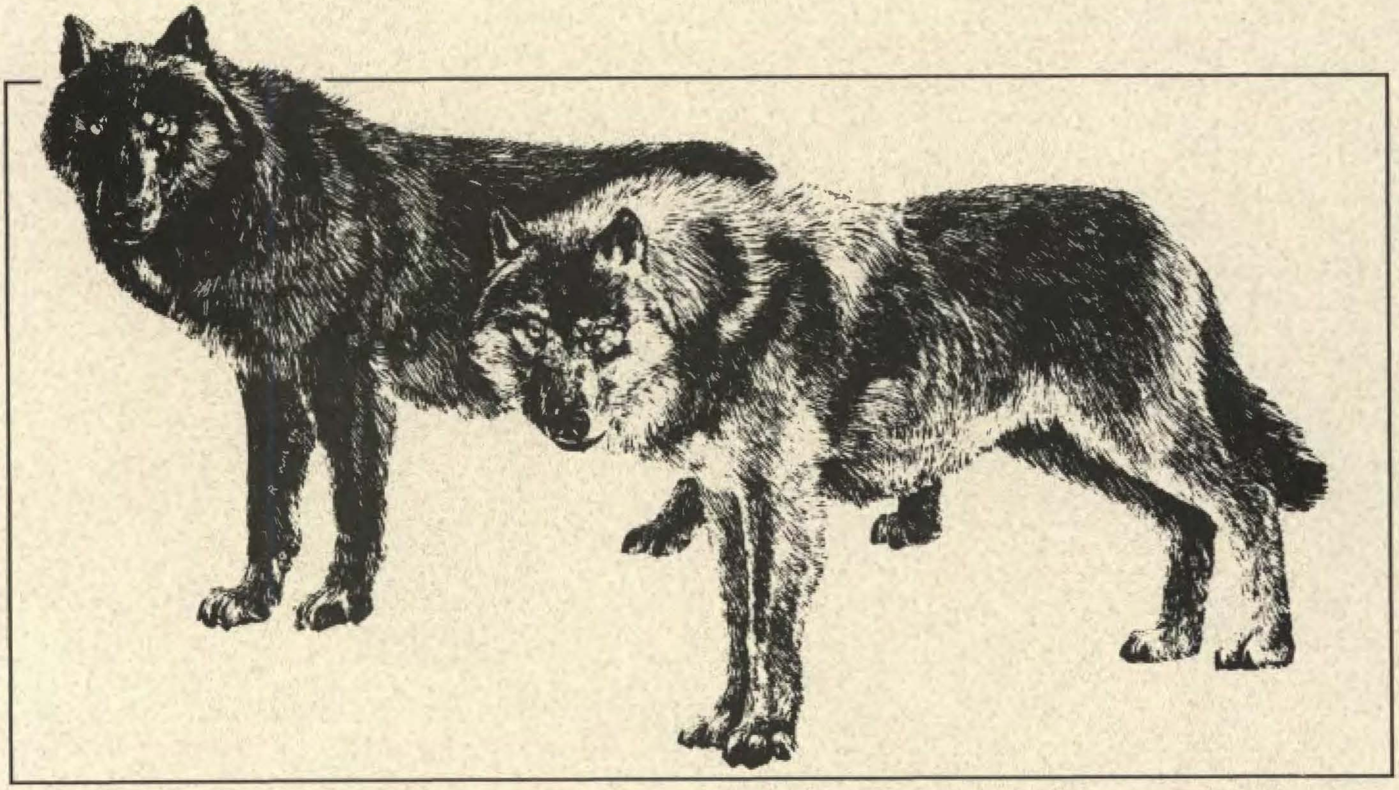
Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Research Progress Report

Evaluation and Standardization of Techniques for Estimating Wolf Numbers in Interior and Arctic Alaska

by

Mark E. McNay



Project W-24-1
Study 14.15
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SUMMARY

During March 1991 we compared the use of a Track Intercept Probability (TIP) estimator with a traditional aerial reconnaissance survey for estimating wolf (*Canis lupus*) densities in western Unit 20B. In the TIP survey, seven random samples were chosen, each consisting of five systematically spaced transects. Three fixed-wing aircraft completed the survey in 19.5 flight hours within 5,011 km^2 on 31 March, 48 hours after fresh snowfall. In the aerial reconnaissance survey, 50.5 flight hours were flown within 8,340 km^2 on 6 days between 12 March and 2 April. Likely wolf travel routes were repeatedly searched after fresh snowfall and estimates of wolf numbers were made from wolves seen and from tracks.

Similar wolf population estimates were obtained by both survey methods. The TIP survey population estimate was 33.4 wolves (6.7 wolves/1000 km^2) with an 80% Confidence Interval of 23.2 to 43.6 wolves (4.6-8.7 wolves/1000 km^2). The aerial reconnaissance estimate was 38-43 wolves (7.8-8.6 wolves/1000 km^2, no confidence interval) within the 5,011 km^2 TIP survey area and 55-71 wolves (6.6-8.5 wolves/1000 km^2, no confidence interval) in the larger aerial reconnaissance area (8,340 km^2). Potential advantages of the TIP survey procedure over other survey methods include objectivity, time-efficiency, reduced cost, reasonable accuracy, and measurable precision.

Key Words: *Canis lupus*, census techniques, density estimator, extrapolation, precision, wolf.

CONTENTS

BACKGROUND

In 1973, the Alaska Department of Fish and Game (ADF&G) began developing aerial survey techniques to provide accurate estimates of wolf numbers. Stephenson (1975) outlined an aerial reconnaissance survey method in which one or more airplanes searched designated areas 1-3 days after a fresh snowfall. He suggested search patterns "coincide in a general way with terrain on which tracks are visible and over which wolves are likely to travel." All wolf tracks encountered during the search were followed until wolves were sighted or until an estimate of wolf numbers could be made from tracks. Using a Super Cub, search intensities of 4-7 hours within a 3,900-km^2 search area were considered adequate. Larger survey areas required multiple aircraft for several days.

Compiling an estimate from aerial reconnaissance data requires subjective decisions to distinguish between equal-sized packs whose territories abut or overlap. To avoid difficulties of pack identification, many studies based wolf estimates solely on intensive radio-telemetry studies (Fuller and Snow 1988). Although accurate, radio-telemetry assisted estimates are too costly for routine survey and inventory programs. As a compromise, some studies combined limited intensive radiotelemetry with aerial reconnaissance estimates to reduce both cost and the subjectivity of interpreting aerial reconnaissance data (McNay 1990, Gasaway et al. 1992). Other wolf survey techniques including howling surveys and line transect surveys have proven to be imprecise or limited to small areas (Crete and Messier 1987, Fuller and Sampson 1988).

The strategic wolf management plan adopted by the Board of Game in November 1991 reflected a broad public interest in a comprehensive management strategy for wolves in Alaska. The strategic plan called for development of area-specific and implementation plans to clearly define the current status of wolves and their prey, and to specify appropriate management actions to meet wolf and prey population objectives.

Currently, estimates of wolf numbers in Interior and Arctic Alaska are based on information sources ranging from hunter/trapper reports to intensive radio-telemetry studies. As a result, the accuracy of wolf density estimates is highly variable among areas and among years.

A recent development in furbearer survey techniques (Becker 1991) can provide estimates of wolf densities (Becker and Gardner 1990; Ballard et al., in prep.) at costs below traditional survey methods. The technique, formally called the Track Intercept Probability (TIP) estimator, is replicable, yields estimates of wolf density with a measure of precision (i.e., confidence interval), and is accurate if six assumptions related to track sightability and track interpretation are met (Becker 1991). Failure to meet the assumptions may give biased estimates. The assumptions are: (1) all wolves have moved between the time of last snowfall and the day of the survey; (2) all wolf tracks are readily distinguishable from those of other species; (3) all wolf track segments are continuous; (4) wolf movements are independent of the sampling process; (5) pre- and post-snowstorm wolf tracks can be distinguished; and, (6) all wolf tracks that cross sample transects are observed.

Becker and Gardner (1990) evaluated assumptions of sightability without the aid of radiocollars by duplicating transects and by intensive aerial searches between transects. They concluded, "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."

Because wolf populations can potentially recover from annual losses of approximately 30% (Keith 1983), management biologists need estimates that will detect wolf population declines of approximately 30-40%. To detect a population change of 30%, with an 80% probability, requires precision of approximately $\pm$ 24% of the estimate and to detect a population change of 40% requires precision of $\pm$ 34% of the estimate.

Precision among six TIP estimator surveys conducted to date (ADF&G, unpubl. data), expressed as a percentage of the estimate at the 80% confidence level, ranged from ± 22% (Colville River, April 1992) to ± 56% (Eastern Talkeetna Mountains, February 1992). The mean precision among those six surveys was ± 40% and therefore, current application of the TIP estimator provides only marginal levels of precision. Both Ballard et al. (in prep.) and Gardner and Becker (1991) recommended further research to determine the effects of survey timing after snowfall on estimation precision.

If precision can be improved through further experimentation with sampling design and survey applications, the TIP estimator can significantly improve the quality, consistency, and efficiency of wolf population estimates in Interior and Arctic Alaska. This study was proposed to provide the experimentation needed to further develop the TIP estimator, however, the project was not funded and was terminated in fall 1992. The progress to date, reported here, consists of data compiled from comparison of the TIP estimator with an aerial reconnaissance survey in Unit 20B and represents the conclusion of this project.

OBJECTIVES

The following objectives were proposed for this study, but after the study was terminated most objectives were abandoned. Progress was made relative to Objectives 1 and 5 before the project was terminated.

1. Conduct literature review of survey techniques to estimate abundance of wolves and furbearers, and of behavioral characteristics of wolves that affect extent and timing of wolf movements.

2. Evaluate compliance with sightability assumptions in different habitat types and during different seasons.

3. Evaluate survey timing, survey area, and sample design effects on precision of the TIP estimator.

4. Determine if differences in prey density, pack size, season, or habitat type are reflected in the length of wolf movements relative to randomly spaced transects.

5. Evaluate the practice of extrapolating wolf density estimates from surveyed areas to larger areas of management concern.

6. Standardize methods for collecting data to estimate wolf abundance among areas and among years.

7. Develop computer programs to help area management biologists interpret data consistently and nonsubjectively.

8. Establish a coordinated Interior/Arctic wolf survey and inventory program to meet anticipated information needs of the comprehensive wolf planning process.

9. Write progress reports, present findings at meetings and workshops, and publish a final report.

METHODS

Wolf numbers were reduced by up to 51% in the Minto Study Area (MSA) of western Unit 20B between November 1984 and April 1986 as part of a government authorized wolf predation control program (Fig. 1). In spring 1991, using experienced pilots we conducted aerial reconnaissance surveys within an 8,340-km^2 area to determine if wolf numbers had recovered to precontrol levels. Surveys were conducted in clear weather, 1-5 days following fresh snowfalls of 7.5 cm or greater. From 1 to 3 aircraft (Piper Supercub and Bellanca Scout) searched 1,000-2,500-km^2 search blocks on each of 5 survey days. We resurveyed search blocks on different days and concentrated search efforts on probable wolf travel routes. Once encountered, wolf tracks were followed until wolves were sighted or until we could estimate wolf numbers from tracks. We backtracked wolves until tracks appeared "old" and plotted all track segments on 1:250,000 scale maps.

The aerial reconnaissance estimate of wolf numbers included wolves seen during surveys plus estimates of additional wolves from track segments where wolves were not seen but were estimated from tracks. None of the wolves within the study area were radio-collared. We identified individual packs by size and color composition when wolves were sighted. The relative timing of track observations, hunter and trapper sightings, and repetitive surveys of search blocks were used to differentiate between packs for which only tracks were observed. No correction factor was applied for single wolves because after thoroughly and repeatedly searching survey blocks we had no clear basis for estimating undetected single wolves.

Before completing the aerial reconnaissance survey we conducted a TIP survey within a 5,011-km^2 portion of the MSA to provide an alternate estimate of wolf numbers and to compare the TIP survey results with those from aerial reconnaissance. The rectangular TIP survey area was positioned on 1:250,000 scale maps so that randomly selected transects would have a high probability of crossing wolf travel routes (e.g., ridges, streams). Locations of surveyed transects were selected using a randomly repeated systematic sample design (Becker 1991). Each sample unit consisted of five systematically spaced, 25.2 km transects. Transects were drawn perpendicular to the long axis (x-axis) of the rectangular survey boundary. Seven sample units were selected by randomly choosing the starting point on the x-axis for the first transect in each systematic sample. The randomization was restricted by forcing a minimum spacing of 1.6 km between any two adjacent transects.

Each survey aircraft (Piper Supercubs and Bellanca Scout) was assigned seven transects. Following completion of assigned transects, each aircraft briefly flew along probable wolf travel routes to help confirm or refute the assumption that all wolf tracks crossing transects were detected. Survey aircraft maintained airspeeds of approximately 60-90 km/hour at altitudes of 60-160 m.

RESULTS AND DISCUSSION

We flew 50.5 hours on aerial reconnaissance surveys in the MSA between 12 March and 2 April 1991. The aerial reconnaissance "best" estimate of 61 wolves (7.3 wolves/1000 km^2) included 12 packs within the 8,340-km^2 study area (Table 1). We calculated low and high estimates of 55 and 71 wolves, respectively, by excluding or including packs whose separate identities could not be clearly established. Among the 12 packs included in the "best" estimate, pack sizes ranged from 2 to 12 wolves and averaged 5.1 (SD = 2.9) wolves/pack.

Deriving estimates from aerial reconnaissance data requires subjective decisions because complete home ranges are not known and estimates are often based upon tracks rather than observed wolves. Of 55 and 61 wolves estimated in the "low" and "best" estimates, respectively, only 39 wolves were seen. Searching the survey area repeatedly after consecutive snowfall events helped us differentiate between adjacent packs because we gained additional wolf movement information after each fresh snowfall. For example, during aerial reconnaissance flights on 21 March we encountered wolf tracks in the northeastern corner of the study area that extended 90 km along an open ridge. Two aircraft encountered the track segment and each search team independently estimated 10-14 wolves from tracks, although only six wolves were sighted. On 1 and 2 April, after fresh snowfall, we saw three packs totalling 19 observed wolves near the track segment observed on 21 March. In this case, we concluded there were three packs totalling 19 wolves. However, absent the fresh snowfall of 1 and 2 April, we would have estimated 1 wolf pack containing 10-14 wolves.

On 31 March, 2 days after snowfall, we flew a TIP survey in a 5,011 km^2 rectangle within the MSA. The entire TIP survey area had been searched by aerial reconnaissance on 20 and 21 March, but all tracks observed during those flights had been covered by 58 cm of snow that fell between 24 and 29 March. Three aircraft (two Supercubs and one Bellanca Scout) flew 19.5 combined hours to complete transects and to conduct renegade searches between transects. Wolves were encountered on all seven systematic samples (Fig. 2). Average group size was 6.3 $\pm$

4.2 (SD) and average distance moved perpendicular to the transects since last snowfall averaged 13.1 $\pm$ 5.7 km per group (Table 2).

During the TIP survey on 31 March, we encountered tracks of four wolf packs totalling 25 wolves that crossed transects. We successfully tracked 3 packs until wolves were sighted, the fourth pack (two wolves) was tracked to where the wolves were concealed by thick spruce. A fifth pack (Baker Pack) was found between transects during the renegade search, but that pack had moved only a short perpendicular distance and failed to cross survey transects. The following day, during aerial reconnaissance surveys, a sixth pack (Hutlinana Pack) was successfully tracked within the TIP survey area. Again, the entire track segment lay within the TIP survey area, but had not crossed any of the survey transects. Therefore, we did not detect two wolf packs totalling 13 wolves during the TIP survey. We continued aerial reconnaissance surveys through 2 April, but found no additional packs.

Similar wolf population and density estimates were obtained from the aerial reconnaissance and TIP surveys. The TIP wolf population estimate within the 5,011-km^2 survey area was 33.4 with an 80% confidence interval (CI) of 23.2 to 43.6 (Table 2). The density estimate was 6.7 wolves/1000 km^2 (80% CI = 4.6 - 8.7 wolves/1000 km^2). Twenty five wolves were seen during the TIP survey. In comparison, the range of estimates from the aerial reconnaissance survey within the TIP survey area (5,011 km^2) was 38-43 wolves (7.6 - 8.6 wolves/1000 km^2), and the range of estimated densities within the entire MSA (8,340 km^2) from aerial reconnaissance was 6.6 - 8.5 wolves/1000 km^2 (no confidence interval).

In this case, extrapolation of the TIP estimate (5,011 km^2 survey area) to a larger area of management concern (8,340 km^2) closely estimated wolf numbers in the larger area (point estimates of 59 wolves in extrapolated TIP vs. 61 wolves estimated by aerial reconnaissance). For management, I believe extrapolation of TIP estimates to areas 2-3 times the size of the TIP survey area are justified if habitat and prey densities within the larger area are relatively homogeneous and known to be similar to those within the smaller TIP survey area.

Potential advantages of the TIP survey procedure over other survey methods include objectivity, time-efficiency, reduced cost, reasonable accuracy, and measurable precision. Aerial reconnaissance surveys require more flight time than TIP surveys because accurate estimates from aerial reconnaissance surveys require detecting and differentiating all wolf packs within the survey area. The TIP survey does not require detection of all packs, only those that cross transect lines. In this case the TIP estimator yielded an apparently accurate wolf density estimate at less than half the operating cost of the aerial reconnaissance survey. The TIP was also time and manpower efficient requiring only 3 aircraft-days and 6 person-days compared to 11 aircraft days and 21 person-days expended completing the aerial reconnaissance survey.

The precision realized during this TIP survey (+/- 30% at the 80% C.I.) was acceptable for detecting long-term population changes of 40% or greater, but would be marginal for detecting annual population trends in most wolf populations. As recommended by Ballard et al. (in prep) and Gardner and Becker (1991), further refinement of the technique is needed to improve precision.

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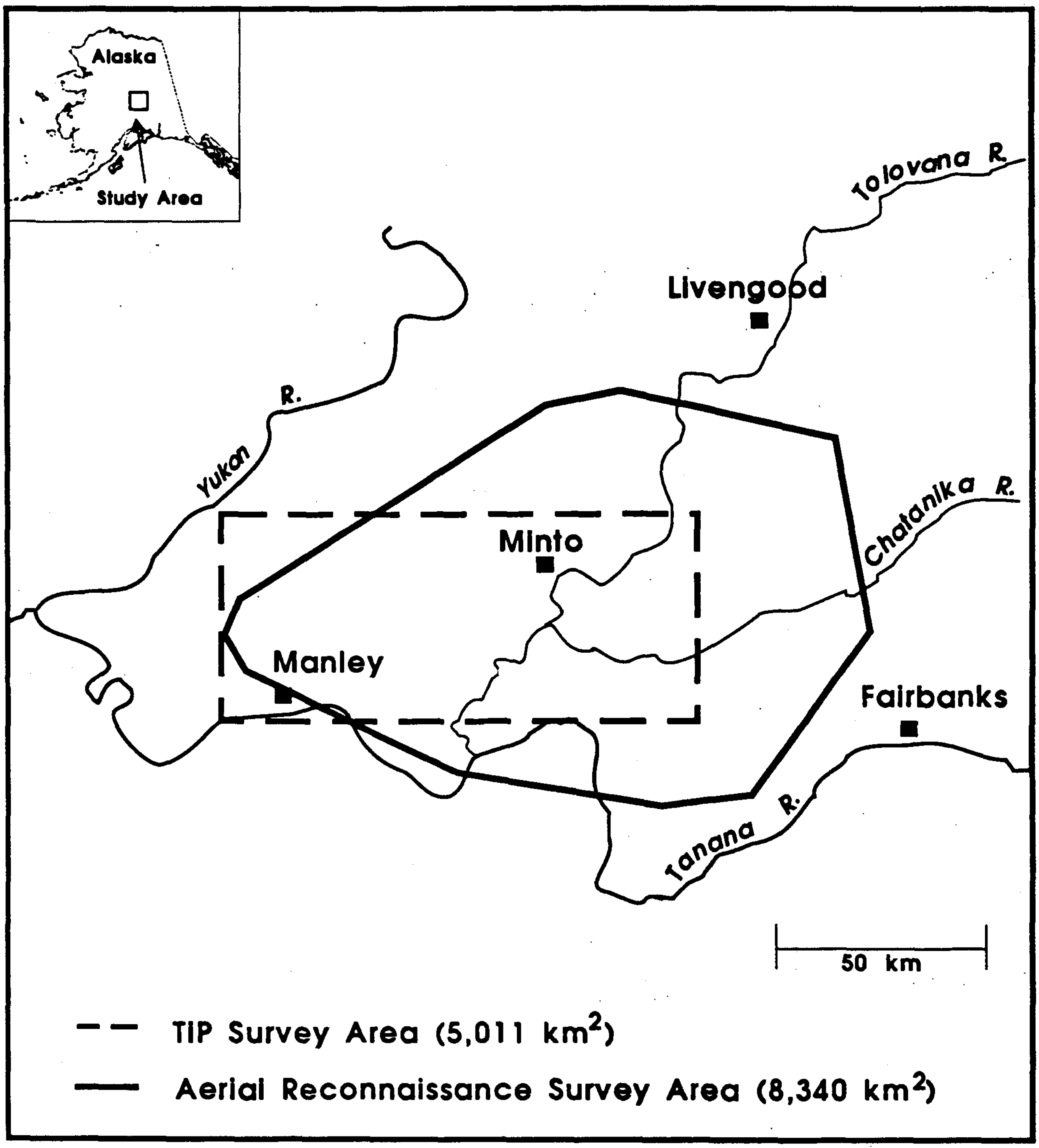


Figure 1. Relative position of aerial reconnaissance and TIP survey areas in the Minto Study Area in Interior Alaska.

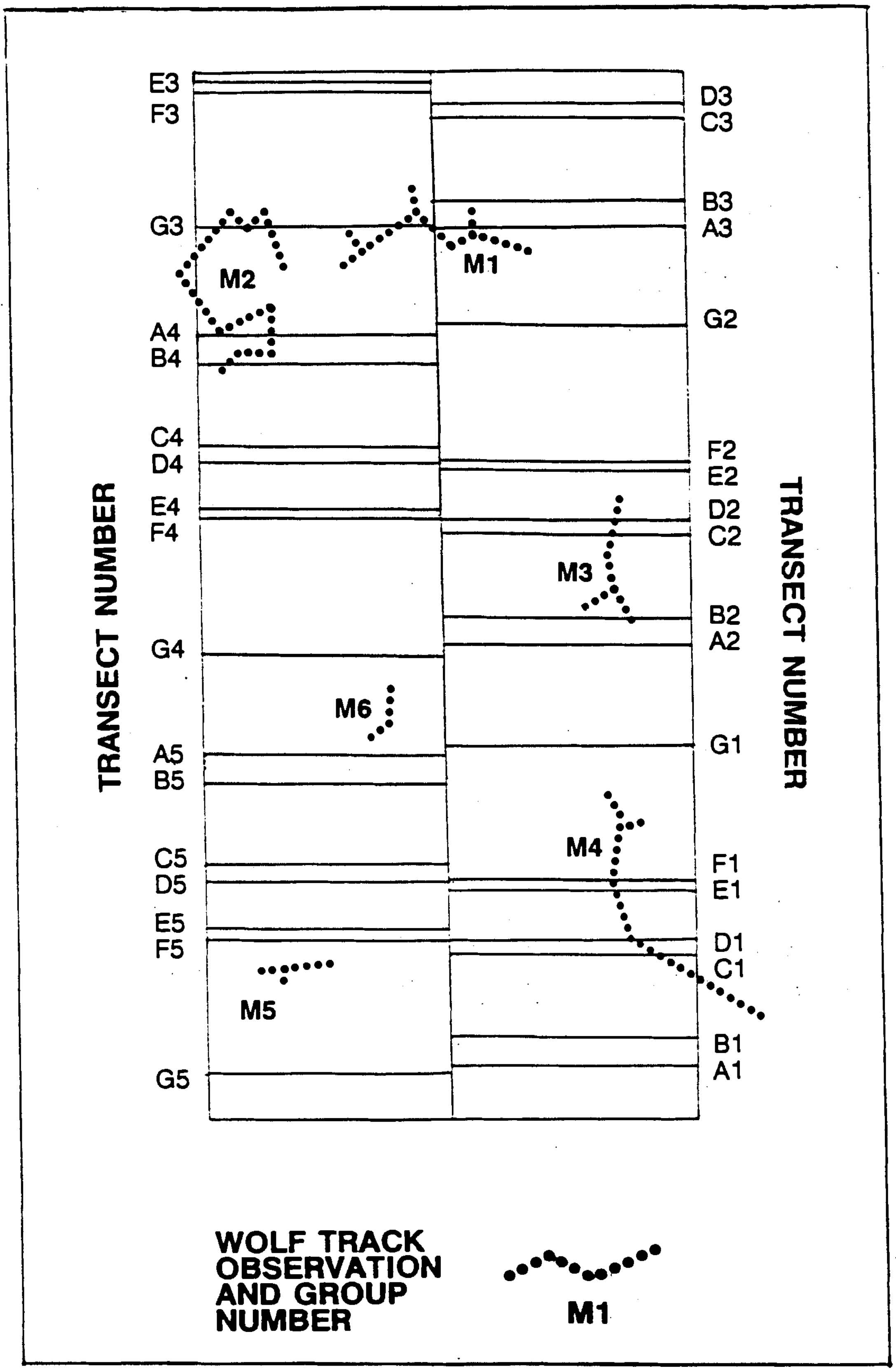


Figure 2. Distribution of observed wolf tracks in relation to randomly spaced transects in the Minto Study Area in Interior Alaska.

Table 1. Estimated size and color composition of wolf packs identified within the 8,340-km^2 Minto Study Area on aerial reconnaissance surveys, 12 March-2 April 1991.

Pack ID #	Pack Name	Estimated number of wolves (no. observed)	Color
M 1	COD[a]	2 (0)	Tracks only
M 2	Tolovana[a]	6 (6)	1 black, 5 gray
M 3	Swanneck[a]	12 (12)	11 black, 1 gray
M 4	Dugan[a]	5 (3)	1 black, 2 gray
M 5	Baker[a]	7 (7)	5 black, 2 gray
M 6	Hutlinana[a]	6 (6)	4 black, 2 gray
M 7	Globe	3 (0)	Tracks only
M 8	Tatalina	8 (0)	Tracks only
M 9	Chatanika	3 (3)	3 black
M10	Minto Lakes	2 (2)	1 black, 1 gray
M11	Manley[a]	3 (0)	Tracks only
M12	Standard	4 (0)	Tracks only
M13	Wolverine Mountain	2 (0)	Tracks only
M14	Uncle Sam[a]	2 (1)	1 black
M15	Deadman	2 (1)	1 black
M16	Dunbar	4 (0)	Tracks only

"Best" Estimate[b] 61 (39) = 7.3 wolves/1,000 km^2
Low Estimate[c] 55 (39) = 6.6 wolves/1,000 km^2
High Estimate[d] 71 (41) = 8.5 wolves/1,000 km^2

[a] Denotes packs observed within the TIP survey area
[b] Best estimate included packs M1-M12.
[c] Low estimate excluded packs M7, M11, M13-M16.
[d] High estimate included all packs M1-M16.

Table 2. Summary of Track Intercept Probability wolf survey conducted on 31 March 1991 and calculations to estimate population size within the 5,011-km^2 survey area (Total axis length, X = 198.8 km, 5 transects per sample).

Wolf Group	Pack Name	Estimated No. of Wolves (no. observed)	D[a] Distance Moved (km)	P[b]	T[c]
M1	C.O.D.	2(0)	6.45	0.162	12.35
M2	Tolovana	6(6)	12.98	0.326	18.40
M3	Swanneck	12(12)	12.50	0.314	38.22
M4	Dugan	5(3)	20.32	0.511	9.78

Sample ID (i)	Wolf Groups Encountered	Pop. Est. Based on ith Sample (T for each group)
A	M1, M2	30.75
B	M2, M3	56.62
C	M3, M4	48.00
D	M3, M4	48.00
E	M4	9.78
F	M4	9.78
G	M1, M2	30.75
Total		233.68

Total population estimate = 233.68/7 = 33.38

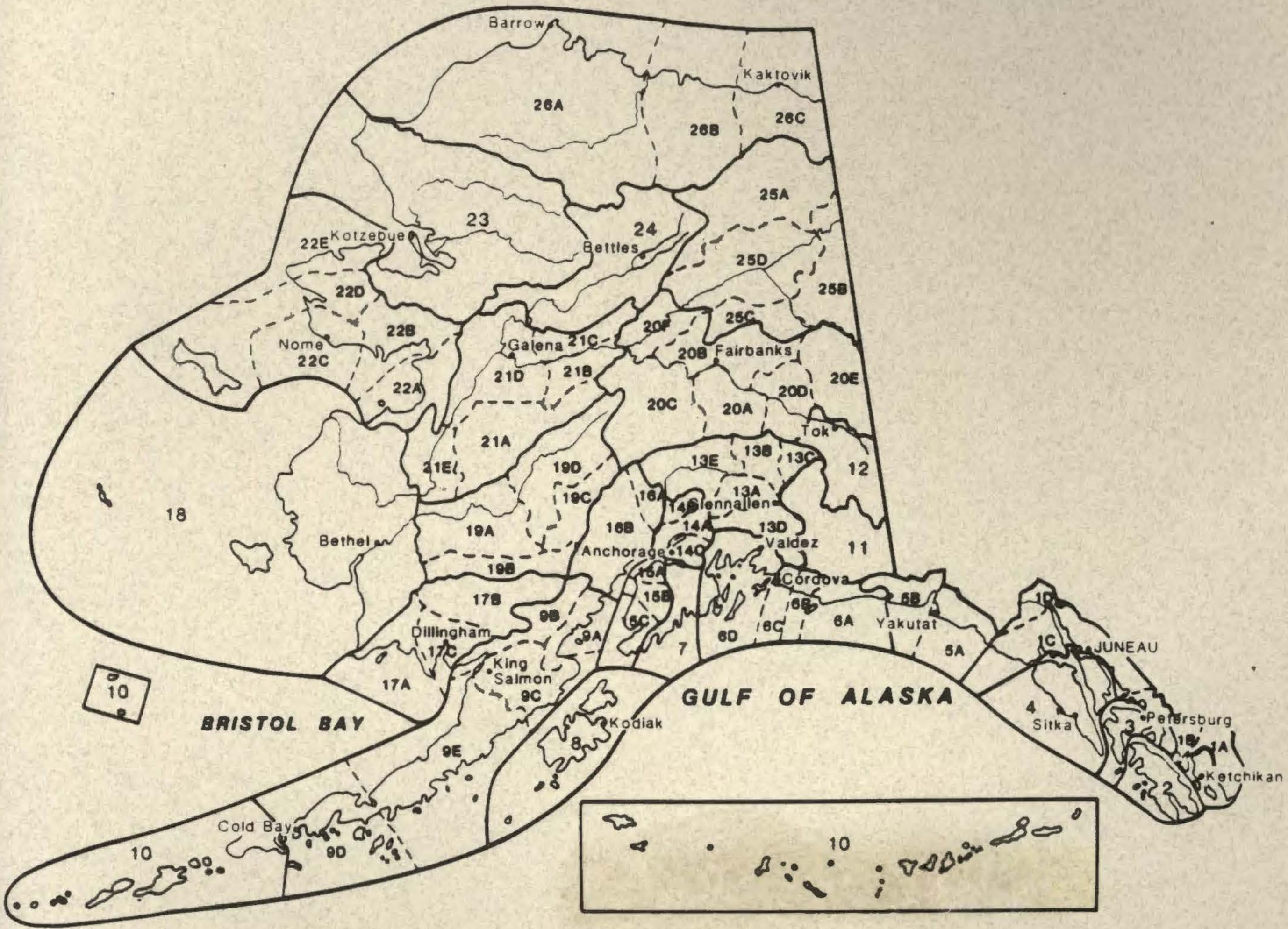
80% confidence interval = 23.21-43.55

[a] D = Distance moved perpendicular to intercepted transect

[b] Probability observed (P) = (D/X)(5)

[c] T = Pack size/P

Alaska's Game Management Units



Federal Aid in Wildlife Restoration

The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program then allots the funds back to states through a formula based on each state's geographic area and the number of paid hunting license holders in the state. Alaska receives 5% of the revenues collected each year, the maximum allowed. The Alaska Department of Fish and Game uses the funds to help restore, conserve, manage, and enhance wild birds and mammals for the public benefit. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes necessary to be reponsible hunters. Seventy-five percent of the funds for this project are from Federal Aid.