower perches in winter. Hawks spent 64.9% of their perched time at heights below 6 m, where they were extremely difficult to detect on road surveys. In many cases hawks used fence posts 2 m high and thus may have been hidden in depressions or behind brush during a road census.

The winter census agreed with the time budget for the afternoon and evening periods, while the morning time periods over-estimated flight time. Assuming low perch height was

responsible for under-representation of perched hawks during morning periods, why was the afternoon road census estimate more accurate? By mid-day hawks are no longer hunting intensely and have moved up to higher perches, where they can maximize radiant absorption as well as competitor detection and territory defense. Observation of perched hawks during a census would be enhanced during these periods thus providing more accurate estimates of activity.

Although the road survey technique is not always accurate for the Red-tailed Hawk, this does not mean that the technique is an imprecise estimator of activity patterns for other species. Activity of Rough-legged Hawks (*B. lagopus*) may be more accurately gauged by the survey technique, since they tend to hunt in more open habitat (Weller, Iowa Bird Life 34:58–62, 1964) making perched birds more obvious. Schnell (1967) in fact used the road census technique to assess the influence of various environmental factors on flight of this species. Activity of larger raptors such as eagles (e.g., Golden Eagle [*Aquila chrysaetos*]), may be more accurately estimated by the road census technique because their larger silhouette is more conspicuous, while the converse may be true for smaller birds of prey (e.g., American Kestrels [*Falco sparverius*]). On the other hand, the road census may be an entirely invalid estimator of activity of some species due to their specific behavioral patterns. For example, Northern Harriers (*Circus cyaneus*) fly a large percentage of the day, but much of their perched time is spent on the ground (Weller, Wilson Bull. 67:189–193, 1955) where they are not always visible. Therefore, before using a survey method for determining activity patterns of raptor species, workers should consider factors I have noted above which affect detectability of perched birds (especially perch-site selection).

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Extreme aggression in Great Blue Herons.—Meyerriecks (Publ. Nuttal. Ornith. Club 2: 98, 1960) noted that contact during aggressive interactions between Great Blue Herons (*Ardea herodias*) was quite rare and he never observed a fight which resulted in damage to either of the combatants. Benson and Penny though (Philosophical Trans. Royal Soc. Lond. B. 260:417–527, 1971) reported an immature Grey Heron (*A. cinerea*) was stunned fighting with another Grey Heron, and Woolfenden et al. (Bird-Banding 47:48–53, 1976) reported starving Cattle Egrets (*Bubulcus ibis*) occasionally grabbed at one another with their toes and pecked during brief fights. The present note describes two observed and one apparent case of extreme aggression by Great Blue Herons.

On 18 July 1982 at 18:00 near the Creston Valley Wildlife Interpretation Centre (CVWIC) at Creston, British Columbia, a young-of-the-year heron carrying a black bullhead (*Ictalurus melas*) landed about 100 m away from a foraging adult heron in an area where earlier an adult heron defended a territory about 300 m in radius. After 30 sec the juvenile, still carrying the bullhead, flew to a location about 20 m from the adult and assumed an aggressive upright display, followed by a forward display (see Meyerriecks 1960). The adult then flew at the juvenile, and landed on its back. The two herons stabbed with their bills and buffetted each other with their wings for about 20 sec before the adult, using its feet, gripped the juvenile's neck and submerged its head and body. About 20–30 sec later the juvenile heron lifted its head above water, still holding the bullhead. The adult struck its bill toward the