Alaska Department of Fish and Game
Division of Wildlife Conservation
Federal Aid in Wildlife Restoration
Research Progress Report

WOLF AND WOLVERINE DENSITY ESTIMATION TECHNIQUES

by
Earl F. Becker
and Craig Gardner

Project W-23-3
Study 7.15
September 1990

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PROGRESS REPORT (RESEARCH)

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SUMMARY

Three wolf (*Canis lupus*) censuses (i.e., to determine density estimates) were conducted in Unit 13. Twelve 57.6-, sixteen 33.1-, and thirty-five 57.6-km-long transects were systematically sampled in the Alphabet Hills, Lake Louise, and Alphabet Hills Two study areas, respectively. The number of wolves that crossed the transects and the distances the wolves moved perpendicular to the transects provided the basis for the following density estimates: 14.4 wolves/1,000 km^2 (80% confidence interval of 8.3-27.2 wolves/1,000 km^2) in the Alphabet Hills study area; 9.5 wolves/1,000 km^2 (4.6-21.8 wolves/1,000 km^2) in the Lake Louise study area; and 23.3 wolves/1,000 km^2 (14.8-32.2/1,000 km^2) in the Alphabet Hills Two study area. Because of time and weather constraints no wolverine censuses were conducted. Although none of the assumptions of the density estimation techniques for wolves appeared to be invalid, more testing is necessary. Recommendations for improving the technique and decreasing the variances are discussed.

Key Words: Alaska, census, population density, radiotelemetry, wolf, *Canis lupus*, wolverine, *Gulo gulo*.

CONTENTS

BACKGROUND

Because wolves (Canis lupus) and wolverines (Gulo gulo) in Alaska inhabit large home ranges, occur in low densities, and are secretive in nature, they are difficult and expensive to monitor; however, intensive trapping pressures have mandated precise population estimates for these species. Previously used methods to estimate wolf populations have been (1) howling-response surveys (Harrington and Mech 1982), (2) wolf track and trapper surveys (Gasaway et al. 1983), and (3) radiotelemetry data and harvest reports (Ballard et al. 1987); however, all had inherent biases that made results difficult to interpret and compare (Becker, In press). Prior to 1988 population densities for wolverines were estimated by using home range data for radio-collared individuals (Gardner and Ballard 1982, Whitman and Ballard 1983, Magoun 1985) and mark and recapture data (Hornocker and Hash 1981). Because both of these methods required assumptions that were invalid, the accuracy of the estimates was questionable.

The management of wolves in Alaska has become very controversial. No longer can managers afford to have ambiguous population data. Recent studies have shown that moose and, to a lesser extent, caribou are predator limited (Gasaway et al. 1990). As the human population in Alaska has grown, so has the consumptive and noncomsumptive demands for moose and caribou. In the past, wolf reduction programs were used to enhance ungulate population growth for human use (Gasaway et al. 1983; Ballard et al. 1987); however, such practices are increasingly becoming unacceptable to the public. One of the public's primary concerns is that the actual number of wolves in an area is unknown or inaccurately estimated.

Wolverine populations have declined throughout Southcentral Alaska (ADF&G files). Because of their pelts, wolverines are highly valued; because of their scavenging lifestyle and large home ranges, they are also easily trapped. Under heavy trapping pressures, wolverine populations can decline over a large area because of their naturally low densities and low reproductive potential (Hornocker and Hash 1981; Van Zylle de Jong 1975). In Alaska, population trends have been monitored through harvest-sealing documents; however, this process is slow and insensitive to changes in the population. Banci (1987), Magoun (1985), and Gardner (1985) concluded that a precise population estimation technique is essential to management of wolverines.

During March 1988 biologists of the Alaska Department of Fish and Game (ADF&G) estimated the wolverine population in a portion of the Chugach Mountains in Subunit 13D (Becker In press). A sampling design based on the probability of observing wolverine tracks crossing a transect (Horvitz and Thompson 1952) was used to obtain that estimate: 5.4 wolverine/1,000 km^2 (80% confidence limit of 4.0 to 7.5 wolverine/1,000 km^2). Although the survey technique worked well, providing precise estimates for both wolves and wolverines, the inherent assumptions of the technique were not adequately tested during the initial study. This project (i.e., Study 7.15) was designed to test the assumptions for population estimates of both wolves and wolverines.

OBJECTIVES

To estimate wolf population density within 2 study areas in Unit 13 using aerial line transect surveys (Job 1).

To test the assumptions of the technique for surveying wolves (Job 2).

To estimate wolverine population densities in 2 study areas in Unit 13 using aerial line transect surveys (Job 3).

To test the assumptions of the technique for surveying wolverines (Job 4).

METHODS

Wolf Density Estimation

A systematic sampling scheme using line transects and probability sampling (Becker, In press) was used to estimate wolf densities in the Alphabet Hills and Lake Louise Flats study areas. These study areas were surveyed by 3 pilot-biologist teams in a Piper Supercub (PA-18). Two to 4 days after a 7.5-cm or greater snowfall, the teams flew systematic groups of randomly selected transects and followed all wolf tracks that intersected the transects. The distance each wolf pack traveled perpendicular to the transect was used to generate the probability of observing that pack (i.e., inclusion probability) (Horvitz and Thompson 1952; Kaiser 1983; Becker, In press). This inclusion probability was used to generate a population estimate for each systematic sample; i.e., the mean of the systematic sample population estimates. This technique assumes that all (1) wolf tracks made since the last snowstorm that intersect the transect are observed; (2) fresh tracks can be backtracked to the pack's location at the end of the snowstorm and forward-tracked to the pack's present location; (3) pack movements can accurately be recorded on a map; (4) wolves move some distance after the end of snowfall and leave tracks; and (5) all wolf tracks are either continuous or occur in segments that can be followed and ascribed to the correct pack.

Assumption Testing

Assumption Nos. 1, 2, and 3 were tested by surveying each transect twice, flying the area between transects, and mapping any wolf tracks encountered to determine if tracks crossing transects had been missed by the transect teams. At the end of the survey, maps illustrating the location of tracks and wolves as well as the number of wolves observed were compared between teams. Assumption No. 4 was tested indirectly during intensive searches between the transects. Assumption No. 5 was tested while tracking individual packs.

Wolverine Density Estimation

Wolverine surveys were not conducted because of the higher priorities for wolf estimation surveys and the eruption and subsequent volcanic ash fall out from Mount Redoubt.

RESULTS AND DISCUSSION

Wolf Density Estimation and Assumption Testing

Success of the density estimate depended on a 7.5-cm or greater snowfall, calm winds, and good flying conditions for a 2- to 4-day period (Schwartz and Becker 1988). During late February and March 1990, several snowstorms hit the Copper River Basin, and 3 wolf surveys were completed.

The 1st survey was conducted on 15 February 1990, approximately 30 hours after a 46- to 51-cm snowfall in the Alphabet Hills study area (4,556 km^2). Two Piper Super Cubs were used to survey 4 systematic samples consisting of three 57.6-km-long transects oriented in a north-south direction (Fig. 1). An additional Super Cub was used to search the most probable wolf travel routes between transects to determine if any wolf tracks originating in these areas had crossed a transect but had been missed by the transect teams. In addition, each transect was surveyed twice to verify if any wolf tracks had been missed.

A total of 4 packs containing 38 wolves were observed; with an 80% confidence interval of 38.0 to 123.8 wolves, the number of wolves in the study area was estimated at 65.8 (Table 1) (SE = 35.42). With an 80% confidence interval of 8.3 to 27.2 wolves/1,000 km^2, the density in the study area was 14.4 wolves/1,000 km^2 (SE = 2.01). The average pack consisted of 9.5 wolves (SE = 3.23), and the average travel distance perpendicular to the transect was 9.0 km (SE = 0.75).

All wolf tracks were continuous and successfully tracked to the animals, except for those of 2 wolves that had become covered by drifting snow when crossing a 3-km-long ridge. These tracks had been faintly visible; consequently, they might have been missed or would have been recorded as having been deposited prior to snowfall had they intersected the transect on the ridge, so they were not used in calculating the X-axis distance traveled by these 2 wolves. Once the tracks left the ridge and were again fresh, they were followed to the carcass of a dead moose that had been used during the past 30 hours by a pack of 18 wolves. To avoid confrontation, the 2 wolves probably did not travel any farther into the territory of the large pack. The avoidance of large resident packs by smaller packs has been documented on Isle Royale by Peterson (1977); therefore, the carcass was used as the western-most point of travel for the 2 wolves.

Five moose, including a cow and her calf, were utilized by 4 different wolf packs after the snowfall. These packs had traveled an average of 8.7 km (SE = 1.70 km).

Resurveying the transects did not produce any new tracks. The team that searched likely habitat for wolves observed 4 wolf packs that had crossed at least 1 transect; however, all of these had been observed by the transect teams. The mapping of the travel routes of wolves and number of wolves/pack corresponded closely between spotter teams.

The 2nd survey was conducted on 20 February 1990, 54 hours after a snowstorm in the 5,201-km^2 Lake Louise Flats study area. Two Piper Super Cubs were used to survey 4 systematic samples consisting of four 33.1-km-long transects oriented in a east-west direction (Fig. 2). An additional Piper Super Cub was used to search areas between transects to determine if any wolf tracks had been missed by the transect teams. After completing their transects, the 2 transect teams searched locally between transects, following any recent wolf tracks to determine if any had crossed the transects and not been observed.

Three packs containing 29 wolves were observed, resulting in an estimate of 49.1 wolves (SE = 39.25), with an 80% confidence interval of 24.0 to 113.4 wolves. The density in the study area was 9.5 wolves/1,000 km^2 (SE = 1.95), with an 80% confidence interval of 4.6 to 21.8 wolves/1,000 km^2. Average pack size was

8.0 wolves (SE = 4.04), and the average distance traveled perpendicular to the transects was 7.3 km (SE = 1.68 km).

Tracks of the 3 packs were continuous, and each one was successfully backtracked to the wolves. One moose and 1 caribou were killed and utilized by 2 packs (i.e., pack Nos. 1 and 2) after the snowfall (Table 2). The 2 packs had traveled a mean distance of 8.9 km (SE = 0.35 km) after the snowfall.

Aerial observations of the areas adjacent to the transects resulted in the identification of 1 pack of 3 wolves that had crossed the transect but had been missed during the regular transect search. The pack had been following Tolsona Creek but prior to encountering the transect the wolves had turned into a thick spruce (*Picea* spp.) stand to follow a caribou trail. This pack was included in the estimate and treated like it had been found during the initial transect survey. The team in the 3rd Super Cub, which searched likely habitat for wolves, found 3 wolf packs; however, none had crossed a transect.

The increased density and height of the overstory and larger number of caribou in the Lake Louise study area made it more difficult to survey than the study areas in the Alphabet Hills. These difficult conditions (e.g., dense overstory, ungulate tracks, overflow, or hard snow) required more time for the survey team to ascertain whether or not wolf tracks were present. In study areas that have large expanses of low sightability, the estimation technique would not produce accurate results, because the assumptions that all tracks crossing transects are observed and can be followed would be violated.

A 3rd survey was conducted on 16 March 1990 (48 hours after a partial snowstorm) in the 5,335-km^2 Alphabet Hills study area. The eastern boundary of the Alphabet Hills study area was moved in order to include several more packs. Three Super Cubs were used to fly 7 systematic samples consisting of five 57.6-km-long transects oriented in a north-south direction (Fig. 3). In addition to aerially surveying transects, localized searches for wolf tracks between transects were conducted to determine if all wolf tracks intersecting them had been observed.

Eight packs containing 77 wolves were observed, resulting in an estimate of 124.2 wolves (SE = 32.82), with an 80% confidence interval of 77.0 to 172.46 wolves. The study area's density was 23.3 wolves/1,000 km^2 (SE = 1.57), with an 80% confidence interval of 14.8 to 32.2 wolves/1,000 km^2. Average pack size was 9 wolves (SE = 2.29), and the average distance traveled perpendicular to the transects was 11.6 km (SE = 4.46 km).

Tracks of the 8 packs were continuous, and all were successfully backtracked to the wolves. A total of 12 moose kills, three of which were outside the study area, had been utilized by wolves after the snowfall. Of the 5 packs observed to be on kills, three (i.e., pack Nos. 3, 4, and 5) had traveled a mean distance of 22.4 km (SE = 8.72) perpendicular to the transects (Table 3), while the other 2 packs (i.e., Nos. 6 and 7) had only moved 2.4 km (SE = 0.58). Pack No. 8, which consisted of a lone wolf, traveled mostly parallel to the transects and only 2.1 km perpendicular to them. One wolf also died of unknown causes. All teams surveyed areas between the transects, and no additional packs were observed.

The tremendous range of distances (1.9 to 36.0 km) traveled by wolves during this survey was due to (1) some packs spending the entire period on a kill and (2) differential snowfall (i.e., timing and amount) in the study area. The eastern portion of the study area had received the most snowfall (7.5 cm) 48 hours before the survey. Snowfall was less in the southcentral portion of the study area; it ended approximately 60 hours prior to the survey. The northwest section of the study area did not receive any new snow. The distances wolves traveled were greatest in the areas that had received little or no snowfall.

Based on the results from these 3 surveys, the density estimation technique will work only if pilots with excellent tracking skills are used. Because the pilots have the best visibility, they have the best chance of detecting tracks. The biologist should also have tracking skills to insure that none are being missed; however, because of the lower visibility in the back seat, the biologist's primary duty is to insure that the transects have been correctly and adequately surveyed. Moreover, the biologist must accurately map wolf movements and locations of kills and take notes on pack size and tracking conditions.

We found that this estimator should not be used in areas with high or moderate caribou densities, because wolf tracks can resemble caribou tracks; also wolves will follow caribou trails, and their tracks can be easily missed. If the study area has low caribou densities, we recommend that all caribou tracks intersecting the transect be followed for a short distance to avoid missing wolf tracks. Our data suggest that the assumption that all wolves crossing the transect are observed is reasonable, especially if intensive searches are conducted in areas of low sightability along the transect.

RECOMMENDATIONS

Wolf Density Estimation and Assumption Testing

We recommend that this study be continued for at least 1 more year. For the density estimation technique to be useful to managers and researchers, the variance of the estimates must be reduced. To decrease the variance but also to keep costs down, we need to determine the minimum number of transects necessary to maintain high inclusion probabilities for most packs. The easiest way to accomplish this is to wait longer after snowfall to conduct the survey. We feel that from 4 to 5 days is optimal for wolves in areas that normally have little wind and low caribou numbers; however, the ideal waiting time and number of transects may have to be increased or decreased, depending upon the nature of the prey base, wolf movements, habitat, and season. Also, we need to determine the optimal time during the winter to conduct the sampling.

The 5 technique assumptions appear reasonable, but more work is necessary to see the effects of different habitats, varying predation rates by season, and pack sizes. Radio-collaring wolves would be an appropriate means of answering these questions.

Wolverine Density Estimation and Assumption Testing

The initial testing of this technique on wolverines in 1987 was promising, but it did not deal with several of the assumptions or problems that could arise from their behavior. Movement patterns of denning females and wolverines that have encountered a large ungulate carcass still need to be determined. Gardner (1985) found where a wolverine did little or no travel away from a moose carcass for at least 4 days, remaining in the area of the carcass for 27 days. This carcass was also known to be visited by at least one other wolverine. A factor that could influence the timing of the survey is that wolverines change their habitat use patterns during the winter (Gardner 1985; Whitman et al. 1987). Wolverines tend to use lower-elevation spruce habitats more often between October and late February (Gardner 1985). For these reasons we feel this project should be funded for at least 1 more year.

If both wolf and wolverine density estimation studies are funded next year, we will be able to conduct 1 survey for each species per snowfall. Past work has indicated that wolverine and wolf surveys should be conducted 1 to 2 days and 4 to 5 days after a snowfall, respectively.

ACKNOWLEDGMENTS

We wish to thank B. Tobey for assisting with the surveys and for sharing his ideas. J. Lee, C. McMahan, and H. McMahan safely and skillfully piloted the aircraft. K. Adler typed several drafts of the report. K. Schneider reviewed this report.

LITERATURE CITED

Ballard, W. B., J. S. Whitman, and C. L. Gardner. 1987. Ecology of an exploited wolf population in southcentral Alaska. Wildl. Monogr. 98. 54pp.

Banci, V. 1987. Ecology and behavior of wolverine in Yukon. M.S. Thesis. Simon Fraser University. 178pp.

Becker, E. F. In press. A terrestrial furbearer estimator based on probability sampling. J. Wildl. Manage.

Gardner, C. L. 1985. The ecology of wolverines in southcentral Alaska. M. S. Thesis. U. of Alaska, Fairbanks. 82pp.

Gardner, C. G., and W. B. Ballard. 1982. Susitna Hydroelectric Project: Phase I. Final Report, Big Game Studies, Vol. VII: Wolverine. Alaska Dept. Fish and Game, Anchorage. 43pp.

Gasaway, W. C., R. D. Boertje, D. V. Grangaard, D. G. Kellyhouse, and R. O. Stephenson. 1990. Factors limiting population growth in Subunit 20E. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Report. Projects W-23-3 to W-23-4. Study 17.2. Juneau. 106pp.

Gasaway, W. C., R. O. Stephenson, J. L. Davis, P. E. K. Shepherd, and O. E. Burris. 1983. Interrelationships of wolves, prey and man in interior Alaska. Wildl. Monogr. 84. 50pp.

Harrington, F. H., and L. D. Mech. 1982. An analysis of howling response parameters useful for wolf pack censusing. J. Wildl. Manage. 46(3):686-693.

Hornocker, M. G., and H. S. Hash. 1981. Ecology of the wolverine in northwestern Montana. Can. J. Zool. 59:1286-1301.

Horvitz, D. G., and D. J. Thompson. 1952. A generalization of sampling without replacement from a finite universe. J. Am. Stat. Assoc. 47:663-685.

Kaiser, L. 1983. Unbiased estimation in line-intercept sampling. Biometrics 39:965-976.

Magoun, A. J. 1985. Population characteristics, ecology and management of wolverines in northwestern Alaska. Ph.D. Thesis. Univ. Alaska, Fairbanks. 197pp.

McDonald, L. L. 1980. Line-intercept sampling for attributes other than cover and density. J. Wildl. Manage. 44:530-533.

Peterson, R. O. 1977. Wolf ecology and prey relatinships on Isle Royale. NPS Monogr. 11. 210pp.

Schwartz, C. L. and E. F. Becker. 1988. Development of population assessment techniques for lynx. Alaska Dep. Fish and Game, Fed. Aid in Wildl. Rest. Proj. W-22-26, Job 7.12R. 19pp.

Van Zyll de Jong, C. G. 1975. The distribution and abundance of the wolverine (Gulo gulo) in Canada. Can. Field-Nat. 89:431-437.

Whitman, J. S. and W. B. Ballard. 1983. Susitna Hydroelectric Project: Phase II. Progress Report, Big Game Studies, Vol. VII: Wolverine. Alaska Dept. of Fish and Game. 25pp.

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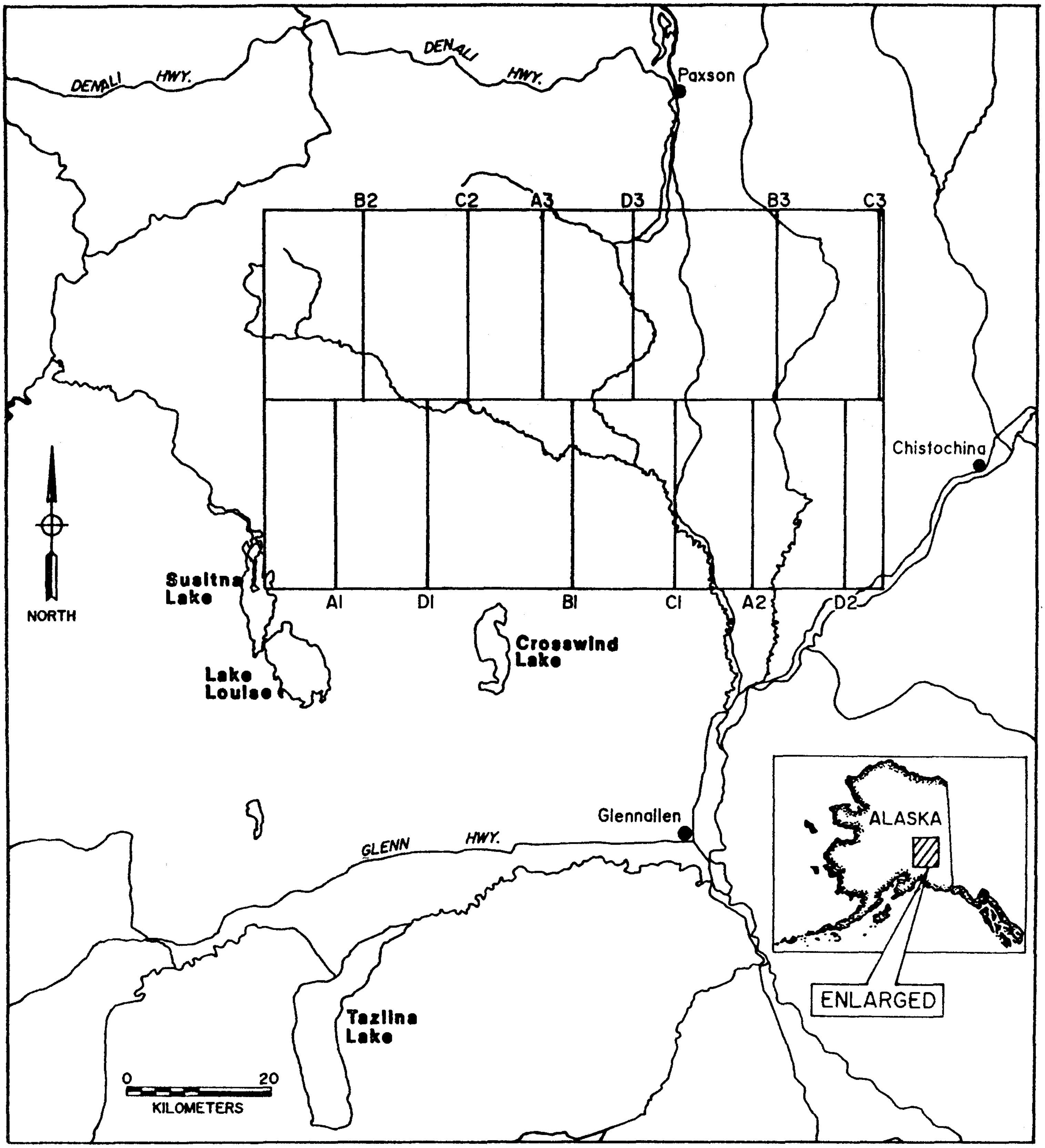

Figure 1. Alphabet Hills wolf study area for the 15 February survey. Study area boundaries and location of 4 systematic samples (A-D) with 3 transects per sample (1-3) are shown.

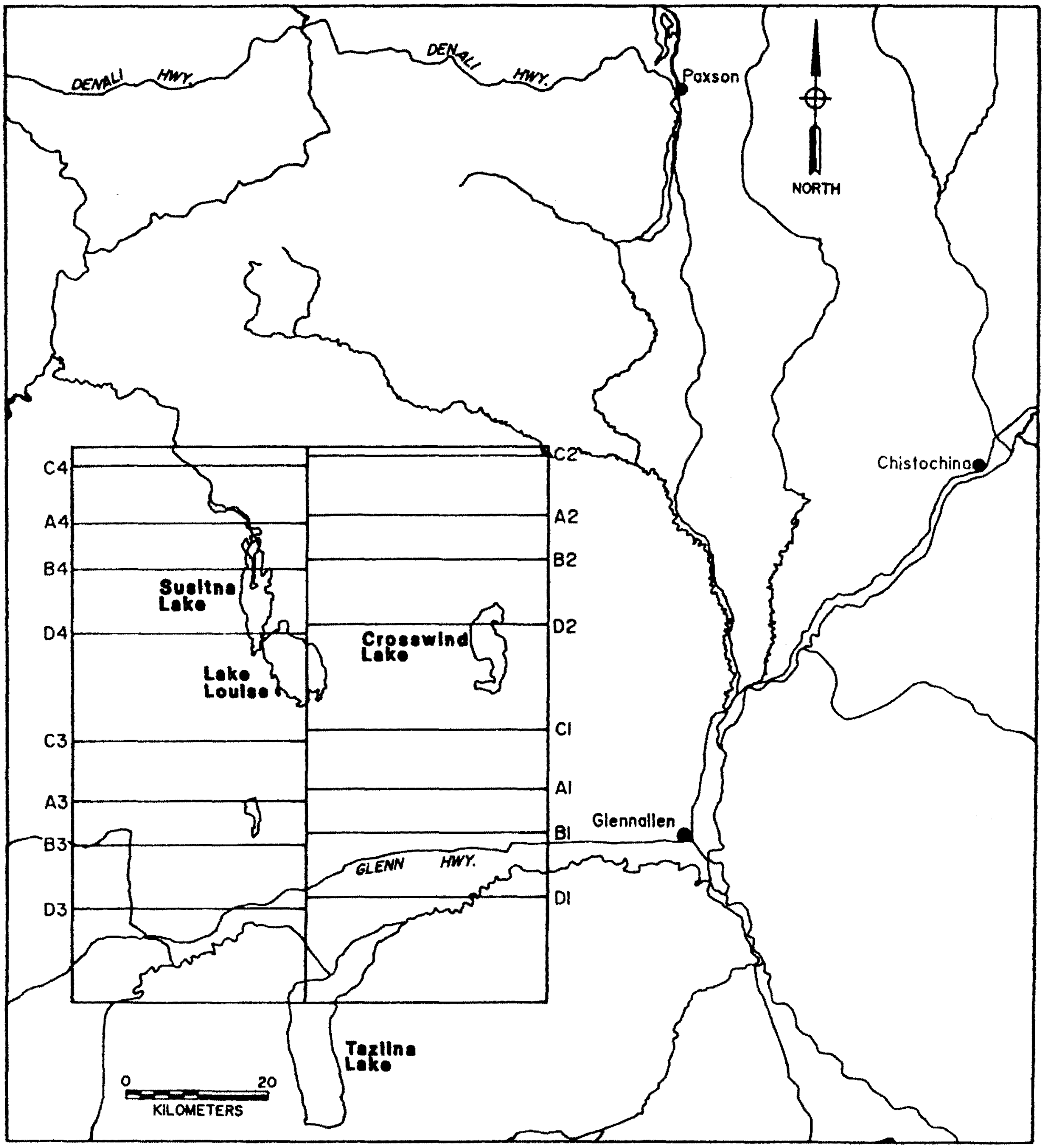

Figure 2. Lake Louise Flats wolf study area for the 20 February survey. Study area boundaries and location of 4 systematic samples (A-D) with 4 transects per sample (1-4) are shown.

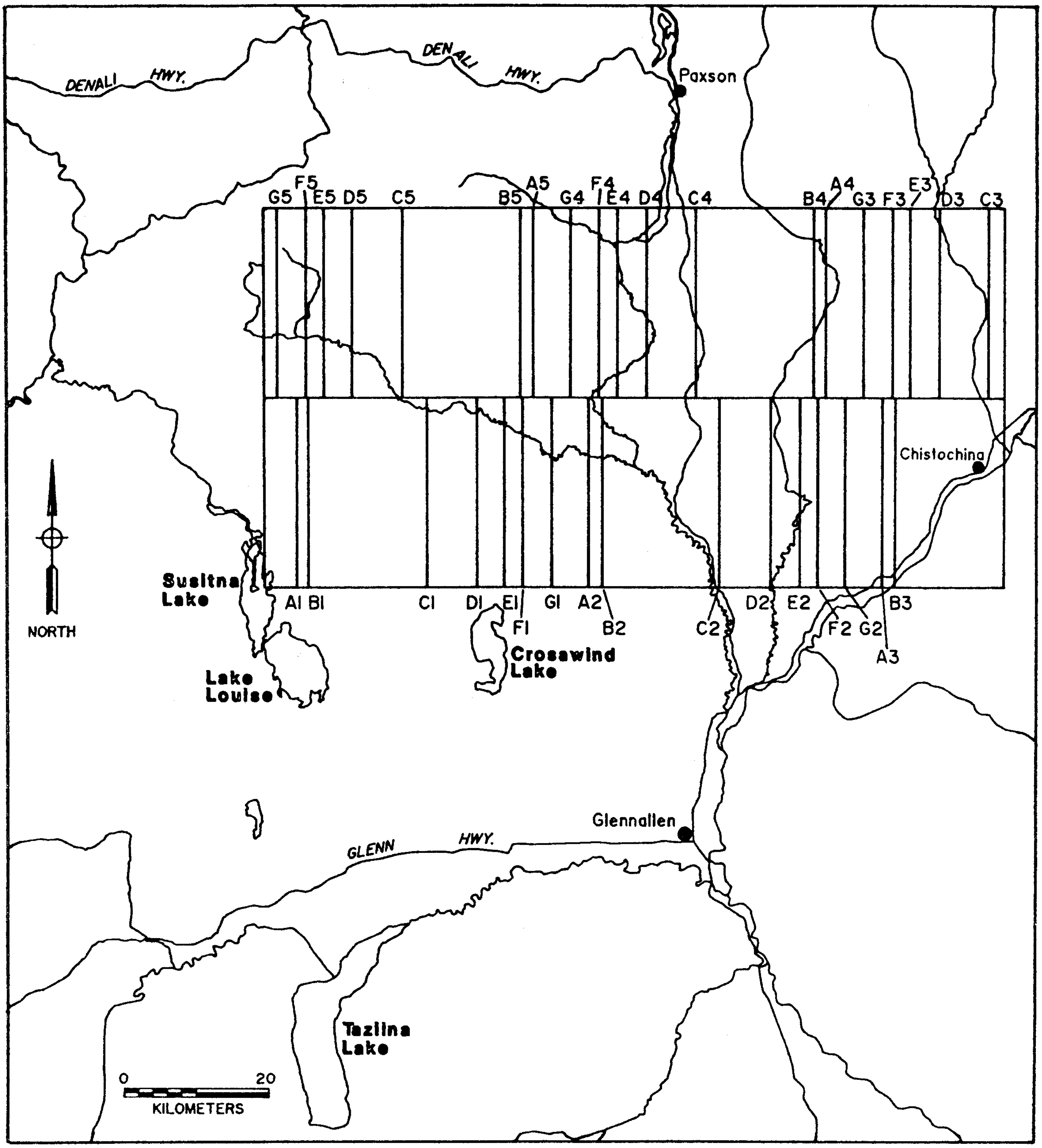

Figure 3. Alphabet Hills wolf study area for the 16 March survey. Study area boundaries and location of 7 systematic samples (A-G) with 5 transects per sample (1-5) are shown.

Table 1. Wolf survey data for a 4,556-km^2 area in the Alphabet Hills region of Subunit 13A, 15 February 1990.[a]

Sample/ transect Id	Pack Id	No. of wolves	X_u	π_u	T_{yij}	$T_{yi.}$
A1	1	9	5.80	0.172	52.35	
A2		0			0	
A3	2	9	4.06	0.120	74.79	
						127.14
B1		0			0	
B2	3	18	4.78	0.142	126.91	
B3		0			0	
						126.91
C1		0			0	
C2	4	2	7.54	0.224	8.95	
C3		0			0	
						8.95
D1		0			0	
D2		0			0	
D3		0			0	
						0

[a] (1) X_u = denotes the distance the pack traversed perpendicular to the transect (mi); (2) π_u = denotes the inclusion probability (probability this pack is observed in a systematic sample); (3) T_{yij} = denotes the contribution to the i^{th} estimate ; (4) $T_{yi.}$ = denotes the population estimate based on the i^{th} systematic sample.

Table 2. Wolf survey data for a 5,201-km^2 area in the Lake Louise flat region of Subunit 13A, 20 February 1990.[a]

Sample/ transect Id	Pack Id	No. of wolves	X_u	π_u	T_{yij}	$T_{yi.}$
A1	1	3	5.36	0.240	12.53	
A2		0			0	
A3	2	5	5.80	0.259	19.31	
A4		0			0	
						31.84
B1		0			0	
B2		0			0	
B3		0			0	
B4		0			0	
						0
C1		0			0	
C2	3	16	2.46	0.110	95.08	
C3	4	5	5.80	0.259	19.31	
C4		0			0	
						114.39
D1		0			0	
D2		0			0	
D3		0			0	
D4		0			0	
						0

[a] (1) X_u = denotes the distance the pack traversed perpendicular to the transect (mi); (2) π_u = denotes the inclusion probability (probability this pack is observed in a systematic sample); (3) T_{yij} = denotes the contribution to the i^{th} estimate; and (4) $T_{yi.}$ = denotes the population estimate based on the i^{th} systematic sample.

Table 3. Wolf survey data for a 5,338km^2 area in the Alphabet Hills region of Subunit 13A, 16 March 1990.[a]

Sample/ transect Id	Pack Id	No. of wolves	X_u	π_u	T_{yij}	$T_{yi.}$
A1	1	12	2.90	0.122	98.64	
A2		0			0	
A3	2	14	8.55	0.359	39.01	
A4	3	18	15.51	1.000	18.00	
A5	4	15	22.61	1.000	15.00	
A5 (cont.)	5	3	3.91	0.164	18.27	
						188.92
B1	1	12	2.90	0.122	98.64	
B2		0			0	
B3	2	14	8.55	0.359	39.01	
B4	3	18	15.51	1.000	18.00	
B5	4	15	22.61	1.000	15.00	
						160.65
C1		0			0	
C2	6	6	1.88	0.079	75.88	
C3	7	8	1.16	0.049	164.40	
C4		0			0	
C5	3	18	15.51	1.000	18.00	
C5 (cont.)	4	15	22.61	1.000	15.00	
						273.28
D1		0			0	
D2		0			0	
D3		0			0	
D4	4	15	22.61	1.000	15.00	
D5	3	18	15.51	1.000	18.00	
						33.00
E1		0			0	
E2	8	1	1.30	0.036	27.40	
E3		0			0	
E4		0			0	
E5	3	18	15.51	1.000	18.00	
E5 (cont.)	4	15	22.61	1.000	15.00	
						60.40
F1		0			0	
F2	2	14	8.55	0.359	39.01	
F3		0			0	
F4	4	15	22.61	1.000	15.00	
F5	3	18	15.51	1.000	18.00	
						72.01

Table 3 continued.

Sample/ transect Id	Pack Id	No. of wolves	X_u	π_u	T_{yij}	$T_{yi.}$
G1	5	3	3.91	0.164	18.27	
G2	2	14	8.55	0.359	39.01	
G3		0			0	
G4	4	15	22.61	1.000	15.00	
G5	3	18	15.51	1.000	18.00	
						90.28

[a] (1) X_u = denotes the distance the pack traversed perpendicular to the transect (mi); (2) π_u = denotes the inclusion probability (probability this pack is observed in a systematic sample); (3) T_{yij} = denotes the contribution to the i^{th} estimate; and (4) $T_{yi.}$ = denotes the population estimate based on the i^{th} systematic sample.

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