Winter raptor composition, abundance and distribution around urban Spokane, eastern Washington

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Abstract

As is true of many urban areas, Spokane has little information on winter raptor populations. Even outside urban areas, many authors have pointed to the lack of available data on wintering raptor populations (Woffinden and Murphy 1977; Craig et al. 1984; Beauvais et al. 1992; and Bunn et al. 1995). To establish a baseline documenting this valuable winter raptor resource in and around a rapidly urbanizing area, a 3-year winter raptor study was conducted around Spokane from 1995-1998.

A total of 110 roadside surveys were conducted covering more than 2,510 km (1,560 mi) of secondary roads. Over 1200 raptors of 12 different species were recorded during the 3-year period. The 4 most common species, red-tailed hawk (*Buteo jamaicensis*) (65% of total), rough-legged hawk (*Buteo lagopus*) (18%), bald eagle (*Haliaetus leucocephalus*) (6%), and northern harrier (*Circus cyaneus*) (5%), comprised almost 95% of all birds sighted. Red-tailed hawks were seen on 58% of all surveys, rough-legged hawks on 42%, bald eagles on 28%, northern harriers on 26%, and American kestrels on 19%. For the entire study, 48 birds were observed for every 100 km (2.1 km/bird) driven.

Significantly more birds were observed in the morning than in the afternoon. More wintering raptors were observed between 12:00 and 1:00 p.m. than any other time period. When first observed, over 70% of the 5 most common species were perched while 27% were flying. Bald eagles and red-tailed hawks were observed most often in evergreen trees and rough-legged hawks were observed to perch most frequently on power poles and fence posts. Kestrels were observed most often on wires. Both the number of raptors and the number of species were lowest near the city and both consistently increased as distance from the city center increased. Results show that the Spokane urban area has one of the highest relative abundance and species richness levels of wintering raptors in the West.

INTRODUCTION

During winter, eastern Washington appears to receive a large influx of migrating raptors, many of which become temporary residents around Spokane, Washington. As is true of many urban areas, Spokane has little information on raptor populations, particularly their winter status. Even outside urban areas, many authors have pointed to the lack of available data on wintering raptor populations (Woffinden and Murphy 1977; Craig et al. 1984; Beauvais et al. 1992; and Bunn et al. 1995). Many studies have documented the use of urban areas by passerines (DeGraaf and Wentworth 1981; Rosenberg et al.1987; DeGraaf et al.1991; and Marzluff 1997), but few have included raptors. Much of the human impact on raptors now occurs on the outer urban fringe, where native habitat is being destroyed, fragmented and converted by humans for their use. In order to establish a baseline database documenting winter raptor use in and around a rapidly urbanizing area, a 3-year winter raptor study was conducted around Spokane from 1995-1998. This study is intended to permit future raptor studies to identify and detect trends in the raptor populations around Spokane as the human population continues to grow and spread across the landscape.

STUDY AREA

Spokane is located in eastern Washington near the boundary of Idaho (Figure 1). The city of Spokane is the second largest in Washington State with approximately 190,000 people. Another 199,000 live in unincorporated Spokane County (WA. Office Financial Management 1998). The county is divided into 2 ecoregions - the Columbia Basin and the Northeast Corner, essentially straddling the transition between the arid Columbia Basin and the more mesic forest zones of the Northeast Corner – a portion of the Selkirk-Rocky Mountains complex (Cassidy1997)(Figure 2). Within these 2 ecoregions, 5 major and 2 minor

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vegetation zones are found in the county (Table 1 and Figure 2). In addition, the Spokane River, a major tributary of the Columbia River, bisects the county running east-west through the City of Spkane.

Spokane County is dominated by the Ponderosa Pine and Palouse vegetation zones (Table 1). The majority of the human population of the county is located within the Ponderosa Pine zone, which covers nearly half of the county. The Palouse grassland zone is located in the southeastern portion of the county and corresponds to the distribution of agriculturally significant loess soils that has been almost completely converted to wheat production (Cassidy 1997). The interior Douglas Fir, Grand Fir, Interior Red Cedar and Subalpine Fir zones are located in the mountainous northeastern portion of the county. The Three-Tip Sage zone is located in the extreme western and southwestern portions of the county (Figure 2).

METHODS

One-hundred and ten roadside surveys were conducted on 5 different routes for 3 consecutive winters covering > 2,510 km (1,560 mi) of secondary roads. These 5 routes, radiating out like the spokes of a wheel, were selected just outside the interim urban growth area of Spokane crossing the 2 major ecological regions and major vegetation types of the county (Figure 2 and 3). The lengths of the 5 survey routes (in km) were 28.9, 27.3, 22.5, 12.1, and 13.7 for Big Meadows, Coulee Hite, Hangman Valley, Little Spokane, and Saltese Flats, respectively. Each route was surveyed 6 times in the winter of 1995-1996 and 9 times each for the 2 subsequent winters, 1996-1997 and 1997-1998. The direction and order in which transects were driven were varied to minimize directional biases. Censuses were conducted throughout the day to minimize time of day biases. All surveys were conducted between 0800-1630 at vehicle speeds of 40 kph or less. Sixty-five surveys were conducted in the morning (before noon), with 55 in the afternoon. Brief stops were made to identify and record observed birds. If weather conditions resulted in restricted vision or if winds were >40 kph (25 mph), surveys were halted and considered invalid for the day.

Only birds initially seen with the unaided eye were recorded. Binoculars (10x40 and 8x42) were used to aid in identification. Both perched and flying raptors were recorded. After first detection, all attempts were made to not recount individual birds. For each sighting the following information was recorded on standardized forms: species, time, date, habitat type, activity (flying, perched, hunting, feeding), perch type, location and comments. Habitat types included: agricultural, field/pasture, forested, lake, mixed (forest and pasture), riparian, shrub steppe, and residential. Perch types included: building, cliff/rock outcrop, deciduous or evergreen tree, fence post, ground, power pole, shrub, snag, trestle/bridge and wire. Relative abundance was derived using the number of raptors observed per 100 kilometers driven.

To determine if there were significant time-of-day influences on the number and species of raptors observed, data were analyzed two different ways. The first technique divided all observations into 4 time categories: 0800-0959, 1000-1159, 1200-1359, and 1400-1600. Also, observations were placed in 2 time periods: morning surveys from 8:00-1159, and afternoon surveys from 1200-1600. Chi-square tests were used to detect differences. Since perch availability and numbers were not collected for this study, actual perch preference could not be determined. However, observed perch use was recorded and analyzed using chi-square tests.

The activity (e.g. perched, flying) of each raptor when first observed was recorded and the data was analyzed to determine if there were any significant patterns of raptor activity. Using Environmental Systems Research Institute's (ESRI) ARCVIEW on a PC, a GIS mapping and contingency testing of the data were conducted to determine if there was any change in raptor abundance or composition as a function of distance from the city center (Figure 3).

For most analyses, chi-square tests (Sokal and Rohlf 1995) were used when adequate sample sizes were available. A correction for continuity was made for chi-square tests with only 1 degree of freedom.

RESULTS

A total of 1205 raptors of 12 different species were recorded during the study (Table 2). The 4 most common species: red-tailed hawk (*Buteo jamaicensis*) (65% of total), rough-legged hawk (*Buteo lagopus*) (18%), bald eagle (*Haliaetus leucocephalus*) (6%), and northern harrier (*Circus cyaneus*) (5%) – comprised almost 95% of all birds sighted. American kestrel (*Falco sparverius*) comprised 3%, 2 other falcons, merlin (*F. columbarius*) and prairie falcon (*F. mexica-nus*) together added only 0.5%, golden eagle (*Aquila chrysaetos*) less than 0.1%, while all 3 species of Accipiters, sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*A. Cooperii*) and northern goshawk (*A. gentilis*), comprised an additional 1%. The only owl recorded during the study was the great-horned owl (*Bubo virginianus*), which made up 1% of the total. Red-tailed hawks were seen on 58% of all surveys, rough-legged hawks on 42%, bald eagles on 28%, northern harriers on 26%, and American kestrels on 19%.

The number of birds observed per 100 km is shown in Table 2. The relative abundance again reflects the predominant 5 species with 31.3 red-tailed hawks, 8.8 rough-legged hawks, 2.9 bald eagles, 2.4 northern harriers, and 1.3 American kestrels for every 100 km of census. For the entire study, 48 birds were observed for every 100 km (or 2.1 km/bird) driven.

Because of the small sample size, some of the following analysis was restricted to the 4 or 5 most common species.

The overall survey showed a significant difference in the number of birds observed in the morning compared to the afternoon ($\div^2 = 76.84$, 1 df, $P < 0.001$). Forty-one percent of all birds were observed in the morning with 59% being observed in the afternoon (Table 2). The difference was even more pronounced than expected because approximately 54% of the surveys were started in the morning, and yet more raptors were observed in the afternoon.

More species were seen in the morning (12 sp.) compared to the afternoon (10 sp.). Red-tailed hawks, rough-legged hawks and northern harriers were observed at significantly higher rates on afternoon surveys than on morning counts ($\div^2 = 55.83$, 1 df, $P < 0.001$; $\div^2 = 13.58$, 1 df, $P < 0.001$; $\div^2 = 11.00$, 1 df, $P < 0.001$, respectively). More wintering raptors were observed between 1200-1300 than any other time period (Figure 4). The number of raptors observed between the hours of 1000-1400 (850 or 70.5%) was significantly greater than all other hours (0800-1000 and 1400-1630) ($\div^2 = 203.3$, 1 df, $P < 0.001$).

When first observed, > 70% of the 5 most common species were perched whereas 27% were flying (Figure 2). Significant differences in observed perch use (Table 3) were found for bald eagles - evergreen trees ($\div^2 = 32.57$, 5 df, $P < 0.001$), rough-legged hawks - power poles ($\div^2 = 120.16$, 6 df, $P < 0.001$) and red-tailed hawks - evergreen trees ($\div^2 = 922.70$, 7 df, $P < 0.001$). Kestrels appeared to have a preference for perching on wires (86%), however, because of low sample size, significance could not be tested.

Both the number of raptors and the number of species were lowest near the city and consistently increased as distance from the city center increased (Figure 3 and Table 4). This increase in the number of raptors was highly significant ($\div^2 = 428.5$, 4 df, $P < 0.001$). Only 2 species, red-tailed hawks and sharp-shinned hawks, were observed in the inner circle. The red-tailed hawk was the dominant species at all distances from the city (12-28 km). Only at a distance >24 km did the rough-legged hawk become a co-dominant species, comprising 22% of the total in both the 24 and 28 km circles. All other species were <7% in all circles, except the bald eagle having 10% in the 20 km circle.

DISCUSSION

When compared to other winter raptor surveys in the West, the area surrounding Spokane has a high number of raptors with a high species diversity (Table 5). Compared to these other studies, Spokane has the highest relative abundance with 48 raptors observed per 100 km driven. The study with the next highest relative abundance (43.25) is another Washington study conducted west of Spokane (Chestnut and Boomgarden 1997). With regard to species diversity, Spokane ranks near the top with 12 species, second only to an extensive study conducted in Kansas which covered 52,439 km and reported a total of 15 species (Fitch 1973).

Red-tailed hawks had the greatest relative abundance of 31.31 while rough-legged hawks had 8.80. Both of these indices are the highest that have been reported for these species. The other Washington study (Chestnut & Boomgarden 1997) reported 20.07 for red-tailed hawks and 7.47 for rough-legged hawks. Around Spokane, red-tailed hawks were predominant and found on each census and on all 5 routes all 3 years. Rough-legged hawks were not quite as prevalent, but were found to be abundant on the routes having extensive open space – grasslands or farmlands. Similarly for Washington, Chestnut, and Boomgarden (1997) also reported red-tailed hawks as the most dominant species and rough-legged hawks being second most common.

These results are different from other studies done in the West. In Colorado and Nebraska, Enderson (1965), Mathisen & Mathisen (1968) and Johnson and Enderson (1972) found the rough-legged hawk to be, by far, the most common buteo on winter roadside censes. Red-tailed hawks were even reported as being scarce. Even in neighboring Idaho, Craig (1978) found rough-legged hawks to be the most numerous wintering raptor. Whether this difference in species abundance is due to habitat differences, differences in prey species, differences in source populations, or differences in snowfall is unknown. A contributing factor may be (Table 1) the fact that the Ponderosa Pine zone covers almost 50% of Spokane County, whereas many of these other studies were conducted in shrub-steppe or steppe habitats.

Bunn et al. (1995) found that although "time of day" is known to affect the results of many avian surveys and censuses, the extent to which roadside surveys of raptors are affected is not known. They found no other study designed to test the time of day factor. In this study, surveys were conducted throughout the day with almost equal distribution of morning surveys (65) and afternoon surveys (55) providing an opportunity to analyze this factor. Raptor activity was found to be the highest for all raptors between 1000 - 1400, except for the northern harrier (Figure 4). Fifty-five percent of all harriers observed were seen after 1400. Bildstein (1987) noted this same pattern for harriers in Ohio, finding high activity in early morning, then decreasing through midday followed with renewed peak in the afternoon. Bildstein (1987) found that red-tailed hawks, rough-legged hawks, and American kestrels were all less active from 0800-1100 than later in the day. Diesel (1984) attributed the in-crease in midday

observations to the contention that most raptors have finished hunting by late morning and have retired to more obvious perching spots where they can maximize radiant absorption, competitor detection, and territorial defense. This study corroborates the suggestion that the easiest time to see wintering raptors, except for the northern harrier, is during midday.

Only harriers were first observed to be flying more frequently (59%) than perched (39%) (Figure 5). This same behavior by harriers has been reported by Bildstein (1979) (59% flying) and by Cox (1978) (99%). The perching percentages for other species in this study (Table 3) are higher than those reported by others. For example, in this study 70% of red-tailed hawks were perched; while Bohall-Wood (1984) found 48% and Schnell (1968) noted 33%.

Bildstein (1979) reported seeing 32% of all birds flying in the morning and 34% in the afternoon. This study recorded 26% flying in the morning and 28% in the afternoon. Activity patterns of all animals vary throughout the day, and raptors are no exception. Knowing when raptors are more likely to be perched or flying may help future surveys to be designed more efficiently, timing survey efforts when species are most visible. In addition, this information can be used to advise or manage Watchable Wildlife raptor areas, providing optimal viewing times.

Bald eagles (41%) and red-tailed hawks (52%) were observed perched most often in evergreen trees, while rough-legged hawks perched most often on power poles (38%) and fence posts (20%). In southeast Idaho, Craig (1978) found 75% of rough-legged hawks perched on power poles. Similarly, Schnell (1968) and Weller (1964) reported that rough-legged hawks perched on poles and lone trees, while red-tailed hawks selected perches in groves of trees especially along wooded edges. Bildstein(1979) also found 99% of all bald eagles perched in evergreen trees. Eighty-six percent of kestrels were observed to perch on wires, consistent with the findings by Fischer et al.(1984) and Bildstein (1987).

These perching affinities of raptors can perhaps be used by urban planners, and other individuals wanting to enhance raptor perches and visibility. Natural perches can be supplemented by providing more poles and fenceposts (not T-posts), by planting or protecting lone trees in pastures and fields, and by keeping power lines for new developments above ground. Future studies need to be designed to determine the actual raptor perch preference in relation to habitat and perch availability. Perhaps, by knowing perch preference, winter raptor populations may be enhanced by supplying the necessary perches. Winter raptor densities may be more easily influenced by such manipulations compared to summer breeding periods when raptor territories are more strictly defined and defended.

Several studies have shown an avoidance to human activity by raptors (Fischer et al. 1984; Smallwood et al. 1996). In this study, raptor abundance and species diversity appeared to be influenced by the proximity to the city. Only 2 species – the red-tailed hawk and the sharp-shinned hawk – were found in the circle closest to the city. Both of these species have been reported to have a higher tolerance for human activity than most other raptors (Bosakowski 1997). Sharp-shinned hawks are known to be frequent visitors to the many bird feeders in urban and suburban backyards (Davis 1992; Powers 1996). Red-tailed hawks seemed to be quite tolerant to human activity and were observed in all habitats during this study. Rough-legged hawks appear to avoid human activity and development, although this may be due to pre-ferred prey distribution or passive avoidance of other raptors as well. Rough-legged hawks were abundant only in areas having very low human density and large open spaces (e.g. large agricultural areas); yet absent or infrequent in small open spaces with higher human densities even though an adequate supply of power poles was present.

In conclusion, this report documents that the Spokane area is an important wintering area for a comparatively large and diverse raptor population. This area can provide many hours of wildlife watching for the 200,000 or more urban residents that have the potential of seeing at least 12 different species of raptors in <15 minutes from their home. Although few of these raptors will remain to breed in the Spokane area, they do reside in, and depend upon, the Spokane area for sustenance for almost half a year. It is important to protect and conserve these important wintering areas. Therefore, it is imperative that developing cities conserve and protect these raptor wintering grounds as open space.

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Table 1. Vegetation zones for Spokane County, Washington (Cassidy 1997)

Vegetation Zone	Area in hectares (acres)	% of Spokane County
Ponderosa Pine	551,476 (1,362,146)	48.4
Palouse Grassland	341,343 (843,117)	30.0
Interior Douglas Fir	189,035 (466,916)	16.6
Three-Tip Sage	55,116 (136,137)	4.8
Grand Fir	2,034 (5,024)	<0.2
Interior Red Cedar	56 (138)	<0.1
Subalpine Fir	(Not identified by GAP)	<0.1
Totals	1,139,060 (2,813,478)	100%

Table 2. Number of raptors seen and their relative abundance during morning and afternoon surveys in Spokane County in eastern Washington, November 15-March 15, 1995-1998.

	Birds Observed					
	Mornings		Afternoons		Total	
	#	# /100 km	#	# /100 km	#	# /100 km
American Kestrel (*Falco sparverius*)	15	1.1	17	1.5	32	1.3
Bald Eagle (*Haliaetus leucocephalus*)	38	2.8	34	2.9	72	2.9
Cooper's Hawk (*Accipiter Cooperii*)	4	0.3	3	0.3	7	0.3
Great-horned Owl (*Bubo virginianus*)	2	0.2	10	0.9	12	0.5
Golden Eagle (*Aquila chrysaetos*)	1	0.1	0	0.0	1	0.0
Merlin (*Falco columbarius*)	1	0.1	2	0.2	3	0.1
Northern Goshawk (*A. gentilis*)	1	0.1	0	0.0	1	0.0
Northern Harrier (*Circus cyaneus*)	20	1.5	41	3.5	61	2.4
Prairie Falcon (*F. mexicanus*)	2	0.2	1	0.1	3	0.1
Rough-legged Hawk (*Buteo lagopus*)	92	6.8	129	11.1	221	8.8
Red-tailed Hawk (*B. jamaicensis*)	320	23.8	466	40.0	786	31.3
Sharp-shinned Hawk (*A. striatus*)	3	0.2	3	0.3	6	0.2
All Species	499	37.1	706	60.6	1205	48.0

Table 3. Use of perch types by 5 raptor species in eastern Washington, 1995-1998.

	Deciduous		Evergreen		Fence Post		Ground		Power Pole		Shrub		Snag		Wire	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Kestrel	1	4.4	1	4.4					1	4.4					20	87.0
Bald Eagle	10	21.8	19	41.3	3	6.5	6	13.0			2	4.4	6	13.0		
Harrier	1	4.0			8	32.0	10	40.0			2	8.0	4	16.0		
Rough-legged	15	8.3	20	11.1	35	19.4	26	14.4	70	38.9	11	6.1			3	1.7
Red-tailed	46	8.2	290	52.1	25	4.5	14	2.5	152	27.3	21	3.8	5	0.9	4	0.7
All Raptors	86	10.0	333	38.8	72	8.4	58	6.8	228	26.6	36	4.2	17	2.0	28	3.3

Table 4. Results of GIS distance-from-center-of-city analysis - length of census in distance circle, number of raptors, relative abundance and total species observed, Spokane, Washington, 1995-1998

Distance from Center of City (km)	Number of Raptors Observed	Raptors Observed/100 km	Census Length in Distance Circle	Total Species Observed
12	38	920	4.1	2
16	120	796	15.1	6
20	258	899	28.7	8
24	393	1753	22.4	9
28	396	1156	34.3	11
Totals	1205	1152	104.6	12

Table 5. Winter raptor surveys in the U.S. showing total species observed and relative abundance (some values were calculated and summarized from literature).

	Location	Number of Species	Relative Abundance raptors/100 km	Total kilometers Traveled
THIS STUDY	Washington	12	48.0	2,510
Andersen & Rongstad (1989)	Colorado	12	7.2	3,406
Andersen (1984)	Colorado	??	17.5	??
Bauer (1982)	Colorado	??	11.2	??
Chestnut & Boomgarden (1997)	Eastern Wash.	11	43.3	1,445
Craig (1978)	Southeast Idaho	12	9.8	5,984
Enderson (1965)	Eastern Colo.	9	15.8	2,695
Fitch (et al.1973)	Kansas	15	??	52,439
Johnson & Enderson (et al.1972)	Eastern Colo.	9	29.2	1,048
Parker & Campbell (1984)	Southeast Ariz.	12	12.7	6,386

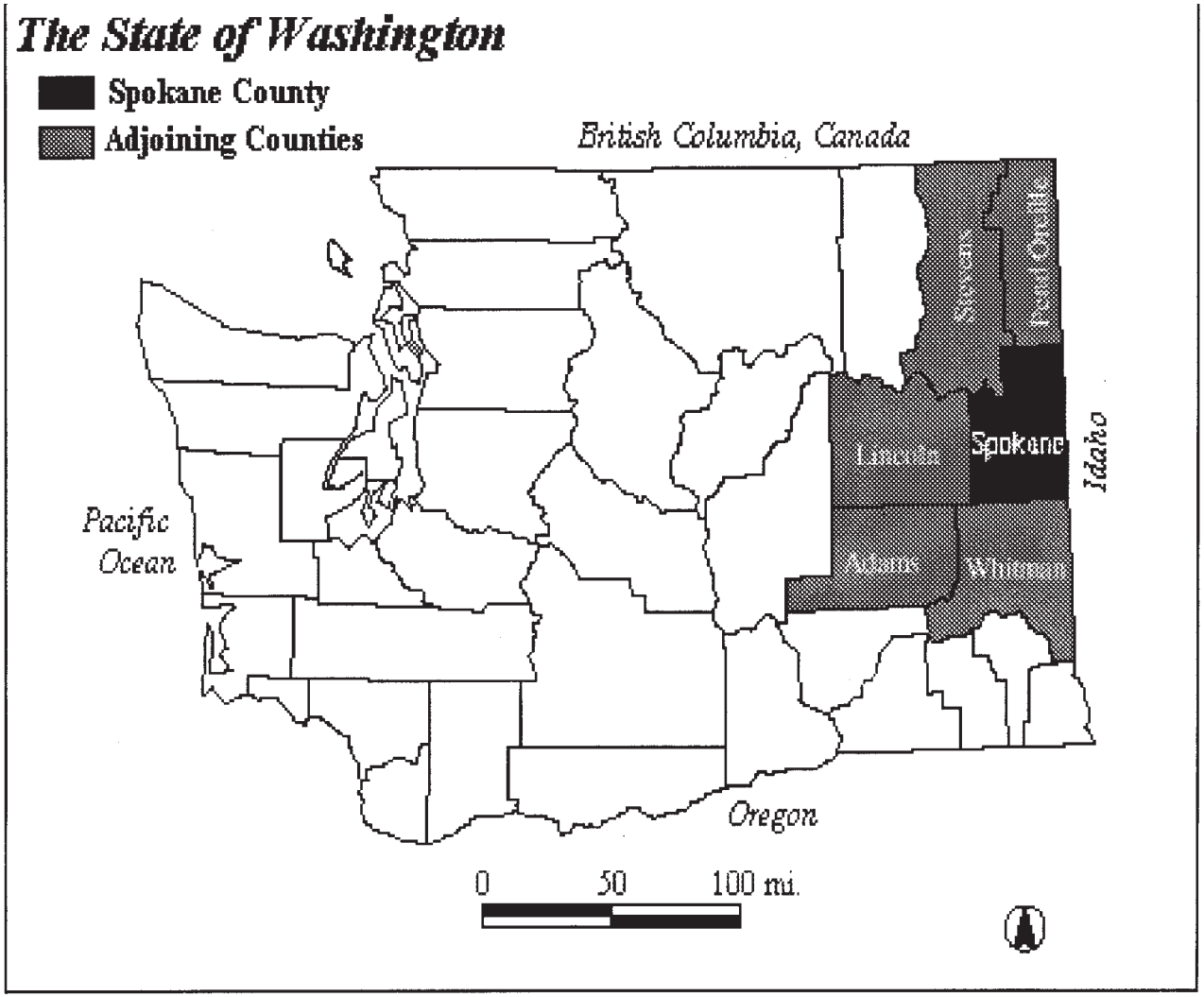

Figure 1. Spokane County and adjacent counties, Washington.

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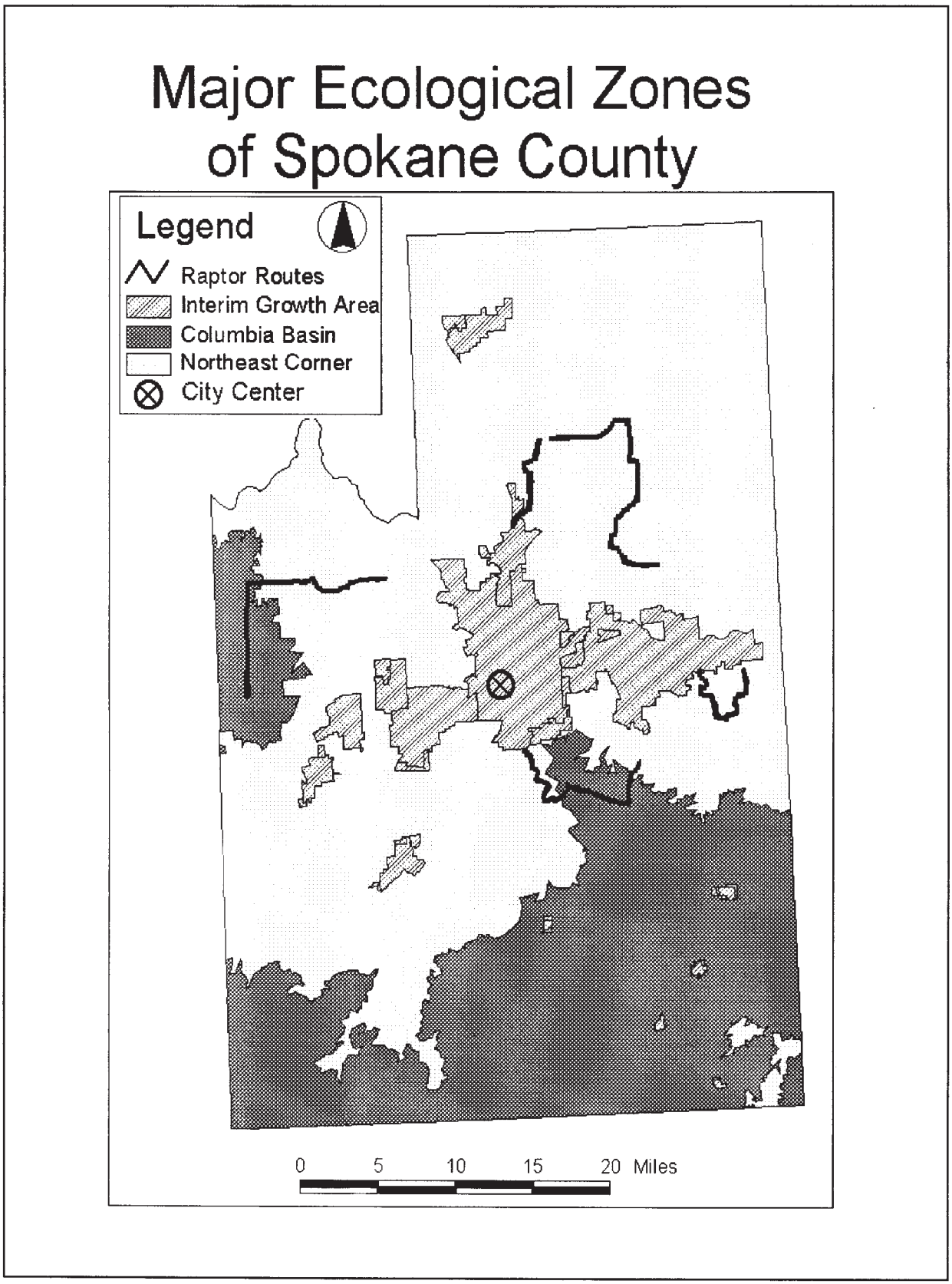

Figure 2. Raptor routes and major ecological zones, Spokane County, Washington.

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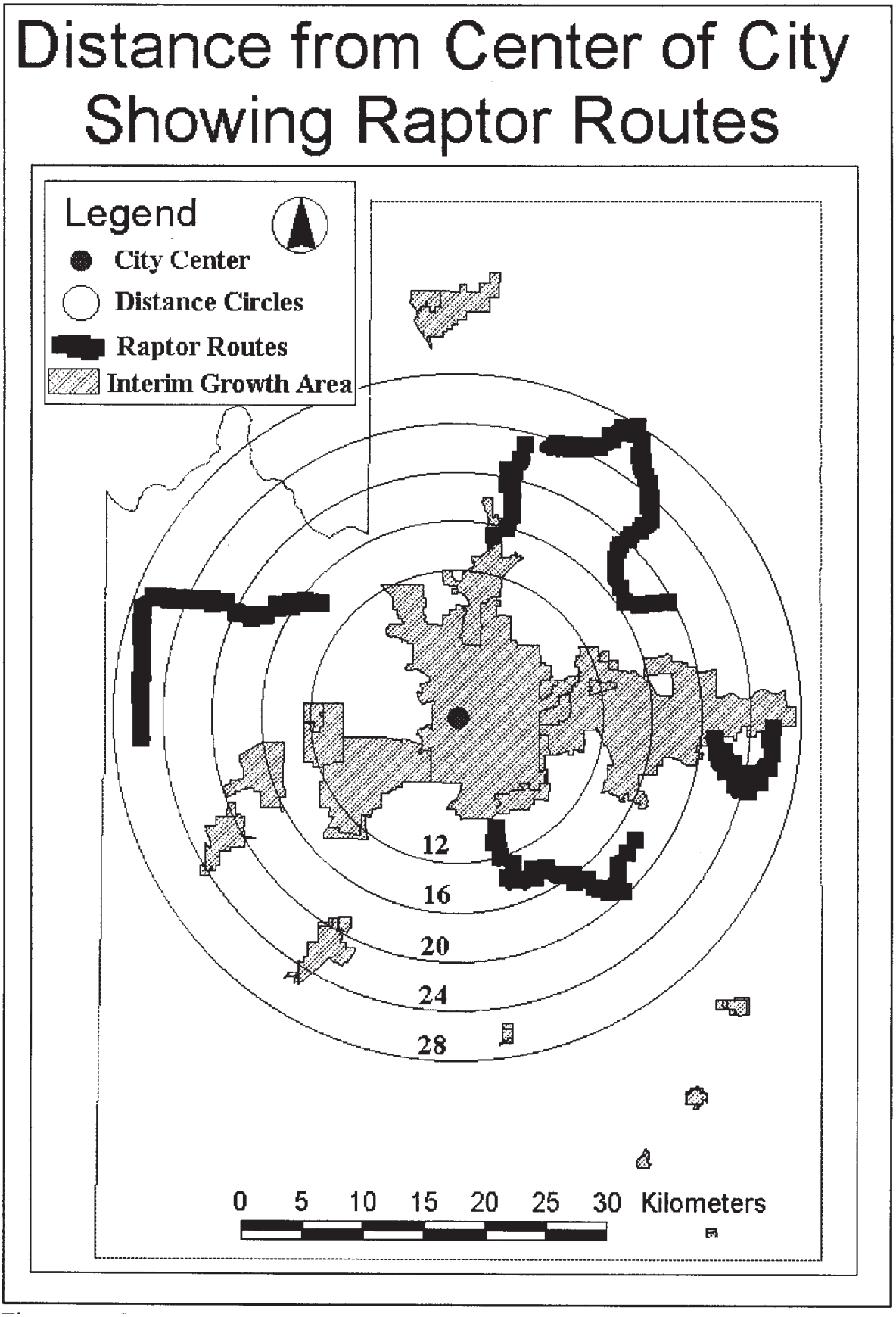

Figure 3. Distance from center of city showing Raptor Routes

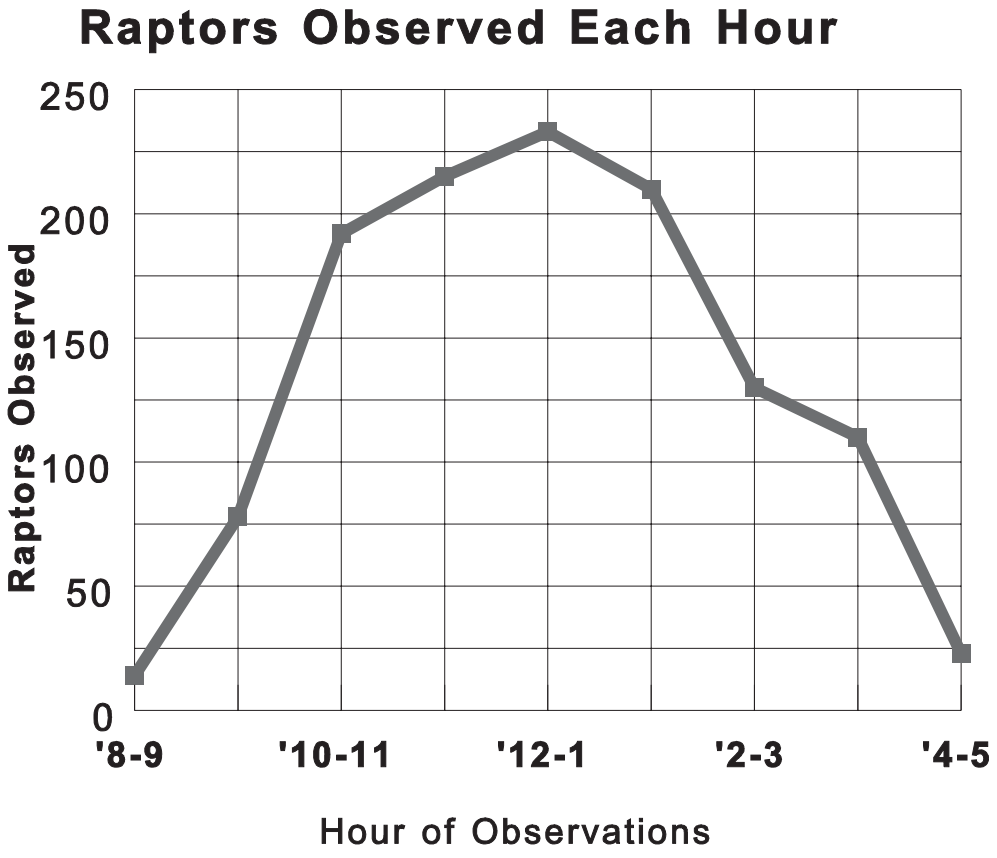

Figure 4. Raptor observations during daylight hours.

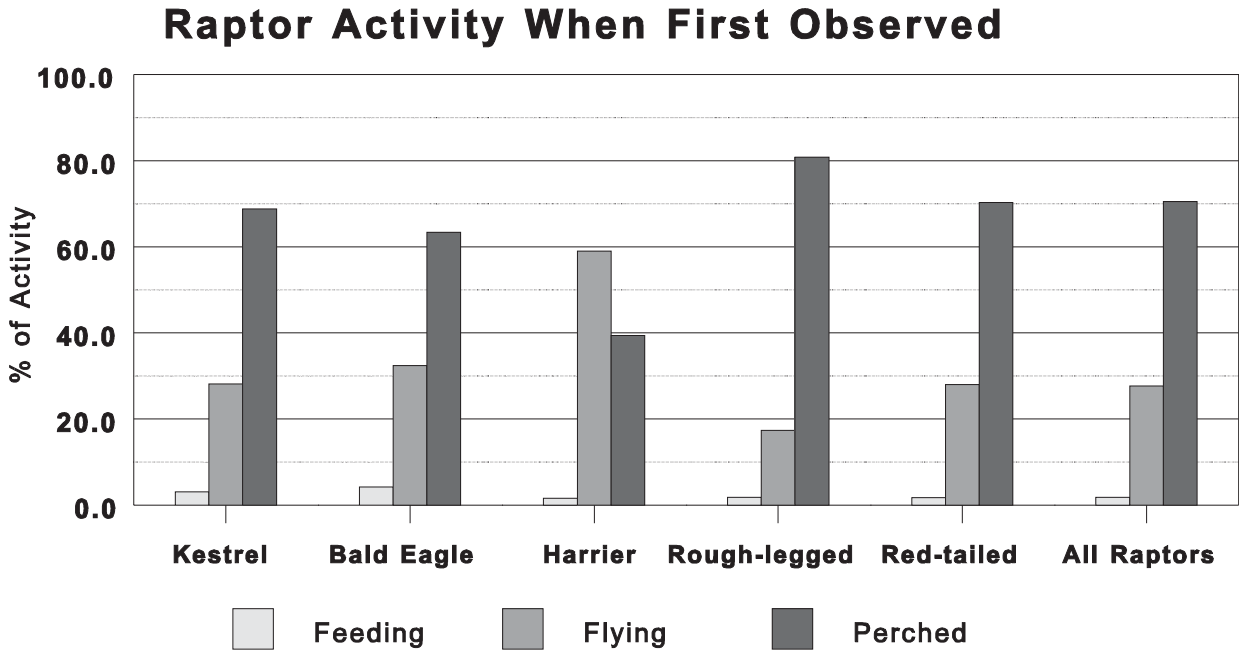

Figure 5. Raptor activity when first observed.