

**MOVEMENTS OF COYOTES  
FROM AND TO  
YELLOWSTONE NATIONAL PARK**



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**Special Scientific Report Wildlife No. 11**

**United States Department of the Interior, Oscar L. Chapman, Secretary  
Fish and Wildlife Service, Albert M. Day, Director**

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In 1945 the Denver Wildlife Research Laboratory was requested by the National Park Service and the Absaroka Conservation Committee to study the migratory habits of coyotes in the Yellowstone region. This request was prompted by the contention of neighboring ranchers and sportsmen in Montana that coyotes from Yellowstone Park spread to surrounding areas where they were not wanted. To determine the facts the Wildlife Research Laboratory, from 1945 to 1950, carried on a coyote-tagging program in the Yellowstone region. Although scattered records may yet be forthcoming, the bulk of the returns have been received and are set forth in this paper.

Mere mention of cooperation cannot adequately acknowledge the immense contributions of others to this project. It has truly been a cooperative program with many agencies and individuals taking part. The Absaroka Conservation Committee suggested and sponsored the tagging study, and all details have been discussed regularly at its semiannual meetings. The National Park Service placed many facilities at the Laboratory's disposal, and Park Superintendent Edmund B. Rogers and his staff aided in all phases, especially in observing and collecting tagged animals. To assure the return of tags from outside areas the Absaroka Conservation Committee early in the study suggested a reward, and the participating Rod and Gun Clubs responded by offering \$1.50 for each

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1/ Formerly Biologist, Wildlife Research Laboratory, Branch of Wildlife Research. The authors are greatly indebted to E. R. Kalmbach, Director of the Laboratory, for guidance and advice and for critically reviewing this paper; to Biologist Robert W. Sears, formerly of the Laboratory, for assistance during a brief period in 1945; and to Drs. O. J. Murie and Adolph Murie for valuable suggestions and field assistance at various times.

tag recovered. A year later this was increased to \$10, paid jointly by the Park County (Montana) Rod and Gun Club and the Montana Fish and Game Commission. Payment of the reward, to be continued even after the study was formally completed, was administered by Vice-chairman R. A. Hamilton of the Committee, and he and Secretary George H. Kern did everything possible to expedite the return of tags. Ranchers of the Yellowstone Valley cooperated in tagging and in the regulation of coyote-control methods to permit the recovery of tags; their willingness to risk depredations that otherwise might have been prevented represents a real contribution. For two summers the Montana District of the Branch of Predator and Rodent Control, Fish and Wildlife Service, assigned an extra trapper to southern Park County adjacent to Yellowstone National Park to aid in the summer recovery of tagged animals. Without this assistance the data would have been gathered much more slowly and would have been far less complete. Although the tagging of coyotes was principally the work of the laboratory, as was the analysis of the returns, the volume of returns has been made possible largely through the contributions of others.

#### Tagging

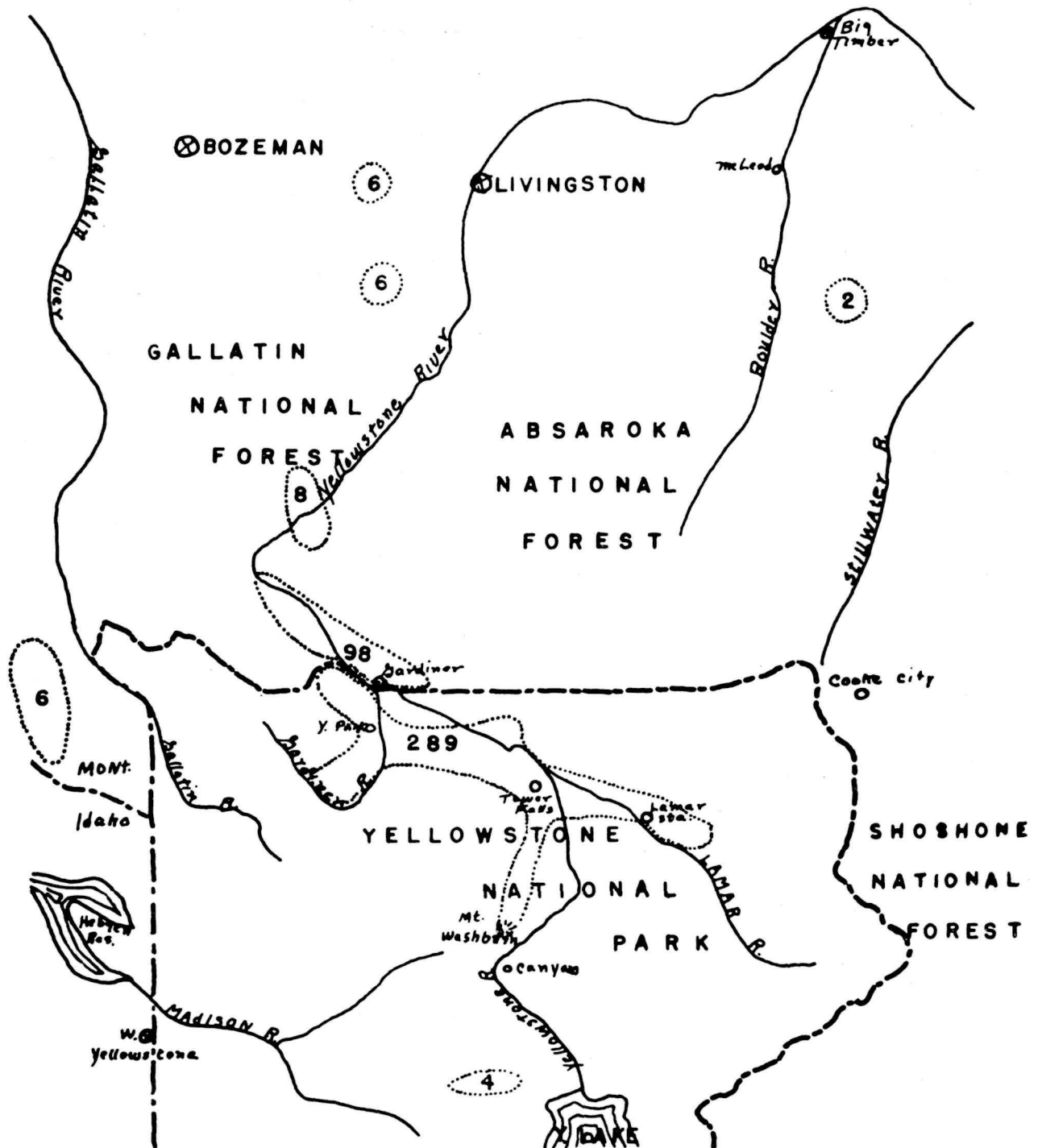
To determine the extent and nature of coyote movements into and out of Yellowstone Park, these animals were tagged not only in the Park but beyond the boundary to the north as well. Likewise, recovery of the tagged animals was not limited to the outside areas but was vigorously conducted by supervised shooting inside the Park. The coyotes to be tagged were taken as pups from dens in the spring, or were captured during other seasons with padded steel traps. A few animals taken by the latter method were unfit for tagging because of injuries and were destroyed immediately. Although an attempt was made to release only those coyotes which would not be permanently disabled, it was not always possible to determine how a trap wound would heal. Some bad flesh wounds would mend completely, whereas a few coyotes with apparently lesser injuries would later be lame, sometimes losing toes or the entire foot. The number of animals so handicapped, however, was relatively small.

A numbered aluminum tag, with printed directions for return to Denver, was attached to one ear of the coyote. At least 5 per cent of the tags were lost by the animals. Some tags, as judged by a scarred notch in the animal's ear, were torn out in fights or by becoming snagged; others seemingly came unclamped, but this loss seemed traceable to defective pliers used in setting some of the tags. To permit distant identification and the recovery only of tagged coyotes in the Park, the tip of the untagged ear of each animal was removed. In the Park, the tag was placed in the left ear and the right ear was cropped. With coyotes trapped outside the Park, a reverse procedure was used. The ear-cropping probably was no more painful to the animal and healed even faster than the incision made by the tag.



**FIGURE 1: LOCATIONS OF TAGGING**

(SCALE - 1 INCH = 12 MILES)



**LEGEND 8 - NUMBER OF COYOTES TAGGED IN AREAS INDICATED.**

Approximately 3 man-months in each of 5 consecutive years were spent in tagging, 2 months in spring denning and 1 month in late summer, fall, or winter trapping. As shown in Figure. 1, 419 coyotes were marked and released - 293 within the Park, and 126 in adjoining areas. Of the 419, 325 were young of the year and 94 were older animals. The preponderance of young animals may be explained by the fact that spring denning produced only pups for tagging, whereas trapping in the fall or winter resulted in the capture of young and older coyotes in about equal numbers.

Two hundred and sixty coyotes were tagged with relative ease in the Park, and 90 in outside areas in the April to September period. When it became evident that the predominant direction of fall and winter movement of these animals was down-country to the north, efforts were made to tag the drifters during the winter at the lower altitudes. Real difficulty was experienced in this phase because the only feasible method of capturing adult coyotes alive was through trapping, and in the cold, mid-winter weather the trapped foot quickly froze. Most coyotes would then chew off the frozen foot. A solution was furnished when returns showed that many of the animals moved down-country as early as October and November. Sixty-nine eventually were marked and released along the north Park boundary from October to March, mostly during the first 2 months of that period - 33 in the Park within 5 miles of the boundary and 36 in contiguous outside areas.

#### Recovery

There are, at this writing, 178 usable returns on which to base conclusions. Since 4 of these coyotes were recovered twice, the figure of 174 animals involved amounts to 41.5 per cent of those tagged. In addition, 34 returns were discarded because the animals were taken as young pups, or so soon after release that the records are of little significance. Ten other coyotes were known to have been killed with the tags missing and 5 with tags in place, but their numbers were not reported. There were actually 227 known recoveries involving 207, or 49.4 percent, of the 419 coyotes originally tagged. One hundred and ninety-five of these are known to have been killed, and no doubt most of the remaining 224 animals have disappeared by this time through natural mortality, predator-control work outside the Park, or other causes. A few scattered returns may be received over a period of several years and may furnish interesting records on longevity and unusual movements.

Although longevity records will be more complete when the flow of returns has stopped, the recovery intervals as set forth in Table 1 may be of interest. The records show that 38.1 percent of those tagged as pups and 62.8 percent of the adults have been recovered. The difference may be due to (1) higher natural mortality among the younger animals; (2) more of the pups being lost through drifting into areas where 1080 was used in coyote control; and (3) even if recovered at the more distant points, less chance of tag return since information about the \$10 reward was not generally known there. The higher incidence of recovery of coyotes tagged in 1948 and 1949 no doubt is due to more intensive hunting during those years. Most of the animals were re-taken during their first year after tagging, and the longer they were at liberty the less chance there was of their tags being reported.

Table 1 - Recovery Intervals

PUPS:

Year	Coyotes Tagged	Eventually Recovered		When Recovered*				
		Number	Per Cent	0-1 Year	1-2 Years	2-3 Years	3-4 Years	4-5 Years
1945	35	12	34.3	5	5	0	1	1
1946	71	23	32.4	9	10	2	2	-
1947	74	20	27.0	16	4	0	-	-
1948	79	37	46.8	25	11	1	-	-
1949	66	32	48.5	23	7	2**	-	-
Total	325	124	38.2	78	37	5	3	1

Yearly percentages of returns based on total number recovered (124)

62.9    29.8    4.0    2.4    0.8

Yearly percentages of returns based on total number tagged (325)

24.0    11.4    1.5    0.9    0.3

ADULTS:

1945	14	10	71.4	4	3	2	0	1
1946	23	8	34.8	2	3	3	0	-
1947	None							
1948	30	23	76.7	15	6	1	1	-
1949	27	18	66.7	14	4	-	-	-
Total	94	59	62.8	35	16	6	1	1

Yearly percentages of returns based on total number recovered (59)

59.3    27.1    10.2    1.7    1.7

Yearly percentages of returns based on total number tagged (94)

37.2    17.0    6.4    1.1    1.1

TOTALS

ALL COYOTES:

419	183***	43.7	113	53	11	4	2
				(	incomplete		)

\* For pups the interval is dated from May 1 of the year they were born; for the adults, whose ages were not known, the tagging date is used.

\*\* These were 1948 pups tagged in January 1949, and were between 2 and 3 years old when killed in 1950.

\*\*\* Includes 180 coyotes killed on recovery and 3 usable records of animals that were retrapped once and then released but not reported later.



## Summer to Winter Movements

Coyotes may range extensively while searching for food, and often it is impossible to say whether an animal's presence at a particular place is due to normal hunting or to migration. Without being able to distinguish home range from what may be construed as a movement therefrom, a distance of 5-1/2 miles from the tagging point arbitrarily was used to separate the two. Fractional distances were converted to the nearest whole number. Thus, each location at which a coyote was tagged was assumed to be the focus of that animal's activity, allowing it a hunting range of 5 miles in all directions, or about 78 square miles. This assumption may be literally true for pups and parent animals taken at dens, but perhaps not for others, which may have been tagged at one end of their hunting ranges. Some coyotes travelling 6 airline miles or more from the tagging points still may have been within their home ranges, but it is equally certain that others going shorter distances - such as 4 that crossed the Park boundary and the unfrozen Yellowstone River - had actually drifted. Since it was impossible to define home range according to terrain, the mileage basis was used in all cases.

Of the 260 coyotes tagged in the Park in the spring and summer (April to September, with 5 trapped October 1 and 2, 1946, included), 79 were recovered in the fall and winter (October to March, inclusive). As shown in Figure 2, 36 were taken within 5 airline miles of the tagging points or within what is considered to be their home ranges, but 9 of these had crossed the Park boundary to the outside. The 43 remaining animals drifted more than 5 airline miles: 1 up-country but still in the Park; 2 out of the Park to the northwest; 1 out of the Park to the south; 1 out of the Park to the northeast; 8 down-country to the north but still in the Park; and 30 outside the Park to the north. Those tagged in the outside regions and recovered during the same seasons moved in the same general directions. Of 90 tagged and 26 recovered, 14 were taken nearby, 1 moved up-country to the east, 1 moved up-country across the northwest corner of the Park, and 10 moved down the Yellowstone Valley in the general direction taken by the drifting Park coyotes.

It is apparent that about half of the coyotes inhabiting the northern drainages of the Park in the spring and summer move to the outside in the fall and winter, predominantly down-country to the north. The conclusion is the same whether based upon movements of 6 airline miles or more, or upon the simpler basis of comparing numbers of tagged Park coyotes taken inside the Park with those taken outside. Of the 79 animals, 43 drifted 6 airline miles or more, and 43 were recovered beyond the Park boundaries. The distances travelled by the 43 migrants averaged 24.7 airline miles with a maximum of 95.

The 260 coyotes tagged in the Park during the spring and summer included 213 pups (81.9 percent) and 47 adults (18.1 percent), a ratio of 4 to 1 in favor of the pups. Recovery of tagged animals during the fall and winter was 3 to 1 in favor of the younger animals, with 59 pups (74.7 percent) and 20 adults (25.3 percent) being taken. The difference

Figure 2 : WINTER RECOVERY OF  
SUMMER-TAGGED COYOTES.  
105 RETURNS (79 TAGGED IN PARK).

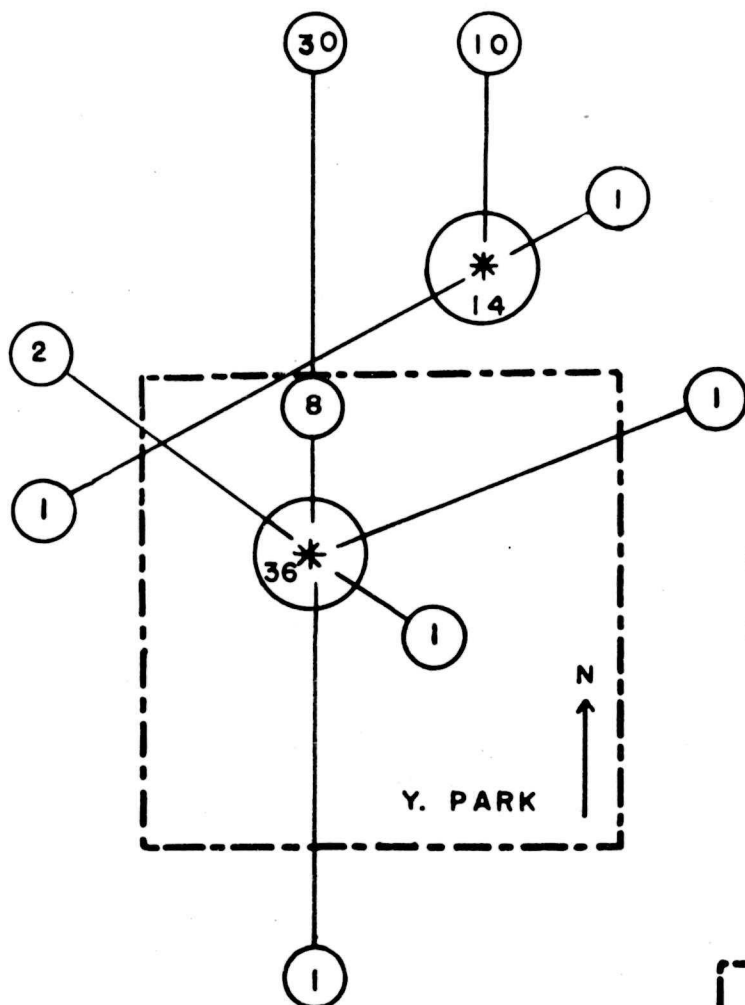
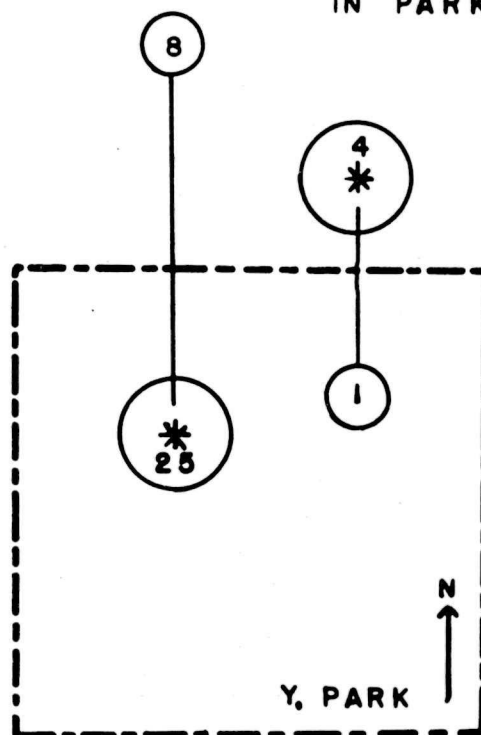


Figure 3: SUMMER RECOVERY  
OF SUMMER-TAGGED COYOTES.  
38 RETURNS (33 TAGGED  
IN PARK),



in the recovery ratios may be the result of higher natural mortality among the younger coyotes from which tags are not retrieved, or it is possible that a greater number of pups moved to more distant points from which tag return was less likely owing to less public familiarity with the project. The records show that both the older coyotes and the young of the year are involved in the down-country shift. Thirty-three, or 55.9 percent, of the 59 pups recovered had moved more than 5 airline miles and 10, or 50.0 percent, of the 20 adults had shown some drift. The younger animals, however, traveled greater distances, averaging 26.4 airline miles to 19.0 for the adults.

Eighteen pups tagged in the spring were recovered between August 21 and October 1 of the same year, all within short distances of the tagging points. The earliest recorded drift was on October 4 when a young coyote was killed 28 airline miles away, and 7 of 12 young of the year taken during that month had moved down-country. By November, 2 young animals had drifted more than 60 airline miles. Also, an adult tagged near timberline on September 12 was killed 32 airline miles down-country a month later. It is evident that the major movements begin in early October and much of the coyote drift precedes and is not dependent upon the movements of big game.

The data show a successive shifting of populations downward in the fall and winter, with some individuals going short distances while others travel farther. A review of a few individual records will reveal the pattern. In the spring of 1948, 3 litters totaling 15 pups were tagged in a river valley known as the Horseshoe, east of Tower Falls Ranger Station, and in September of that year 10 coyotes were marked and released in higher country to the south on Mount Washburn. In succeeding periods (October to March), 4 of the Mount Washburn coyotes were collected in the Tower Falls-Horseshoe area and 3 moved beyond the Park boundaries; at the same time only 1 of the Horseshoe pups was taken nearby while 4 drifted down out of the Park. In other words, many of the coyotes inhabiting the Horseshoe-Tower Falls area in the summer had moved down-country in the winter, they being replaced and their number even increased by migrants from the higher mountains. This pattern no doubt applies to all of the northern, open section so densely populated with coyotes in the winter.

#### Summer to Summer Movements

Do the drifting coyotes return to the Park after the down-country movements in the fall and winter, or do they remain outside? A partial answer is contained in the records of summer recovery of summer-tagged coyotes as shown in Figure 3. Of 33 Park coyotes tagged during the spring or summer and recovered during the same seasons in later years, 8 were taken outside the Park to the north and 25 near their tagging points. Five coyotes tagged on the outside were recovered during similar seasons; 4 of these were recaptured nearby in later years, and 1 had moved into higher country in the Park a few days after

release. The last record illustrates the difficulty of defining home range even on an arbitrary mileage basis. The fact that this adult animal was retrapped 13 miles away 16 days after tagging, and was later killed near the first point of capture, suggests that the coyote was captured the second time while on a hunting foray even though 7 miles beyond the limits of the suggested home range.

The records of the 8 Park coyotes (6 tagged as pups and 2 as adults) being taken outside in subsequent summers show that there is some permanent drift from the Park. The proportion, 8 outside to 25 inside, indicates that about one-fourth the yearly numbers are permanent migrants. Conceivably the intensity of recovery efforts could influence this proportion, but no doubt a greater percentage of the tagged coyotes in the Park eventually were taken than in the outside areas. In a 15 day period in April 1950, 235 coyotes observed by the senior author in the Park (with attempts to avoid daily duplications) were classified as follows: Untagged, 203; tagged, 18; not identified, 14. In June 1950, an average of not more than 1 out of 15 coyotes encountered there was tagged, whereas in the same period a trapper working north of the Park boundary found an average of 1 of 5 adult coyotes tagged and his predecessor found 1 out of 7 in the summer of 1949. These relative proportions suggest that a higher percentage of the tagged coyotes remaining in the Park were recovered than in the outside areas and that the figure of one-fourth the spring and summer population of coyotes in the Park taking up permanent residence each year beyond the boundaries is not excessive.

An analysis of the age classes of coyotes taken during the spring and summer in the Park indicates that some of those drifting down-country in the fall and winter had returned while others had remained away. As pointed out earlier, pups outnumbered adults about 4 to 1 (213 to 47) in tagging and about 3 to 1 (59 to 20) in fall and winter returns. Although coyotes of both age classes drifted downward during the winter, the pups were making the longer movements averaging 26.4 airline miles as compared to 19.0 for the adults. It is logical to assume, therefore, that the younger animals were ending up at more distant points from which they would be less likely to return to their birth-sites. Subsequent recovery efforts during the spring and summer on the home ranges in the Park produced 11 coyotes tagged as adults to only 14 tagged as pups. The greater relative



abundance of the adults suggests a general return of this age class of drifters to their previous home area, and the scarcity of coyotes tagged as pups indicates that many of these had remained away <sup>2/</sup>. That some adults may likewise take up permanent residence elsewhere is shown by the fact that 2 were taken during summer, 13 and 14 airline miles down-country and across the Yellowstone River 1 and 2 years, respectively, after tagging. However, since coyotes apparently do not breed until their second year under Yellowstone conditions <sup>3/</sup>, the subadults may show a dispersal pattern similar to that of pups. One of the adults taken down-country in the summer was listed as a young animal, probably a yearling, at the time of tagging and the other one also may have been of that age class.

#### Combined Returns from Spring and Summer Tagging

Figure 4 shows the general areas where 260 coyotes were marked and released in the Park during the spring and summer and 112 recovery points of these animals at all seasons. Sixty-one coyotes were taken within the Park - 52 within five airline miles from the tagging points and 9 at greater distances. Fifty-one were recovered beyond the Park boundaries - 9 were 5 airline miles or less from the tagging locations and 42 were 6 airline miles or more away. The distances traveled by the 42 migrants averaged 28.3 airline miles with a maximum of 115.

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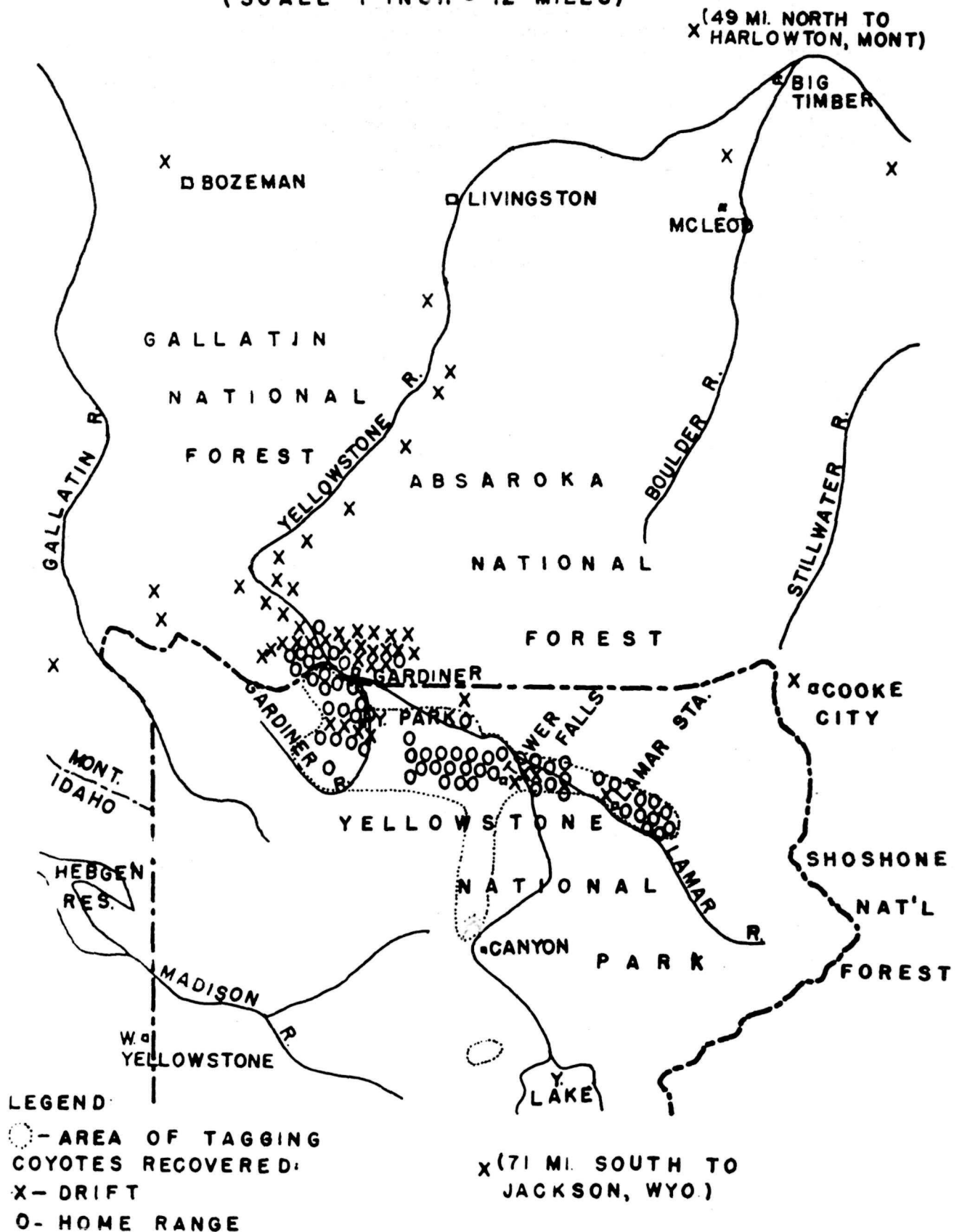
Since the records show that about half of the pups and half of the adults drift down-country in the winter with the balance remaining near the tagging points, these non-drifters should show the same ratio of 4 pups to 1 adult. Assuming that all of the adults and none of the pups returned to their original ranges, the ratio there in the summer should be 2 to 1 in favor of the younger animals. The difference between this theoretical proportion and the approximately equal numbers actually found there in the summer may be due to higher natural mortality and other losses among the younger animals.

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3/

Seven females known to be yearlings when collected were nonbreeders, while at the same time 11 older females, including 2 two year olds, killed in the spring or summer had bred that year. The failure of Yellowstone coyotes to breed as yearlings may not hold true in all areas, and this, together with other pertinent information, may be the subject of a later paper.

Figure 4 : RECOVERY POINTS OF PARK COYOTES  
TAGGED IN SPRING OR SUMMER  
(SCALE - 1 INCH = 12 MILES)



## Winter to Winter Movements

To clarify the amount of return and the amount of permanent drift resulting from the down-country movements in the fall and winter, it was necessary to mark and release some coyotes during those seasons at the lower altitudes. Obviously it was impossible to attempt tagging at the many distant points to which Park coyotes had drifted with the expectation that any significant number would ever find their way back to the Park and be recovered there. The only solution was to confine winter tagging to nearby areas. The area chosen was a 20 mile section - 5 miles inside the Park and 15 miles outside - astride the main migration route down the valley of the Yellowstone River. Sixty-nine coyotes, including 35 classed as pups and 34 as adults, were marked and released there in the fall and winter. It was at times difficult to distinguish between large pups and yearlings this late in the season, but it is believed that mistakes, if any, were few in number.

Twenty-two of the 69 coyotes tagged in the fall and winter were killed during those seasons, mostly a few months after tagging. As shown in Figure 5, 11 adults and 5 pups were taken nearby, 3 pups and 1 adult had gone farther down-country, and 2 adults had turned back into the Park. The area of fall and winter tagging was an especially dangerous one for tagged coyotes, and the fact that twice as many adults as pups were killed near the tagging points suggests that fewer of the younger animals had remained long in that vicinity. Their chances for survival increased as they traveled away from the Park because of the intense hunting pressure along the boundary during big-game season. However, this lease on life may have terminated abruptly if migrating coyotes journeyed 40 airline miles to an area in which the Montana Predator Control district annually placed winter 1080 stations for coyote control. If killed in that manner there would be little chance for tag recovery.

Thirteen of the 69 coyotes (Figure 6) tagged in the fall and winter were recovered in the spring and summer. Five (3 adults and 2 pups) were taken nearby. Three animals had continued on beyond the Park boundary - 1 pup 34 airline miles to the east, another 50 miles to the north, and a third (a young female of uncertain age at the time of tagging but called a pup when killed because it had not yet bred) 8 airline miles to the northwest. Five coyotes had traveled 9 to 29 airline miles to higher elevations back into the Park - 3 were older adults, 1 probably a yearling, and the fifth a pup.

Figure 5: WINTER RECOVERY OF  
WINTER-TAGGED COYOTES.  
22 RETURNS.

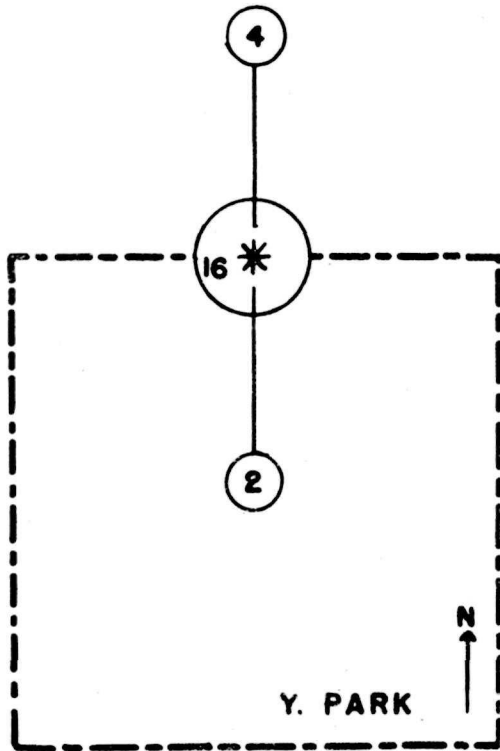
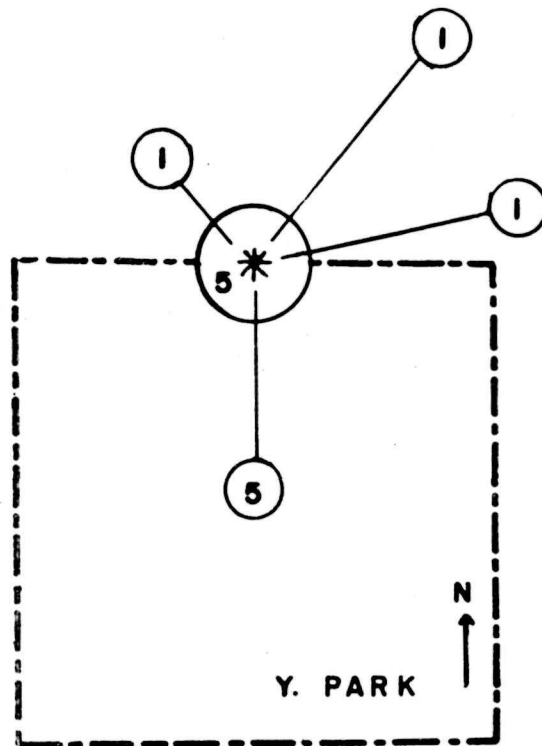


Figure 6: SUMMER RECOVERY OF  
WINTER-TAGGED COYOTES.  
13 RETURNS.





### Combined Returns from Fall and Winter Tagging

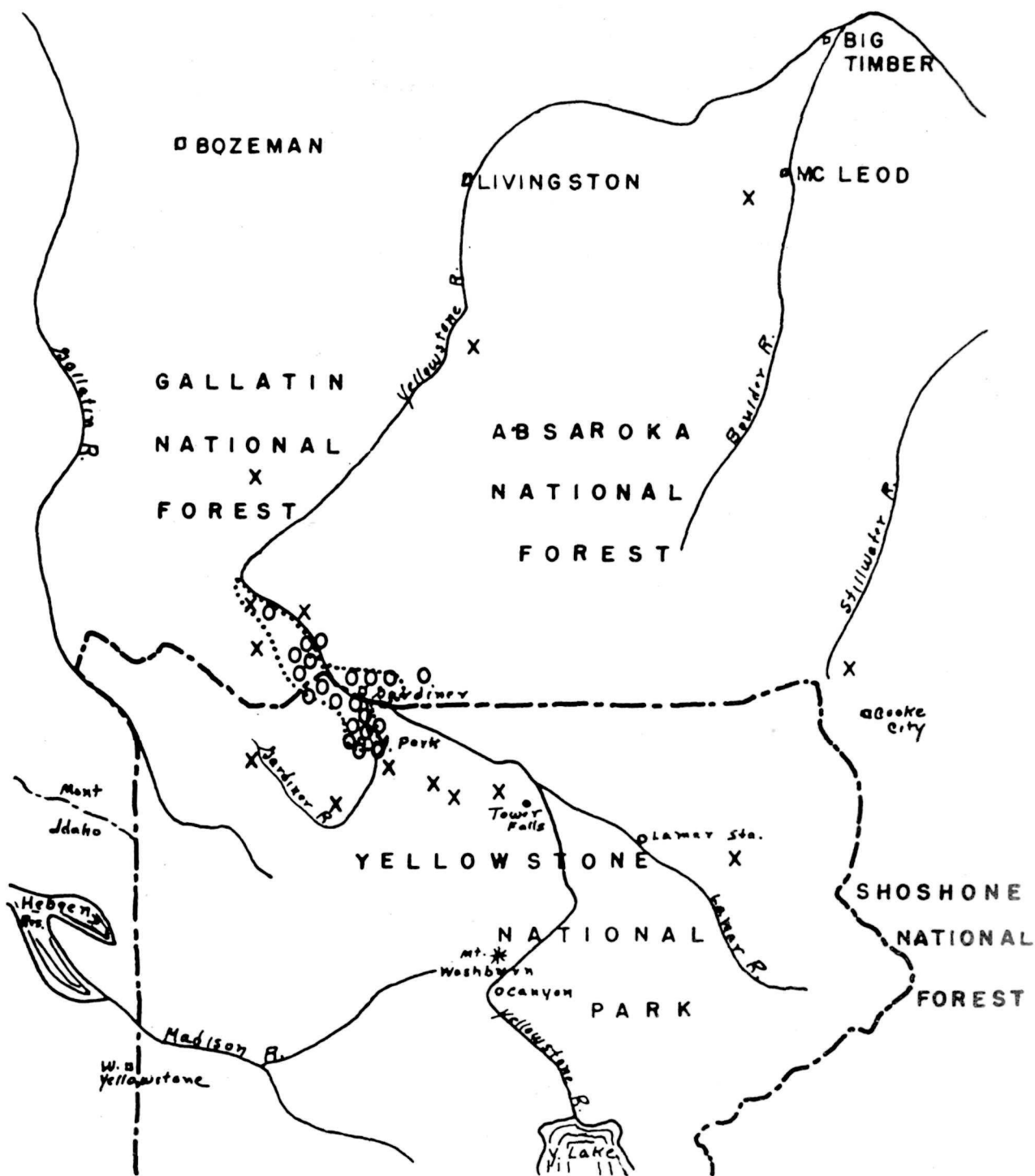
The general area of fall and winter tagging and the points of recovery of coyotes marked and released there are shown in Figure 7. Seven coyotes that had moved 6 to 50 airline miles in general directions away from the Park were later recovered; 6 were pups and 1 an adult. An equal number had returned 9 to 29 airline miles to higher altitudes in the Park; 5 were adults, 1 probably a yearling, and 1 a pup. These returns confirm the general tendency of the younger animals to disperse and the older animals that have become established in the Park to return there by spring.

When it is considered that the Park is a high plateau and mountainous section surrounded by lower areas, and supports a maximum coyote population, it becomes apparent why the outward movements are greater than the inward movements. The dispersal tendency of juveniles, whether they be birds or mammals, is common knowledge. With coyotes this occurs in the fall as the young animals become old enough to shift for themselves, and then there is only one logical direction for them to go, down-country. Since the initial direction of movement of the dispersing pups is determined by altitude, it follows that more will leave the park than ever find their way back. As the wandering pups mature, some no doubt continue the upward and downward seasonal movements in their new locations, but, once beyond the Park boundary, this sanctuary then becomes just one of the many mountainous areas available to them.

Ranger Rudolf L. Grimm observed that ear-cropped (tagged) coyotes began appearing at the higher altitudes in the Park in February following their capture along the north Park boundary in October and November. One adult tagged in October was killed 16 airline miles up-country the following February, and another tagged in November was killed in April, 10 airline miles up-country in a region still covered with deep snow. Tracks show that these predators reappear in the deep snow areas as soon as the snow crusts sufficiently to permit them to travel freely. This occurs sometimes as early as January, with activity increasing in February and March. Just as the downward drifts in the fall occur before the movements of big game, the return of coyotes to the higher altitudes may precede by several weeks that of game animals.

Figure 7: RECOVERY POINTS OF FALL AND WINTER-TAGGED  
COYOTES

(SCALE - 1 INCH = 12 MILES)



LEGEND:

○ - AREA OF TAGGING

COYOTES RECOVERED

X - DRIFT

O - HOME RANGE

## Drift by Sexes

In earlier tagging by the Control Methods Research Laboratory, Garlough (1940) reported a maximum migration of 100 miles for a male coyote and 80 miles for a female, with males traveling slightly greater average distances. Sheldon (1950) recorded a maximum movement of 40 miles for a male red fox and 2 miles for a female, but stated that other evidence showed that female foxes also disperse widely. In the Yellowstone study, males outnumbered females 121:100 in tagging and 105:100 in returns. Of the coyotes moving more than 5 airline miles, 44 were females, averaging 23 miles and 34 were males, averaging 21 miles. Also, the 3 longest drifts were by females. Collections near the tagging points were in reverse proportions, 57 males to 43 females. Contrary to expectations the females showed a greater tendency to migrate, though the difference may be slight.

## Summary and Conclusions

At the request of the National Park Service and the Absaroka Conservation Committee, a study was conducted of the migratory habits of coyotes in Yellowstone National Park. This was prompted by the contention of neighboring ranchers and sportsmen in Montana that the Park, through its policy of maintaining coyotes as desirable members of the Park fauna, supplied these predators to surrounding areas where they were not wanted. Over a 5 year period 419 coyotes were tagged and released in the Yellowstone region, and 178 usable returns justify these conclusions:

(1) About half of the coyotes raised or summering in the Park drift down-country and out in the fall and winter, the other half being more or less permanent residents of the Park.

(2) Both the older coyotes that have become established in the Park and the young of the year are involved in this drift, with the younger animals moving the greater distances.

(3) Coyotes tagged beyond the boundaries likewise move in a general direction away from the Park in the fall or early winter. There is, therefore, no reason to believe that persecution tends to drive coyotes into the Park for protection or that this area is recognized by many coyotes, particularly the younger ones, as either a sanctuary or preferred hunting ground.

(4) About half of the downward migrants, mostly the older coyotes, return to the Park by spring.

(5) The other half of the drifters, largely the dispersing young of the year, remain beyond the Park boundaries and, no doubt, some continue the upward and downward seasonal movements in new locations. Thus, about a fourth of the coyotes in the Park are permanent migrants each year to points beyond the boundaries.

(6) The distances traveled by the drifters from the Park, tagged there in the spring or summer and recovered at all seasons, averaged 28 airline miles with a maximum of 115.

(7) Much of the coyote drift precedes and is not dependent upon the movements of big game.

(8) Females showed a slightly greater tendency to migrate and males to remain nearer the tagging points.

(9) Coyote movements from the Park, as well as those from other high regions, are bound to have a certain populating effect in surrounding areas.

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