SUSITNA HYDROELECTRIC PROJECT

PHASE I FINAL REPORT

BIG GAME STUDIES

Volume IV CARIBOU

Kenneth W. Pitcher

ALASKA DEPARTMENT OF FISH AND GAME
Submitted to the Alaska Power Authority
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PREFACE

In early 1980, the Alaska Department of Fish and Game contracted with the Alaska Power Authority to collect information useful in assessing the impacts of the proposed Susitna Hydroelectric Project on moose, caribou, wolf, wolverine, black bear, brown bear and Dall sheep. This information, along with information on furbearers, small mammals, birds, and plant ecology collected by the University of Alaska, is to be used by Terrestrial Environmental Specialists, Inc. of Phoenix, New York, in preparation of exhibits for the Alaska Power Authority's application for a Federal Energy Regulatory Commission license to construct the project.

The studies were broken into phases which conformed to the anticipated licensing schedule. Phase I studies, January 1, 1980 to June 30, 1982, were intended to provide information needed to support a FERC license application. If the decision is made to submit the application, studies will continue into Phase II to provide additional information during the anticipated 2 to 3 year period between application and final FERC approval of the license.

Wildlife studies did not fit well into this schedule. Data collection could not start until early spring 1980, and had to be terminated during fall 1981 to allow for analysis and report writing. (Data continued to be collected during winter 1981-82, but could not be included in the Phase I report.) The design of the hydroelectric project had not been determined. Little data was available on wildlife use of the immediate project area, although some species had been intensively studied nearby. Consequently, it was necessary to start with fairly general studies of wildlife populations to determine how each species used the area and identify potential impact mechanisms. This was the thrust of the Phase I Big Game Studies. During Phase II, we expect to narrow the focus of our studies to evaluate specific impact mechanisms, quantify impacts and evaluate mitigation measures.

Therefore, the Final Phase I Report is not intended as a complete assessment of the impacts of the Susitna Hydroelectric Project on big game.

The reports are organized into the following eight volumes:

Volume I.	Big Game Summary Report
Volume II.	Moose - Downstream
Volume III.	Moose - Upstream
Volume IV.	Caribou
Volume V.	Wolf
Volume VI.	Black Bear and Brown Bear
Volume VII.	Wolverine
Volume VIII.	Dall Sheep

SUMMARY

The Nelchina caribou herd which has occupied a range of about 20,000 mi² in southcentral Alaska has been important to hunters because of its size and proximity to population centers. Currently, a proposal is being studied to construct a large hydroelectric project on the Susitna River in the western portion of the Nelchina range. The proposed impoundments would inundate a very small portion of apparent low quality caribou habitat. Concern has been expressed however, that the impoundments and associated development might serve as barriers to caribou movement, increase mortality, decrease use of nearby areas and tend to isolate "subherds." Overall objectives of this study were to evaluate potential impacts of the proposed hydroelectric project on Nelchina caribou and to suggest possible mitigating measures. Because of the changeable nature of caribou movement patterns short-term studies of distribution and movements must be tempered with historical perspective. Fortunately, the Nelchina herd has been studied continuously since about 1948 and records previous to that time have been reviewed. The primary methodology for this study was the repetitive relocation of radio-collared caribou. Population estimates were made with a modified version of the aerial photo-direct count-extrapolation census procedure.

Caribou from the main Nelchina herd were found during winter primarily on the Lake Louise Flat, foothills of the Alphabet Hills and middle portions of the Gakona and Chistochina River drainages areas distant from the proposed hydroelectric development. Caribou primarily utilized open spruce forest during this period at elevations ranging from 2,100 to 4,300 feet (x=2,779).

During spring migration females moved across the Lake Louise Flat onto the calving grounds in the eastern Talkeetna Mountains on a broad front from Lone Butte to Kosina Creek. Some caribou utilized the Susitna River in the area of the proposed Watana impoundment as a travel route. A small portion of the herd ap-

peared to migrate across the plateau north of the Susitna River crossing the Susitna between Deadman Creek and Jay Creek enroute to the calving grounds. Open spruce forest was still the primary vegetation type utilized, however, shrublands and tundraherbaceous types became increasingly important. Females were found at elevations ranging from 1,900 to 5,600 feet (x=2886). Males lagged behind females during spring migration using mostly spruce forests. Elevations averaged 2,280 feet, ranging from 2,000 to 3,100.

During the calving period, virtually all females from the main Nelchina herd were found from Kosinia Creek into the Oshetna River in the eastern Talkeetna Mountains. Tundra-herbaceous vegetation accounted for 75% of the sightings and shrublands for 25%. Elevations for females ranged from 2,400 to 5,400 feet (x=3871). Nelchina bulls were found scattered throughout the range during calving mostly in transit to summer ranges. Spruce forests were still the primary vegetation type used by bulls. Elevations averaged 2,872 feet (range 2,100 - 4,400).

Summer range for Nelchina females was the northern and eastern slopes of the Talkeetna Mountains between 3,300 and 6,000 feet elevation (x=4,250). Tundra-herbaceous was the dominant vegetative type utilized followed by shrublands. Bulls were scattered in "bull pastures" in the high country throughout the Nelchina range. Shrublands and tundra-herbaceous were the main vegetative types utilized. Elevations ranged from 2,200 to 4,600 feet (x=3,572).

During autumn considerable dispersal, particularly of females, occurred as caribou moved out of the Talkeetna Mountains across the Lake Louise Flat into the Alphabet Hills then back to the west. Limited use of the Watana impoundment area was documented during this period. The sexes became mixed particularly late in September. Use of vegetative types and elevations of relocations were the most varied of any seasonal period.

During the rut males and females appeared to be well mixed and the herd moved from the foothills of the Talkeetna Mountains eastward across the Lake Louise Flat. Spruce forest was the principal vegetative type used during this period while shrublands received minor use. Caribou ranged in elevation from 2,200 to 3,900 feet (x=2,832).

Historically, Nelchina caribou have used the same calving grounds however considerable variation in summer and winter range use has been noted. Migratory routes, although somewhat traditional, have varied depending on the relationship of the calving grounds to summer and winter ranges.

On a year around basis habitat use by Nelchina bulls and cows was significantly different. Use of shrublands and bare substrate were similar while bulls occurred more frequently in spruce forest and at lower elevations while cows were found more frequently in tundra-herbaceous vegetation and at higher elevations.

It appeared (based on the year around relocations of radio-collared caribou) that at least three distinct subherds with separate calving areas existed in addition to the main Nelchina herd. These included the upper Talkeetna River (400 animals), Chunilna Hills (350 animals) and upper Susitna-Nenana (1000 animals) subherds. Another subherd probably occurs in the upper Gakona River and others may exist in the Alaska Range and western Talkeetna Mountains.

In October 1980, the Nelchina herd was estimated to contain 18,713 caribou and in October 1981, the herd was estimated at 20,730. Herd composition in October 1981 was estimated at 49% females ≥1 year, 30% males ≥1 year and 21% calves.

Calf survival to 11 months of age (May 1980 to April 1981) was estimated at 0.43. Average annual natural mortality for caribou

one year old and older was estimated at 0.07 for females and 0.14 for males. Reported hunter harvest of Nelchina caribou averaged 670 animals between 1972 and 1981.

It was apparent from historical records (and to a lesser extent from movements of radio-collared animals) that the proposed Watana impoundment would intersect a major migratory route. Crossings of the impoundment area and use of range to the northwest will probably increase as herd size increases. It is not known precisely how project construction will affect the caribou. The impoundment could prove to be a barrier to movement causing abandonment of a portion of the range or dividing of the herd. The migratory route could be changed by extending it around the eastern end of the reservoir. Caribou could continue to cross at traditional points and could experience increased mortality because of hazards such as ice shelving, ice sheets, overflow and wind-blown glare ice, particularly during spring migration. Developments and activities associated with project construction and operation such as roads, railroads, airfields and recreational activities of project personnel would undoubtedly negatively impact Nelchina caribou although the extent is unknown. The proximity of the calving grounds to the Watana impoundment and the probability of increased human access is of concern. The Susitna hydroelectric project should be viewed as one of a number of probable developments which will occur on the Nelchina caribou range. While no one action may have catastrophic results the cumulative impact will likely be a reduced ability for the Nelchina range to support large numbers of caribou.

It is recommended that in Phase II a pool of radio-collared caribou be maintained to monitor caribou use of the impoundment area. Population status should be monitored with annual censuses and composition sampling. A study of causes and extent of mortality of caribou calves should be considered.

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INTRODUCTION

The Nelchina caribou (*Rangifer tarandus*) herd, one of 22 herds in Alaska (Davis 1978), has been important to sport and subsistence hunters because of its size and proximity to population centers in southcentral Alaska. Between 1954 and 1981 over 100,000 caribou were killed by hunters (Skoog 1968; unpublished data Alaska Department of Fish and Game). In 1981 6,662 people applied for 1,600 permits to hunt for Nelchina caribou.

The herd occupies an area of approximately 20,000 mi^2 (Fig. 1) bounded by four mountain ranges: the Alaska Range to the north, the Wrangell Mountains on the east, the Chugach Mountains to the south and the Talkeetna Mountains to the west (Hemming 1971). The Nelchina range contains a variety of habitats ranging from spruce-covered lowlands to steep, barren mountains. Human development is largely limited to the peripheries of the Nelchina range and consists primarily of the Alaska Railroad, Parks Highway, Denali Highway, Richardson Highway, Trans-Alaska Pipeline and Glenn Highway.

Because of its importance and accessibility, the Nelchina herd has been the most intensively studied caribou herd in Alaska (Doerr 1979). The U.S. Fish and Wildlife Service initiated research in 1948 and continued through 1959. The Alaska Department of Fish and Game has been continually involved with the Nelchina herd since statehood including intensive research and population, harvest, distribution, disease and range monitoring (Skoog 1968, Lentfer 1965, McGowan 1966, Glenn 1967, Hemming and Glenn 1968, 1969, Pegau and Hemming 1972, Neiland 1972, Pegau and Bos 1972, Pegau et al. 1973, Bos 1973, 1974, Alaska Department of Fish & Game Survey and Inventory Reports 1970-1980). Skoog's (1968) doctoral dissertation, a major work on caribou biology, dealt largely with the Nelchina herd.

There is currently under study a proposal to construct a large

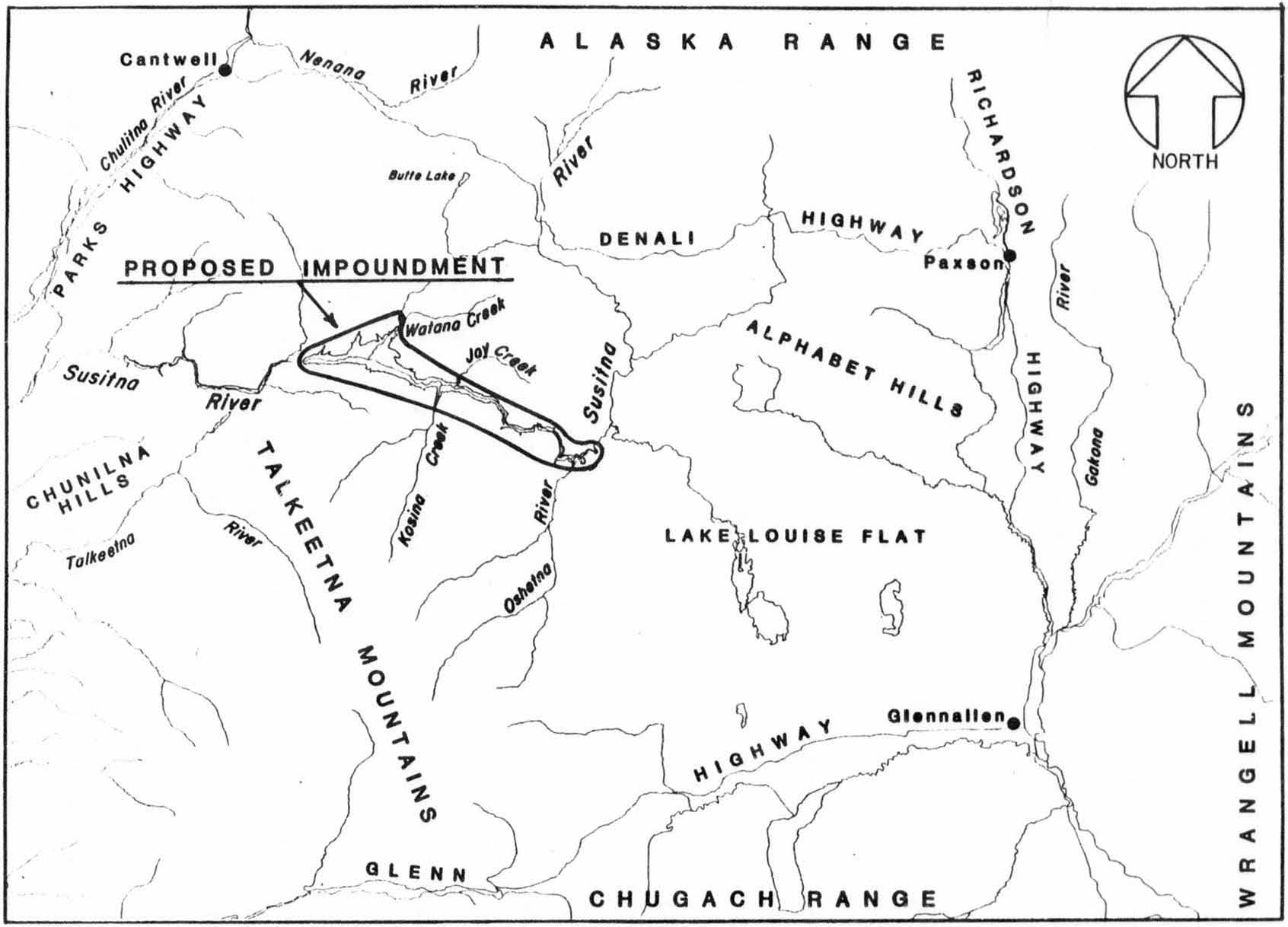

Figure 1. Nelchina caribou range with basic geographic features.

hydroelectric project on the Susitna River in the western portion of the Nelchina caribou range. Impacts of the development, which may include two dams and impoundments, access roads and electrical transmission lines, on the Nelchina herd are unclear. Habitat loss due to inundation does not appear to be a serious consideration as less than 1% of the total Nelchina range would be involved. Skoog (1968) concluded that caribou usage of this area was largely limited to transient animals although they occasionally spend time in the area in spring using snow free areas. The proposed Watana impoundment could serve as a barrier to migrating caribou. The area along the Susitna River between Deadman Creek and Jay Creek has served as a traditional migration route both during spring migration and the post-calving shift (Hemming 1971). Ice shelving along the edges of the reservoir has been suggested as a potential source of mortality to migrating caribou (Hanscom and Osterkamp 1980). Roads, railroads and electrical transmission lines have all been reported to disrupt caribou movements (Klein 1971, Vilmo 1975, Cameron et al. 1979). Disturbance associated with construction and maintenance of the hydroelectric facilities could result in a reduction of caribou use of nearby areas as shown for the Prudhoe Bay oil fields (Cameron et al. 1979). Proximity of the traditional calving grounds to the Watana impoundment is of some concern because of the importance of the area to the Nelchina herd and increased human activity in the area implicit to development. Suspected "subherds" in the general area of the proposed impoundment could become more isolated by development of the Susitna hydroelectric project depending on their movement patterns and routes and their reactions to the impoundments and related developments.

Overall objectives of this project were to evaluate the potential impacts of proposed Susitna hydroelectric development on the Nelchina caribou herd and to suggest possible mitigating actions. Specific objectives included: (1) determination of movement patterns, migration routes and timing of major movements with emphasis on activities occurring in the vicinity of proposed de-

velopment; (2) delineation of subherds (based on separate calving areas); (3) estimation of numbers and sex and age composition of the main Nelchina herd and subherds; and (4) determination of habitat utilization of Nelchina caribou.

Complicating the interpretation of data gathered during short-term studies of caribou migratory routes is the well recognized tendency for changes in use of winter and summer ranges (Skoog 1968). The analysis of data resulting from this study must rely heavily on historical information. It is fortunate that results of intensive research by Skoog (1968) and others on the Nelchina caribou herd are available and they are used extensively.

METHODS

Data on movement patterns, migration routes, timing of major movements, subherd status and habitat use were collected by periodic relocations of radio-collared animals. It was assumed that the behavior of radio-collared caribou was representative of the herd in general and I did not make observations indicating otherwise. Caribou were captured by use of immobilizing drugs [etorphine (M-99) and xylazine (Rompun)] administered with projectile syringes (Cap-Chur equipment) shot from a helicopter. Radio-collars in the 152.000-153.000 MHz range, purchased from Telonics Inc., were used. Radio-collared caribou were relocated from a fixed-wing aircraft (Cessna 180, 185 or PA-18-150) equipped with two Yagi antennas, one attached to wing struts on each side of the aircraft. Antenna leads were attached to a right/left switch box coupled to a radio-tracking receiver/scanner. Animals were located by balancing the transmitter signal between the two antennas through use of the left/right switch and orientation of the aircraft and following the signal.

Initially (April and May 1980), 41 caribou were radio-collared. Capture related mortalities (5) and shed collars soon after capture (2) reduced the number of active animals to 34. These included three animals in the upper Susitna - Nenana area, one in the Chunilna Hills, three in the upper Talkeetna River and 27 in the main Nelchina herd. During the first year (April 1980 to April 1981) one radio-collared caribou was killed by a hunter, two were apparently killed by wolves, one died of injuries probably received from another caribou and five adult males lost their collars after shedding their antlers in November and December. In April and May 1981 five males from the main Nelchina herd and two females from the Chunilna Hills were radio-collared bringing the total number of active radio-collared caribou up to 32. The geographical distribution was: upper Susitna - Nenana, three females; Chunilna Hills, two females; upper Talkeetna River, two females; and main Nelchina, 8 males

and 17 females. Radio-collared caribou were classified as belonging to the main Nelchina herd or a particular subherd based on their locations during calving (females) or during the rut (males). Radio-collared caribou relocation data included in this report were collected between 14 April 1980 and 22 September 1981. Sequential sightings for each radio-collared animal are presented in Appendix I.

A modified version of the aerial photo-direct count-extrapolation census procedure (Hemming and Glenn 1969, Davis et al. 1979, Doerr 1979) was used to estimate the size of the Nelchina herd. This technique is composed of three separate procedures: (1) a complete count of all animals in the post-calving aggregation; (2) a composition count of these same animals to determine the proportion of adult females; and (3) representative fall composition sampling of the entire herd to determine the proportions of females, males and calves (Doerr 1979). Acceptance of four assumptions is necessary for the APDCE technique: (1) all females in the herd are present in the post-calving aggregations; (2) adult females are randomly distributed throughout the post-calving aggregations; (3) the sex and age cohorts are randomly distributed throughout the herd during fall; and (4) mortality of adult females from the time of post-calving aggregation to the fall composition counts is zero (Davis et al. 1979) or is accounted for. An evaluation of these assumptions by Davis et al. (1979) indicated that all but assumption #3 were valid and that the collection of representative fall composition data was the most difficult procedure.

The fall population estimate is calculated from the following equation.

$$FP = N_a \times P_f - M_f \times (1 + R)$$

where

FP = estimated fall population;

N_a = number of animals in the postcalving aggregation;

P_f = proportion of females in post-calving aggregation;

M_f = mortality of females from the time of post-calving counts until the fall; and

R = ratio of caribou other than females to females in the fall.

Reconnaissance flights were made in a C-180 to determine when caribou were suitably aggregated to census. PA-18-150 Super Cubs were used to survey the aggregations and the caribou herds were either photographed or directly counted. Hand-held, motor driven, 35 mm cameras were used to photograph caribou groups. The 35 mm color slides of caribou groups were projected on a paper screen and caribou images marked. The number of images were then counted.

A helicopter (Bell 206B) was used to sample the post-calving aggregations, the herd during the breeding season and the herd in April to estimate proportions of females, males and calves. Groups of caribou were approached from the rear until the sex of each animal older than calves could be determined from the external gentalia (presence or absence of the vulva).

Methodology for data storage, retrieval and analysis was included in the 1980 report for data management:biometrics (wildlife ecology/big game).

The study area consisted of the entire range of the Nelchina caribou herd as detailed in the Introduction (Fig. 1). However, monitoring frequency of radio-collared animals was much more frequent when they were in the vicinity of the proposed impound-

ments.

Estimates of annual adult survival rates were made from radio-collared animals using a formula provided by Trent and Rongstad (1974) which is based on the number of mortalities detected and the period of time the radio-collared animals were monitored.

An estimate of calf survival to 11 months of age was made by multiplying the calf to female ratio obtained in April by the estimate for annual survival of females ≥1 year then dividing by the ratio of calves to females ≥1 year at birth (Fuller and Keith 1981).

RESULTS AND DISCUSSION

Distribution and Movements: Main Nelchina Herd

Current distribution: year around use of the Nelchina range by radio-collared caribou from the main herd during this study is portrayed by Fig. 2 and encompassed an area of about 7,000 mi^2. Two major areas which were used extensively at times in the past received minimal use during the study period. These areas were the northwestern portion of the range including drainages of the Chulitna, Nenana and upper Susitna Rivers and the far eastern portion of the range including the Mentasta and Wrangell Mountains.

Winter: between 1 December 1980 and 31 March 1981 the Nelchina herd was located on the Lake Louise Flat and middle portions of the Gakona and Chistochina River drainages (Fig. 3). During early winter (2-5 December 1980 survey) perhaps 25% of the herd was in the southwestern portion of the Lake Louise Flat around Slide Mountain and the Little Nelchina River but by 12 February 1981 they had rejoined the rest of the herd. Considerable use of the western foothills of the Alphabet Hills was noted.

Nelchina caribou have used numerous winter ranges during the past 30 years (Table 1, Fig. 4) ranging from the Nenana-Yanert Fork drainages to the Talkeetna River east to the Mentasta and Wrangell Mountains (Skoog 1968, Hemming 1971).

Spring Migration: the primary migratory route from winter range on the Lake Louise Flat to the calving grounds in the eastern Talkeetna Mountains was westward across the Flat from Crosswind Lake and Lake Louise into the Talkeetna Mountains on a front from Lone Butte to Kosina Creek (Fig. 5). Based on sequential sightings of radio-collared caribou and sightings of tracks and uncollared caribou it appeared that many animals used the frozen Susitna River between the Oshetna River and Kosina Creek as a travel

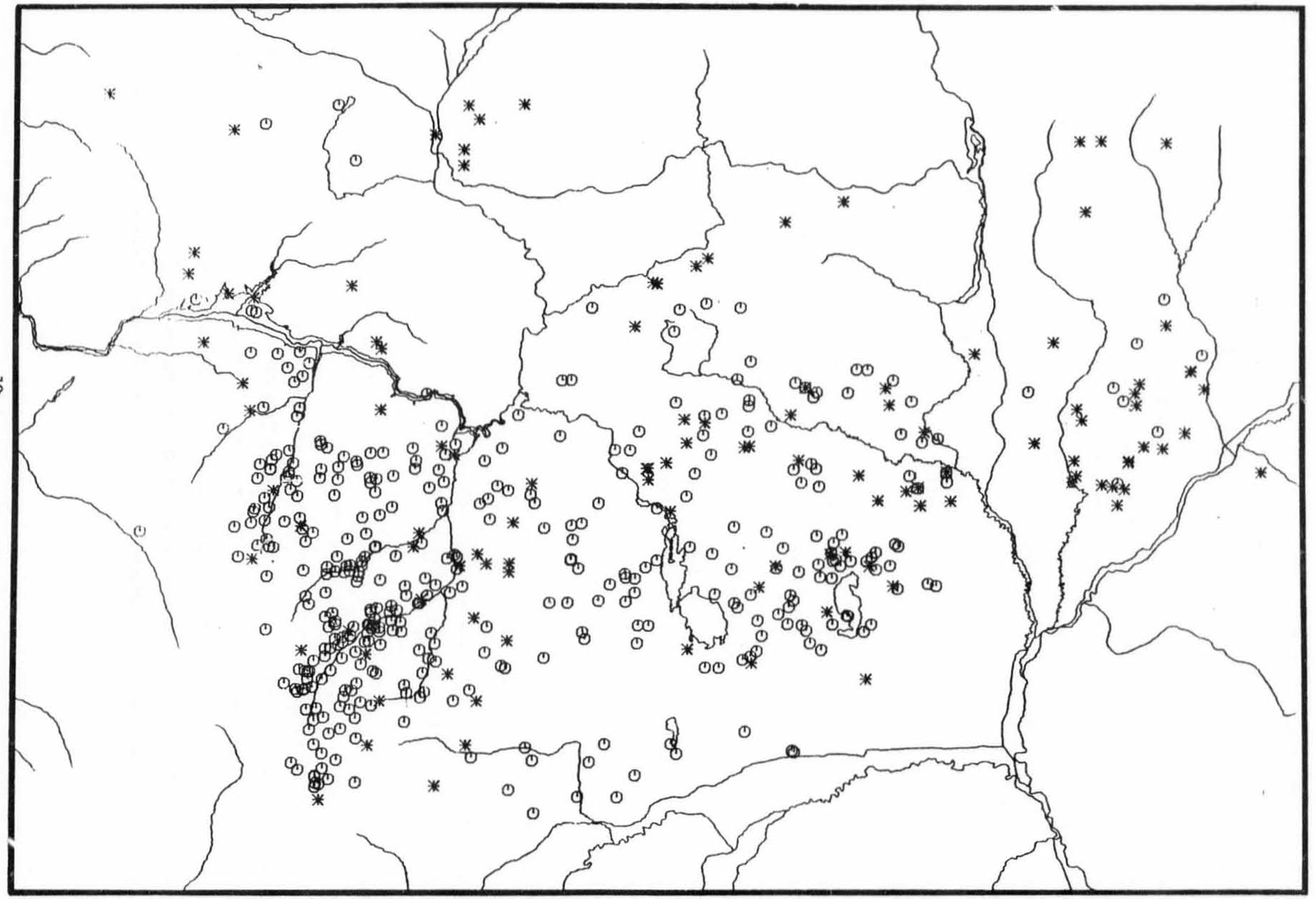

Figure 2. Distribution of main Nelchina radio-collared caribou, 14 April, 1980 through 29 September, 1981.
○ = females, ✳ = males.

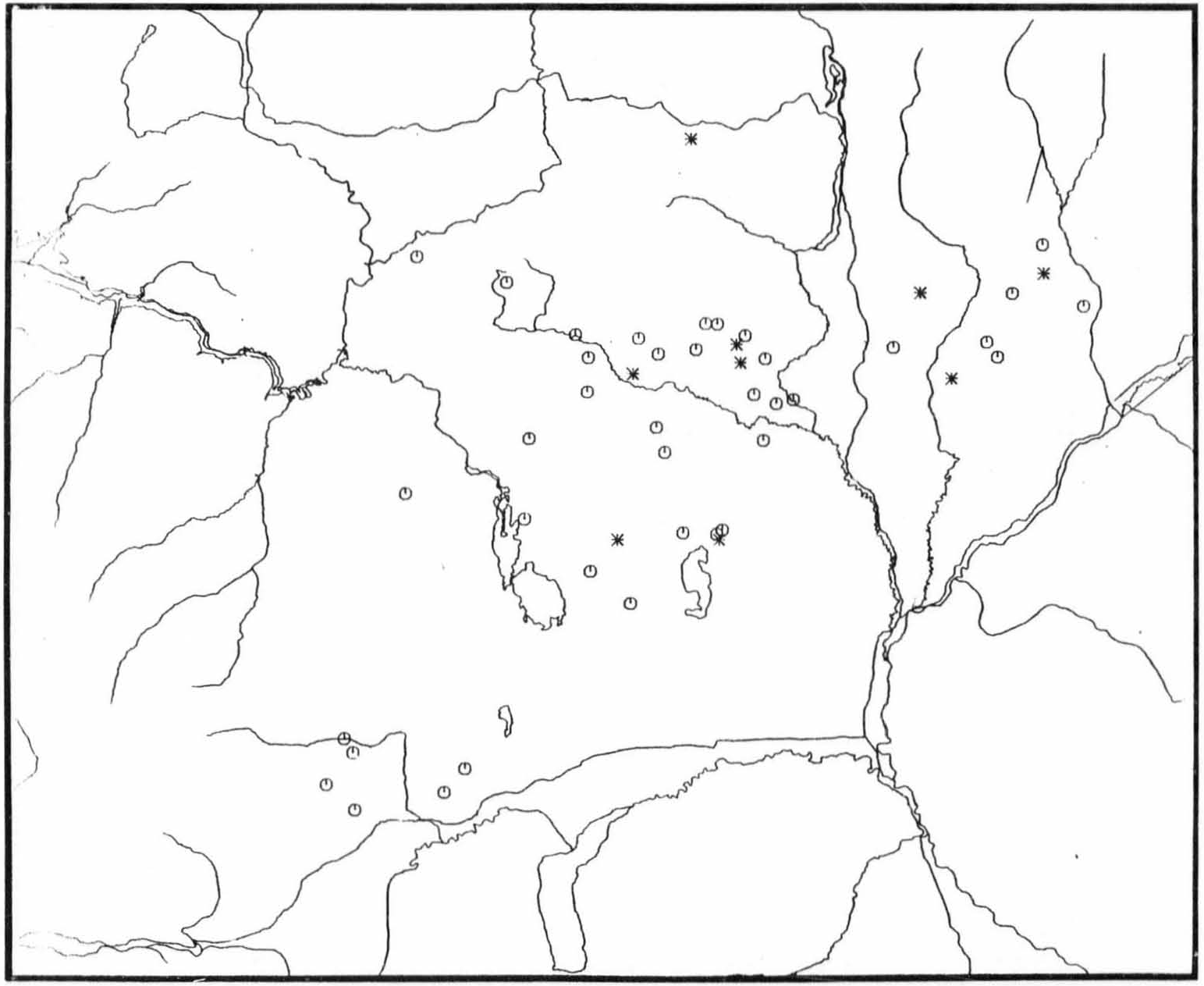

Figure 3. Distribution of Nelchina radio-collared caribou during winter, 1 December, 1980 through 31 March, 1981. ⏲ = females, ✱ = males.

Table 1. Historical range use of Nelchina caribou (modified and expanded from Skoog 1968).

Year	Calving* Grounds	Summer* Range	Rut*	Winter* Range
1951-51	12	12,5	13,5,12	13,12
1952-53	12	12,5,15	13,12,15	13
1953-54	12	5,12	5,12,13	13
1954-55	12	5	5,6	13
1955-56	12	12,15	12,15,16	5,12,6,9
1956-57	12	5,12,15	5,6,	5,1,6,11
1957-58	12	5,12	5,6,13,15	11,2,5,15
1958-59	12	5,12	5,13,11,12,13	11,15,1,5,6,13
1959-60	12	5,12	12,15,6	1,11,5,13
1960-61	12	5,9,6,12	13,15,5,11	5,11,1,2,13
1961-62	12	5,9,6,12	12,13,6,15	1,6,2,5,11
1962-63	12	5,12	13,15,6,12	1,13,2,5,11,15
1963-64	12	5,12	5,13,6,12	1,5,6,11
1964-65	1,5,12	5,12	5,9,13,6	1,5,6
1965-66	12,8,11	5	6,9,13	16,13,15
1966-67	12,8,11	5,4	9,11,13	16,13,1,2
1967-68	12	5,4,12	--	16,13,1,4,5
1968-69	12	5,12	13	13,7,8,11,2
1969-70	12	12,5	12	13
1970-71	12	5,12	13	16,13
1971-72	12	5,12	13	16,13,15
1972-73	12	12,5	12,15	15,7,13
1973-74	12	--	15,13,12	15,13,12
1974-75	12	12	--	16,13
1975-76	12	12	--	13
1976-77	12	12,5?	12,13	13,16
1977-78	12	12	12,13	13,16
1978-79	12	12	13	13,16
1979-80	12	12	--	13,7
1980-81	12	12,15	13	13,7
1981-82	12	12,15	13,7	

*Range units modified from Skoog (1968): see Figure 4.

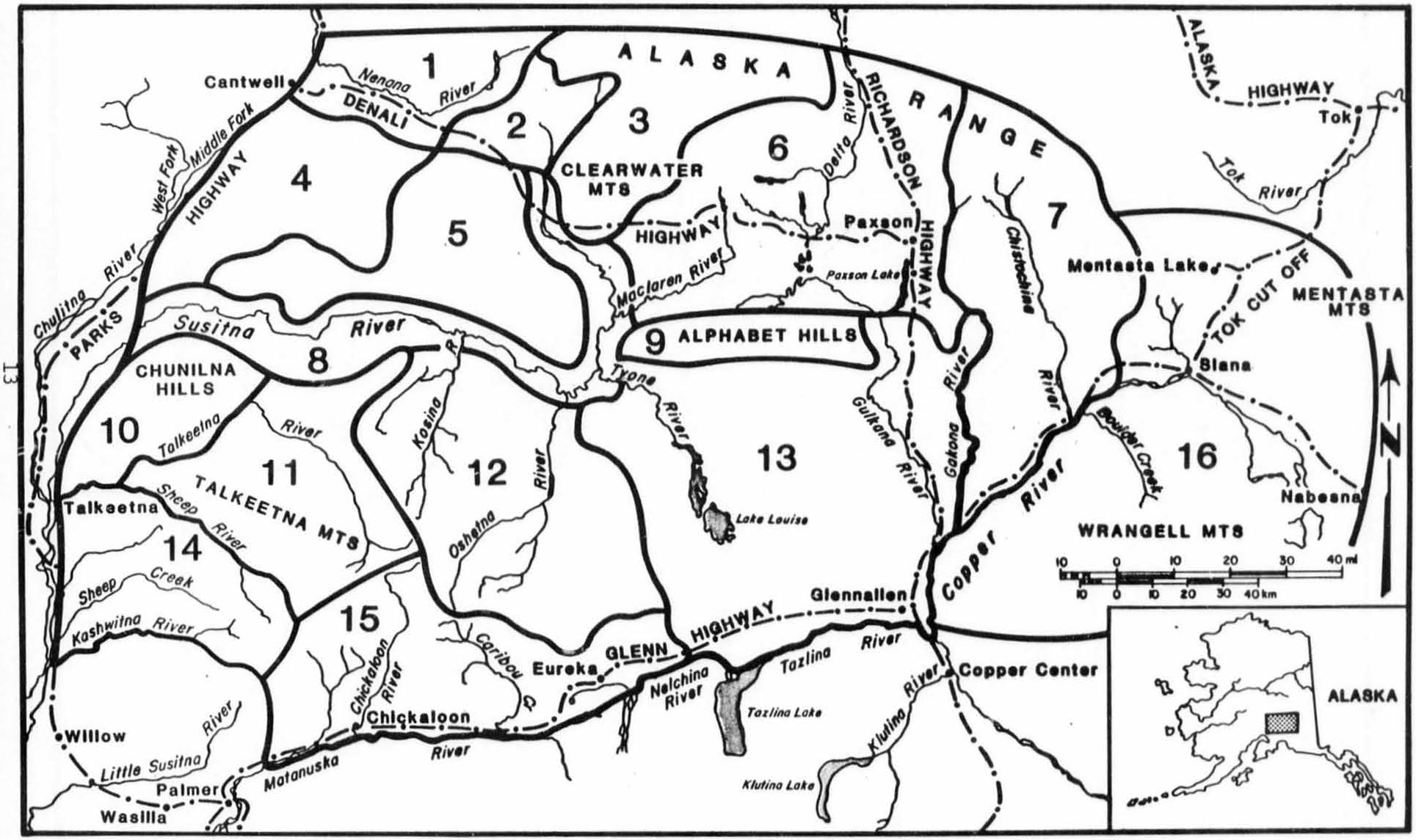

Figure 4. Division of Nelchina range into areal units based upon topography, vegetation and caribou use (modified from Skoog 1968).

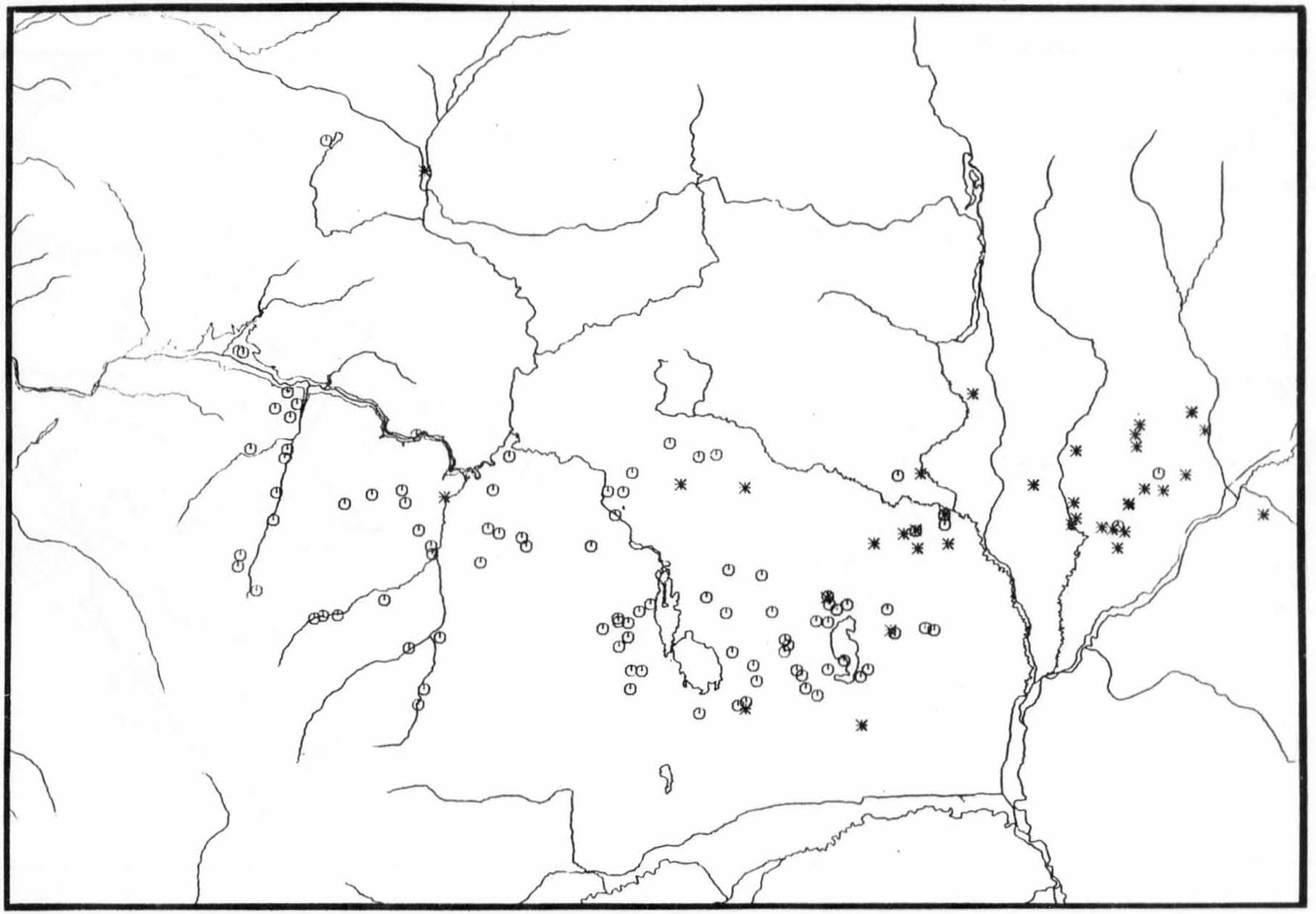

Figure 5. Distribution of Nelchina radio-collared caribou during spring migration, 1 April through 14 May, 1980 and 1981. ⊙ = females, ✳ = males.

route in the spring of 1981. In the spring of 1980, one animal (Appendix 1: 182) which was captured in the vicinity of Butte Lake moved south and crossed the Susitna near the mouth of Deadman Creek. Historically many animals used this route to the calving grounds after wintering in upper Susitna-Nenana drainages (Skoog 1968). It was apparent from the relocation records (Fig. 5) that most males lagged behind the females and remained on the winter range longer in the spring.

Calving Period: observations of radio-collared females during the calving period (15 May - 10 June) indicated that calving occurred in drainages of Kosina Creek, Goose Creek, Black River and Oshetna River (Fig. 6). Observations of females outside this area during the calving period were of nonbreeders (Appendix 1: 70, 182) which reached the calving grounds later in the calving period. During the calving period, radio-collared Nelchina bulls were found in a wide variety of locations mostly in transit to summer ranges.

Since 1949, the first year for which records are available, Nelchina caribou have utilized an area of about 1,000 mi^2 in the northern Talkeetna Mountains for calving (Skoog 1968, Hemming 1971, Bos 1974). While the precise areas utilized have varied, calving has taken place between Fog Lakes and the Little Nelchina River between about 3,000 and 4,500 feet elevation. The only deviations have been during years with extremely heavy snow accumulations when some calving took place during the migration to the traditional calving grounds (Skoog 1968, Lentfer 1965, Bos 1973).

Summer: the female-calf segment of the Nelchina herd spent the summer period (11 June through 31 July) of both 1980 and 1981 in the northern and eastern slopes of the Talkeetna Mountains (Fig. 7). Observations of radio-collared females during this period ranged from Fog Creek to the Little Nelchina River and Caribou Creek but most observations centered around the upper

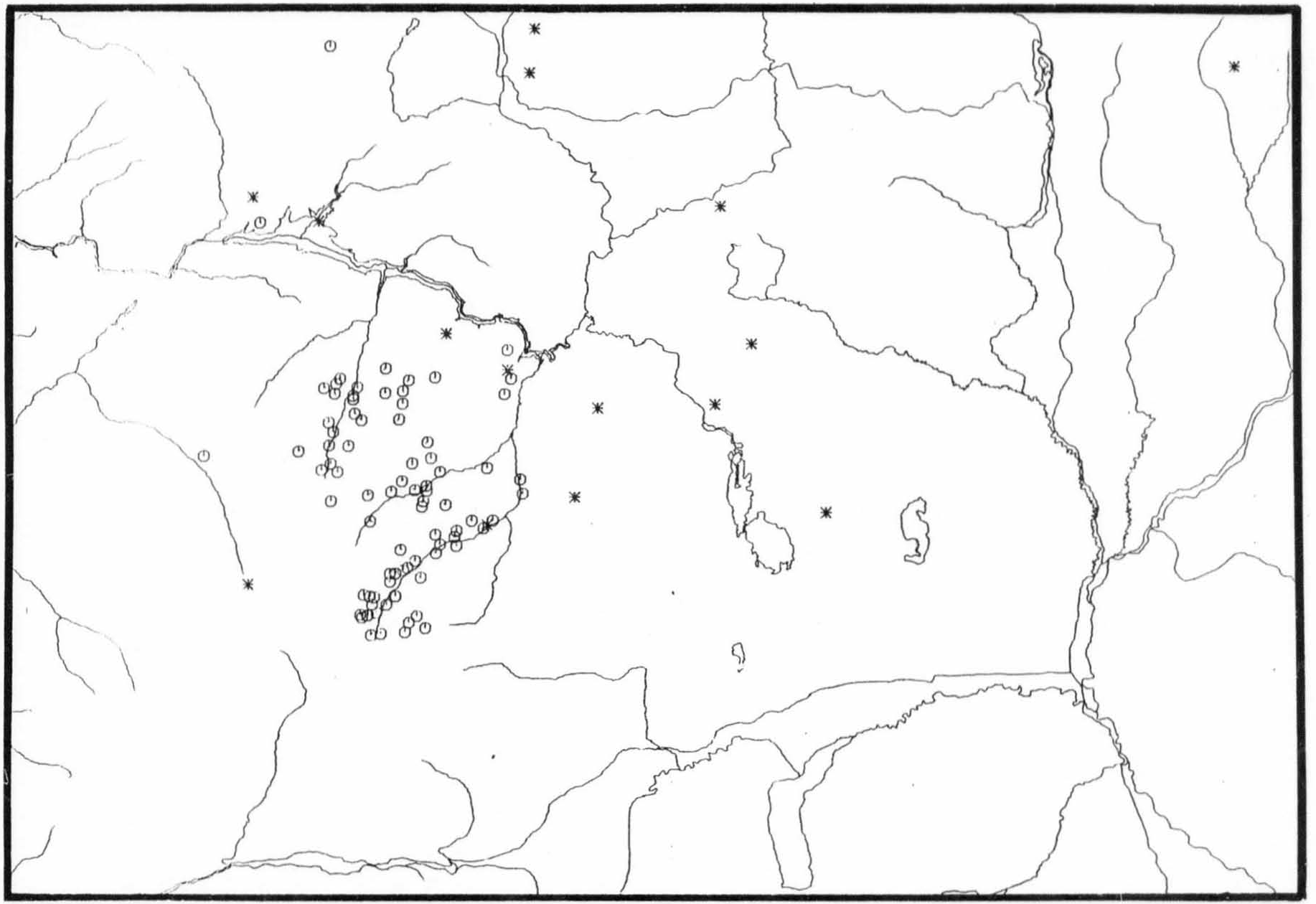

Figure 6. Distribution of Nelchina radio-collared caribou during the calving period, 15 May through 10 June, 1980 and 1981. ⏲ = females, ✳ = males.

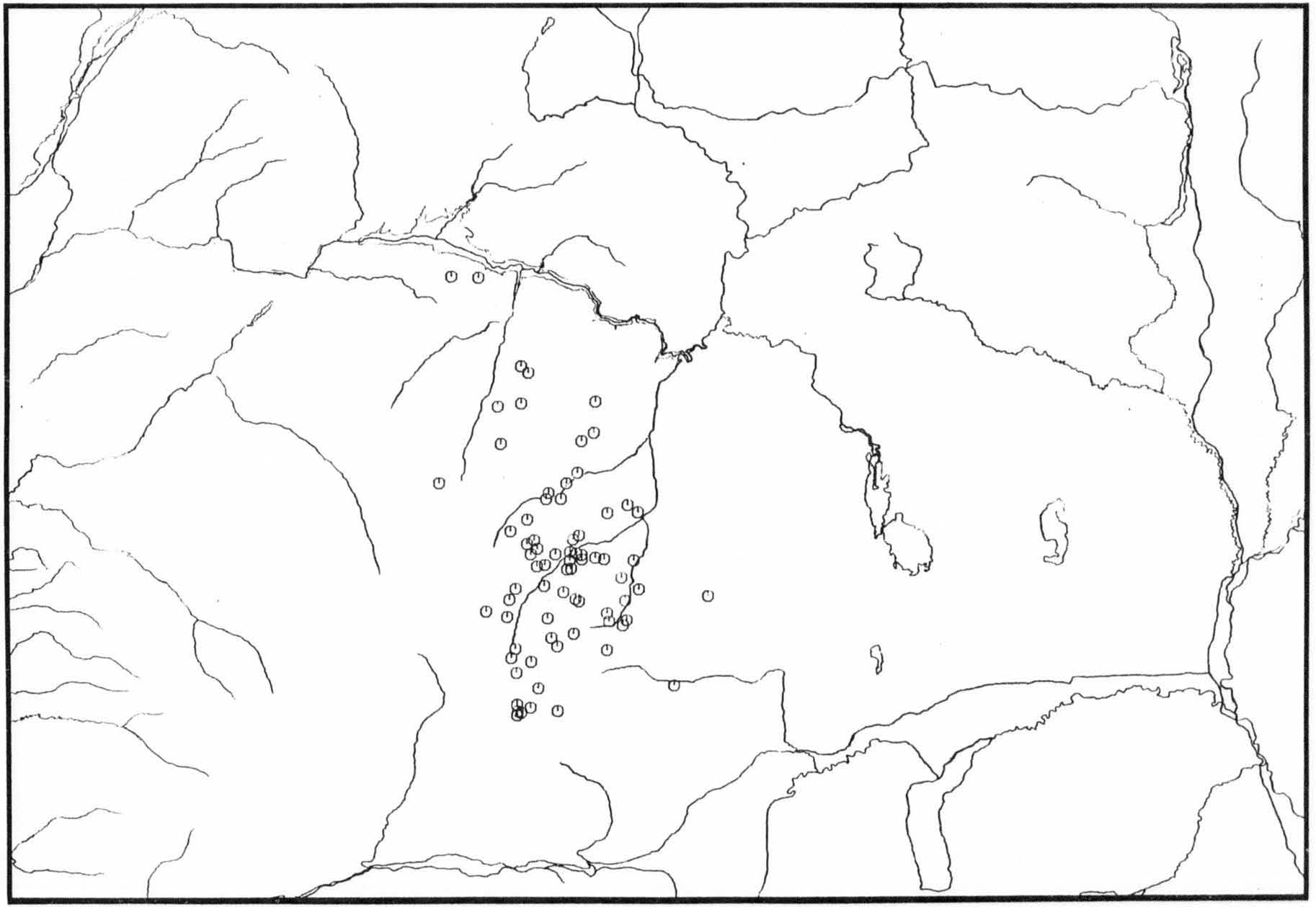

Figure 7. Distribution of Nelchina radio collared caribou cows during summer, 11 June through 31 July, 1980 and 1981.

Oshetna River. Summering radio-collared males were found in many locations in the high country of the Nelchina Basin (Fig. 8); including the Chulitna Mountains, the Jay Creek - Coal Creek area, the Clearwater Mountains, the Alphabet Hills, the upper Gakona River, Deadman Creek and many locations in the Talkeetna Mountains. Skoog (1958) referred to additional summer "bull pastures" in the upper Nenana, Chickaloon and Talkeetna River drainages. It was obvious from relocations of radio-collared animals (Figs. 7, 8) that the female segment of the herd was a relatively cohesive unit during this period while small groups of males occurred in widely dispersed locations.

Historically, the female-calf segment of the Nelchina herd has primarily summered in two areas; the eastern Talkeetna Mountains (Fig 4: Unit 12) and across the Susitna River in the Brushkana, Butte, Deadman, Watana, Jay and Coal Creeks complex (Fig. 4: Units 4, 5) (Skoog 1968, Hemming 1971). In 1960 and 1961 some females and calves summered in the Alphabet Hills and Amphitheater Mountains (Skoog 1968). Postcalving and summer movements of varying proportions of the female-calf segment (ranging from 0-100%) from the calving grounds and summer range in the Talkeetna Mountains across the Susitna River occurred in most years between 1950 and 1973. Timing of major movements ranged from mid-June through July. Crossings apparently occurred between Deadman Creek and the big bend of the Susitna.

Autumn: this period (1 August through 31 September) was a time of considerable movement and dispersal by cows and bulls in both 1980 and 1981 (Fig. 9). It appeared that considerable mingling of the sexes occurred compared to the obvious segregation which was apparent in June and July. In mid to late August 1980 a portion of the main summering concentration moved out of the Talkeetna Mountains onto the western portion of the Lake Louise Flat and in some cases into the Alphabet Hills. The exact routes of movement were not determined, however it seemed that while a few animals may have crossed the Susitna River in the area of the

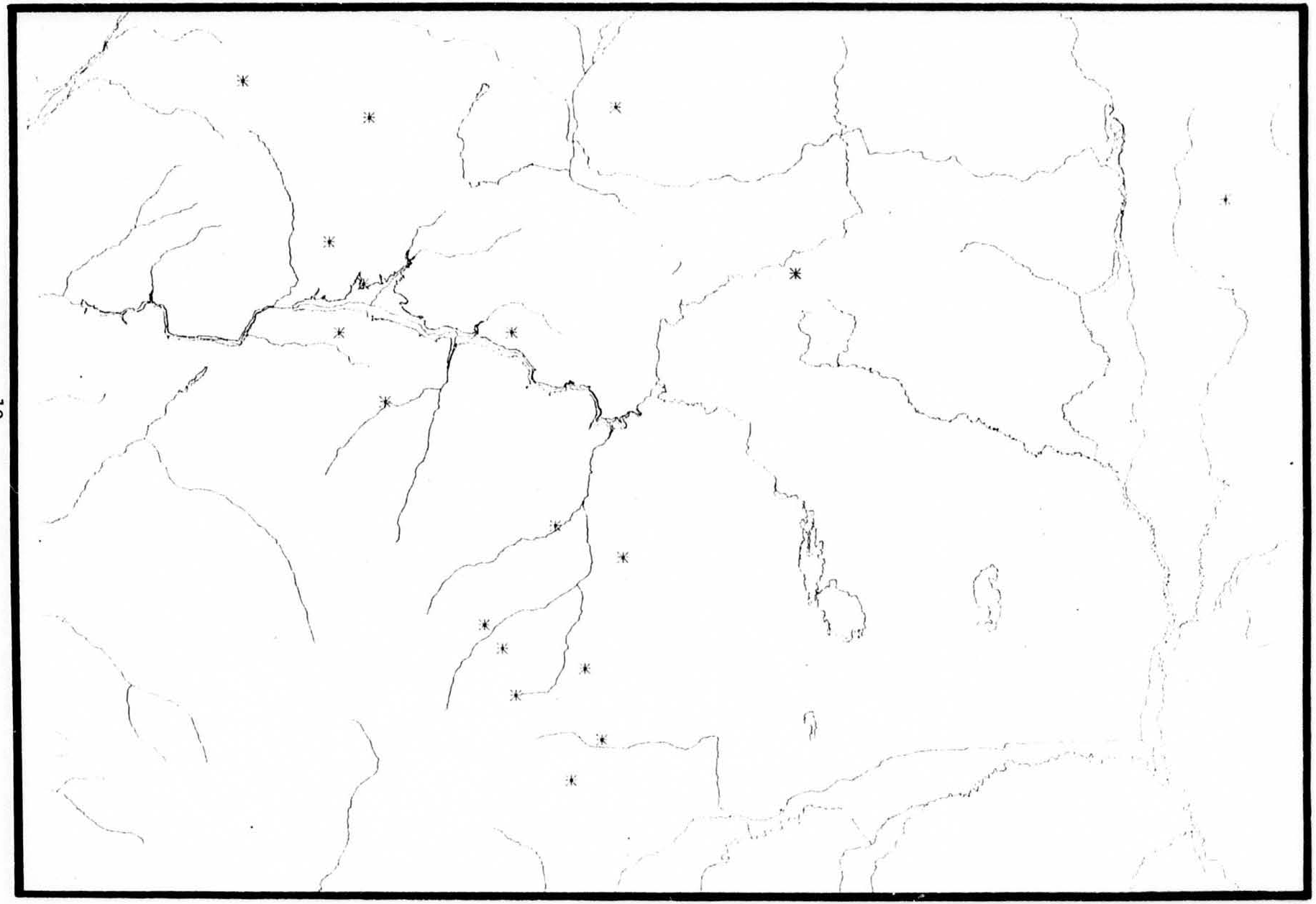

Figure 8. Distribution of Nelchina radio-collared caribou bulls during summer, 11 June through 31 July, 1980 and 1981.

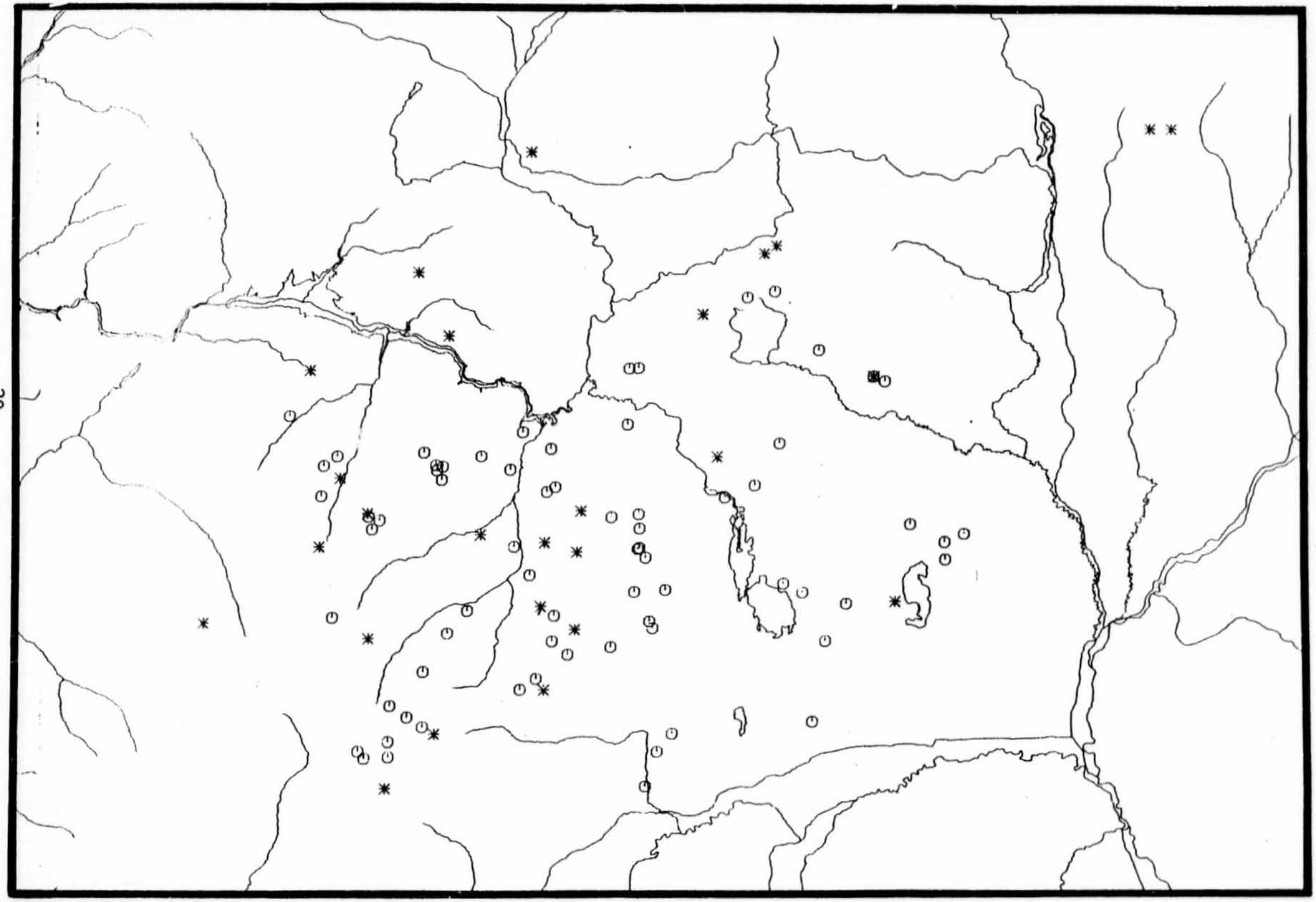

Figure 9. Distribution of Nelchina radio-collared caribou during autumn, 1 August through 30 September, 1980 and 1981. ⊙ = females, ✳ = males.

proposed Watana impoundment most probably moved onto the Flat further to the east. Through September the distribution remained relatively stable with the main herd divided between the northeastern Talkeetna Mountains, the Lake Louise Flat and the Alphabet Hills.

By mid-August 1981 most of the females had moved out of the Talkeetna Mountains and were scattered over the Lake Louise Flat as far north as the Alphabet Hills. By early September the herd was even more dispersed as a number of females had moved back into the eastern Talkeetna Mountains while others remained in the Alphabet Hills and Lake Louise Flat. In late September a large segment of the herd was in the lower Oshetna River - Big Bones Ridge area. Again in 1981 as in 1980 limited use of the area which would be flooded by the upper portion of the Watana impoundment probably occurred.

Rut: during both 1980 (Fig. 10) and 1981 (computerized data not available) considerable movement from west to east occurred during the rut. In both years a portion of the herd was in the eastern foothills of the Talkeetna Mountains in early October but by mid-October most animals were in the northern Lake Louise Flat. In 1980 a small group remained in the Slide Mountain area. In 1981, a third to a half of the herd had crossed the Richardson Highway and Trans-Alaska Pipeline by 20 October.

Historically, Nelchina caribou have rutted in a number of locations (Fig. 4, Table 1) however range units 13 (Lake Louise Flat) and 12 (eastern Talkeetna Mountains) have been the most widely used. Range unit 5 (Deadman Lake area) was also used extensively during the rut in many of the years when major segments of the herd summered in the area.

Subherds

Eide (1980) suspected that subherds with separate calving areas

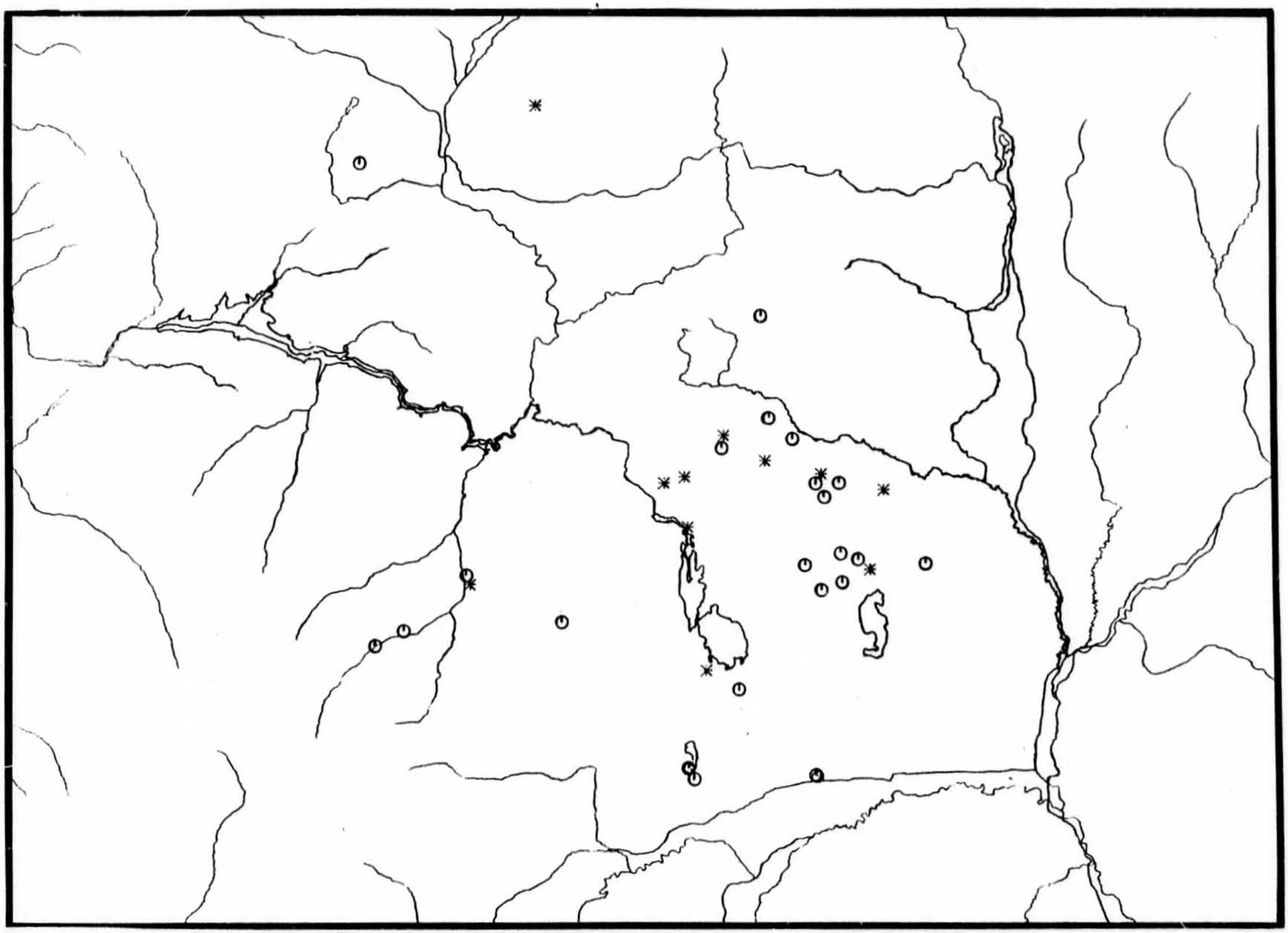

Figure 10. Distribution of Nelchina radio-collared caribou during the rut, 1 - 20 October, 1980. ⊙= females, ✱= males.

existed in several areas of the Nelchina range. He based this conjecture on reports of sighting of animals, including young calves, in these locations during all seasons including the calving period. Locations of these possible subherds were the Watana Creek Hills (upper Susitna-Nenana drainages), the upper Talkeetna River, Chunilna Hills, Alaska Range and Gakona River. Because of their proximity to the proposed hydroelectric development and potential for increased isolation, radio-collars were placed on animals in three of the suspected subherds; Talkeetna River, Chunilna Hills and upper Susitna-Nenana River drainages. Because of the changeable nature of caribou movements and the short duration of the study the results are tentative.

Upper Talkeetna River: two adult females and one adult male were collared on 18 April 1981. These animals were relocated 50 times and were always found in drainages of the upper Talkeetna River or in the upper reaches of the nearby Chickaloon River (Fig. 11). One female raised a calf in 1980 and both raised calves in 1981. The male spent the summer of 1980 in the mountains west of the Talkeetna River and then lost his collar in the upper Talkeetna River in November 1980. I have seen, incidental to radio-tracking flights, small groups of caribou including cows and calves in most of the side drainages of the upper Talkeetna River. This appears to be a legitimate, resident subherd probably composed of 400 animals. Some overlap with the main Nelchina herd occurred. I located a radio-collared female from the main Nelchina herd on the Talkeetna River on 1 June 1981. Historically (1956-57, 1961-64), major segments of the Nelchina herd wintered in the Talkeetna River area (Skoog 1968). It seems that a temporary influx of large numbers of caribou could either bolster or draw animals away from a small subherd. Chunilna Hills: in 1980 one adult bull and one adult female were collared in late April. The female died within a month after capture. The bull remained in the Chunilna Hills through November when it shed its collar. Two additional females were collared in the spring of 1981, both of which subsequently gave birth to calves

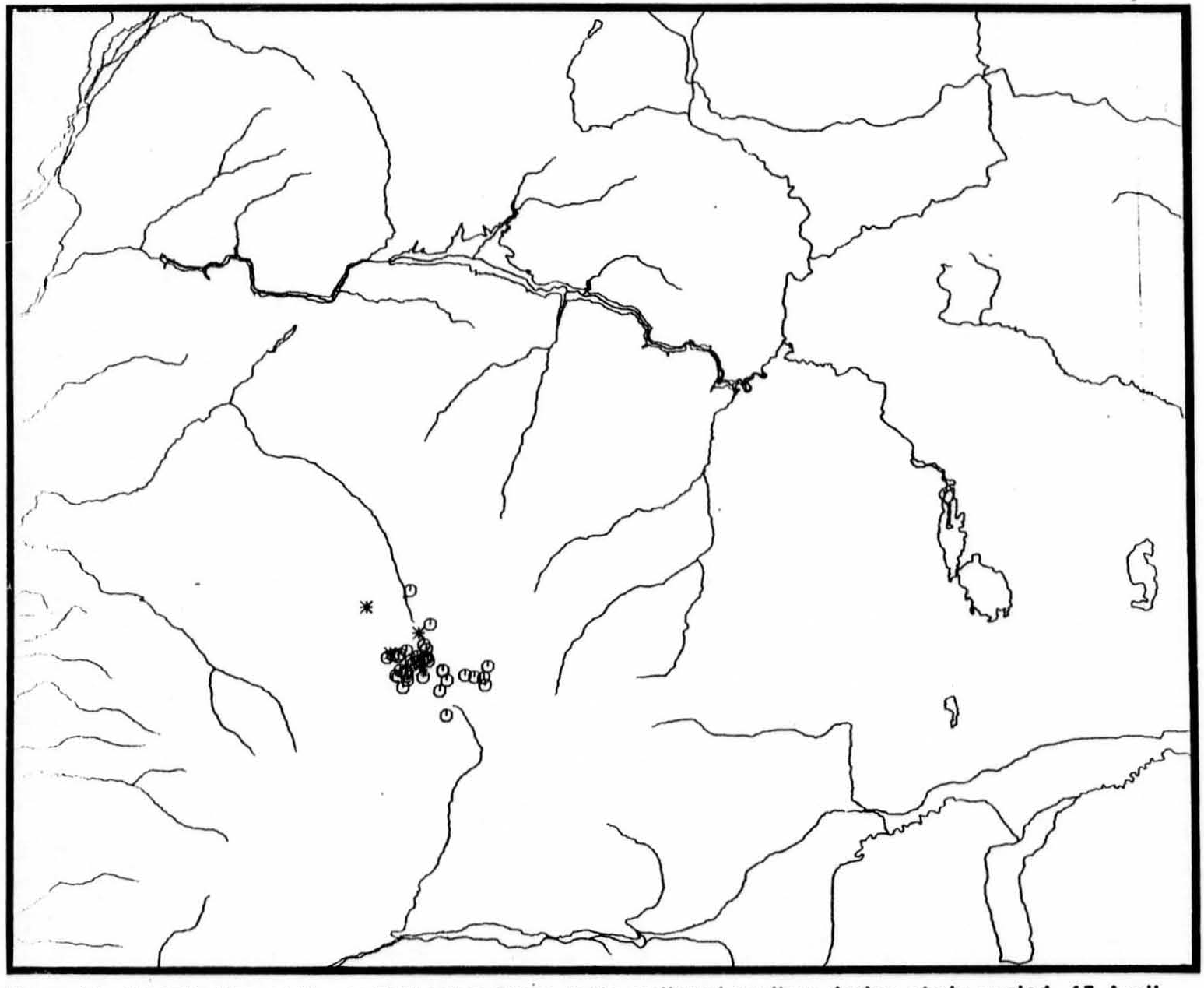

Figure 11. Distribution of Upper Talkeetna River radio-collared caribou during study period, 17 April, 1980 through 22 September, 1981. ⊙= females, ✳= males.

in the area. Relocations of Chunilna Hills caribou are shown in Fig. 12. No overlap with radio-collared animals from the main herd or other subherds was noted although one female did move across the Talkeetna River. The largest group seen in the Chunilna Hills was about 125 caribou although I have received unconfirmed reports of 200-300 animals in the area. This appears to be a resident subherd numbering 350 animals. Upper Susitna-Nenana: four adult females and one adult male were radio-collared in early May 1980. One of the females migrated to the main Nelchina calving area, summered in the Talkeetna Mountains, migrated back through the upper Susitna-Nenana area in the fall and rejoined the main Nelchina herd during the rut and early winter on the Lake Louise Flat. She was subsequently killed by wolves. The other three females remained in the upper Susitna-Nenana area throughout the study period (Fig. 13), two producing calves in 1980 and two having young in 1981. The bull summered in the Clearwater Mountains then joined the main Nelchina herd during the rut in the Lake Louise Flat after which it shed its collar. Two other main Nelchina radio-collared bulls spent portions of summers in the upper Susitna-Nenana area. It appears that a resident subherd of 1,000 caribou exists in this area, however the situation is confounded by movements of animals from the main Nelchina herd through the area and by use of the area by summering bulls from the main Nelchina herd. Between 1955 and 1968 this area was a primary wintering area for much of the Nelchina herd and during many years it has been important summer range (Skoog 1968; Hemming 1971). Alaska Range: I have received unconfirmed reports of females with calves occurring along the southern slopes of the Alaska Range between the Susitna River and the Richardson Highway during summer. I have seen only bulls in the area during summer but have not rigorously surveyed the area. Upper Gakona-Chistochina Rivers: Again I have received reports of a resident subherd in this area. A reconnaissance survey of the area on 9 June 1981 produced sightings of a group of 20 cows, some of which had calves, and a group of 12 bulls. One radio-collared bull, captured with a segment of the main Nelchina herd

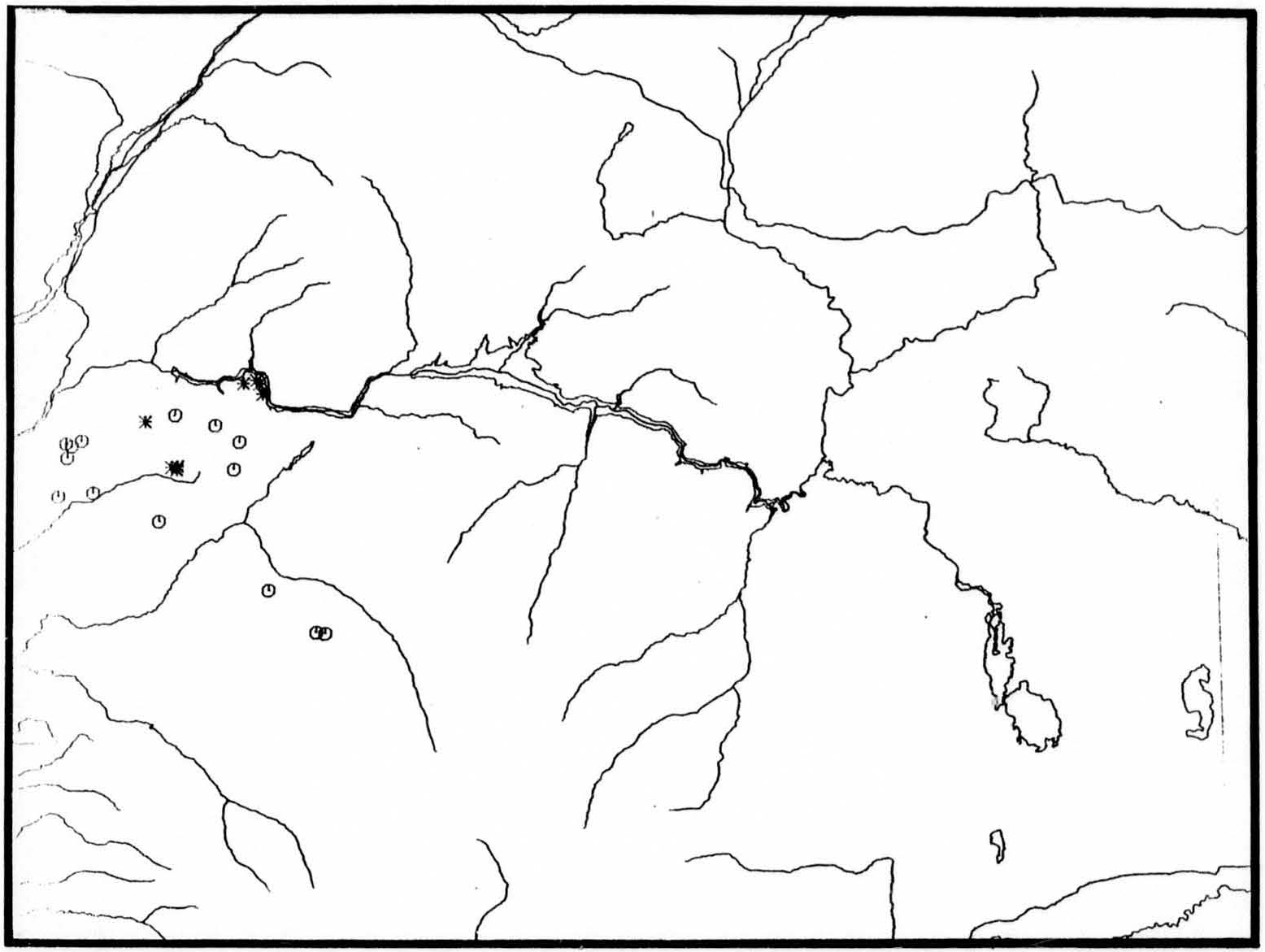

Figure 12. Distribution of Chunilna Hills radio-collared caribou during study period, 18 April, 1980 through 8 September, 1981. ⊙= females, ✳= males.

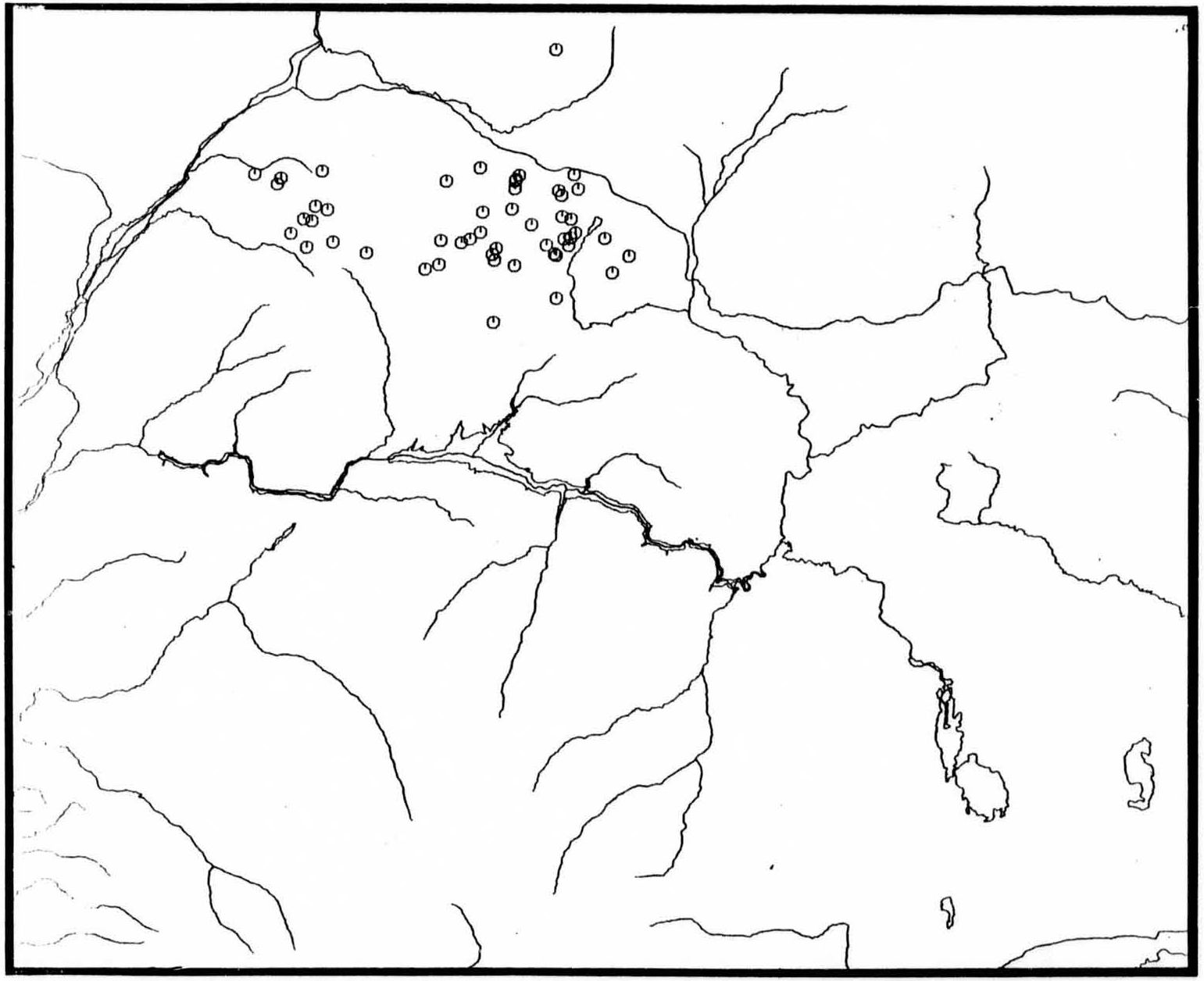

Figure 13. Distribution of Upper Susitna – Nenana radio-collared caribou during study period, 9 May, 1980 through 22 September, 1981. ⏲ = females, ✱ = males.

in the spring of 1981 spent the summer of 1981 in the area but was located with the main Nelchina herd on 17 October 1981 at the end of the rut. This is probably a small subherd which mingles with the main Nelchina herd during some winters and overlaps with summering bulls from the main herd.

I suspect another subherd(s) is present in the western Talkeetna Mountains based on sightings made by other biologists during the study period. Bulls are frequently seen during summer in scattered locations throughout the area, however I received reports of females with calves from two locations, the Wells Mountain area and the alpine area between Willow and Little Willow Creeks.

Habitat Use

I examined habitat use by caribou in the main Nelchina herd and the Talkeetna River, Chunilna Hills and upper Susitna-Nenana subherds by recording vegetation type and elevation on each relocation of radio-collared caribou. The vegetation classifications were simplifications of Viereck and Dyrness's (1981) level I categories. My inability to precisely classify vegetative cover from an aircraft plus the fact that snow covered ground vegetation during much of the year precluded more precise classification in most cases. Categories used included: spruce forest (virtually no use of deciduous or mixed forest types was seen), tundra and herbaceous, shrubland, and bare substrate. For seasonal analyses the following categories were used; calving, 20 May-10 June; summer, 11 June-3 July; autumn, 1 August-30 September; rut, 1-20 October; winter, 20 October-31 March; spring migration 1 April-19 May.

In the main Nelchina herd habitat use by bulls and cows was significantly different (P 0.01). Use of shrublands and bare substrate was similar while bulls were found more often in spruce forest and cows in tundra and herbaceous vegetative types (Table 2). This is likely related to the tendency for bulls to

Table 2. Crosstabulation of radio-collared caribou relocations from the main Nelchina herd by habitat and sex.

P/F	VAR006 FEMALE (IF)	MALE (IM)	ROW TOTAL
1. SPRUCE FOREST	116	55	171
	34.2	50.9	38.3
2. TUNDRA-HERB.	122	21	143
	36.0	19.4	32.0
3. SHRUBLAND	81	26	107
	23.9	24.1	23.9
6. BARE SUBSTRATE	20	6	26
	5.9	5.6	5.8
COLUMN TOTAL	339	108	447
	75.8	24.2	100.0

CHI SQUARE = 13.00181 WITH 3 DEGREES OF FREEDOM. SIGNIFICANCE = .0046

remain on winter ranges longer in the spring (Fig. 5) and to spend spring and summer months at lower elevations (Fig. 14). Both male and female radio-collared caribou from the main Nelchina herd showed significant (P 0.001) differences in seasonal habitat use (Tables 3, 4). The main differences were heavy use of spruce forests during the rut, winter and spring and increased use of the tundra-herbaceous type during calving and summer. Both sexes occurred in shrublands with nearly equal frequency (FF=23.9%, MM=24.1%; Tables 3, 4) however seasonal use patterns were different. Female use of shrublands occurred nearly equally in spring, calving and summer while male use peaked in summer and autumn.

Radio-collared caribou from the upper Susitna-Nenana, Talkeetna River and Chunilna Hills subherds were primarily found in tundra-herbaceous vegetative type (Tables 5, 6, 7). Shrublands were also used frequently by animals from the upper Susitna-Nenana and Chunilna Hills areas.

Seasonal Elevation Patterns

Male and female radio-collared caribou from the main Nelchina herd were located at similar elevations during autumn, the rut and winter (Fig. 14). During spring migration, calving and summer females were found at higher elevations than males. During spring and calving males lagged far behind the females remaining longer on winter range (Fig. 5) and then often spending the summer period in the lower shrublands.

Population Size and Composition

1980: census activities were conducted from 2-5 July 1980. Reconnaissance flights showed that the post-calving female:calf segment of the main Nelchina herd (including 19 of 20 radio-collared females considered to be main Nelchina animals) was in an area of about 260 mi^2 in the southeastern Talkeetna Mountains

Table 3. Crosstabulation of radio-collared male caribou relocations from the main Nelchina herd by habitat and season.

HAB	COUNT / COL PCT	SEASON: CALVING (1.)	SUMMER (2.)	AUTUMN (3.)	RUT (4.)	WINTER (5.)	SPRING (6.)	ROW TOTAL
1. SPRUCE FOREST		7	0	6	5	7	30	55
		63.6	0	25.0	83.3	77.8	76.9	50.9
2. TUNDRA-HERB.		3	8	5	0	0	5	21
		27.3	42.1	20.8	0	0	12.8	19.4
3. SHRUBLAND		1	10	10	1	1	3	26
		9.1	52.6	41.7	16.7	11.1	7.7	24.1
6. BARE SUBSTRATE		0	1	3	0	1	1	6
		0	5.3	12.5	0	11.1	2.6	5.6
COLUMN TOTAL		11	19	24	6	9	39	108
		10.2	17.6	22.2	5.6	8.3	36.1	100.0

HAB CHI SQUARE = 49.88392 WITH 15 DEGREES OF FREEDOM. SIGNIFICANCE = .0000

Table 4. Crosstabulation of radio-collared female caribou relocations from the main Nelchina herd by habitat and season.

HAB	SEASON: CALVING 1.	SUMMER 2.	AUTUMN 3.	RUT 4.	WINTER 5.	SPRING 6.	ROW TOTAL
1. SPRUCE FOREST	0	0	20	15	22	59	116
	0	0	36.4	71.4	57.9	56.2	34.2
2. TUNDRA-HERB.	46	41	16	3	3	16	122
	74.2	70.7	29.1	0	7.9	15.2	36.0
3. SHRUBLAND	16	16	9	5	5	30	81
	25.8	27.6	16.4	23.8	13.2	28.6	23.9
6. BARE SUBSTRATE	0	1	10	1	8	0	20
	0	1.7	18.2	4.8	21.1	0	5.9
COLUMN TOTAL	62	58	55	21	38	105	339
	18.3	17.1	16.2	6.2	11.2	31.0	100.0

RAW CHI SQUARE = 189.39782 WITH 15 DEGREES OF FREEDOM. SIGNIFICANCE = 0

Table 5. Crosstabulation of radio-collared female caribou relocations from the upper Susitna-Nenana subherd by habitat and season.

HAB	COUNT / COL PCT	SEASON 1. CALVING	2. SUMMER	3. AUTUMN	4. RUT	5. WINTER	6. SPRING	ROW TOTAL
2. TUSSOCK-HERB.		8	8	2	1	5	6	30
		80.0	72.7	28.6	33.3	83.3	46.2	60.0
3. SHRUBLAND		1	2	4	2	1	6	16
		10.0	18.2	57.1	66.7	16.7	46.2	32.0
6. BARE SUBSTRATE		1	1	1	0	0	1	4
		10.0	9.1	14.3	0	0	7.7	8.0
COLUMN TOTAL		19	11	7	3	6	13	50
		20.0	22.0	14.0	6.0	12.0	26.0	100.0

RAW CHI SQUARE = 15.49809 WITH 10 DEGREES OF FREEDOM. SIGNIFICANCE = .3979

Table 6. Crosstabulation of radio-collared female caribou relocations from the upper Talkeetna River subherd by habitat and season.

HAB	SEASON 1. CALVING	2. SUMMER	3. AUTUMN	5. WINTER	6. SPRING	ROW TOTAL
2. TUNDRA-HERB.	8	6	6	4	9	33
	100.0	75.0	75.0	100.0	100.0	89.2
3. SHRUBLAND	0	1	1	0	0	2
	0	12.5	12.5	0	0	5.4
6. BARE SUBSTRATE	0	1	1	0	0	2
	0	12.5	12.5	0	0	5.4
COLUMN TOTAL	8	8	8	4	9	37
	21.6	21.6	21.6	10.8	24.3	100.0

RAW CHI SQUARE = 5.88636 WITH 8 DEGREES OF FREEDOM. SIGNIFICANCE = .6600

Table 7. Crosstabulation of radio-collared female caribou relocations from the Chunilna Hills subherd by habitat and season.

HAB	SEASON	1. CALVING	2. SUMMER	3. AUTUMN	5. WINTER	6. SPRING	ROW TOTAL
2. TUNDRA-HERB.	COUNT	2	1	2	1	3	9
	COL PCT	100.0	100.0	50.0	100.0	60.0	69.2
3. SHRUBLAND	COUNT	0	0	2	0	2	4
	COL PCT	0	0	50.0	0	40.0	30.8
COLUMN TOTAL		2	1	4	1	5	13
		15.4	7.7	30.8	7.7	38.5	100.0

RAW CHI SQUARE = 2.67222 WITH 4 DEGREES OF FREEDOM. SIGNIFICANCE = .6141

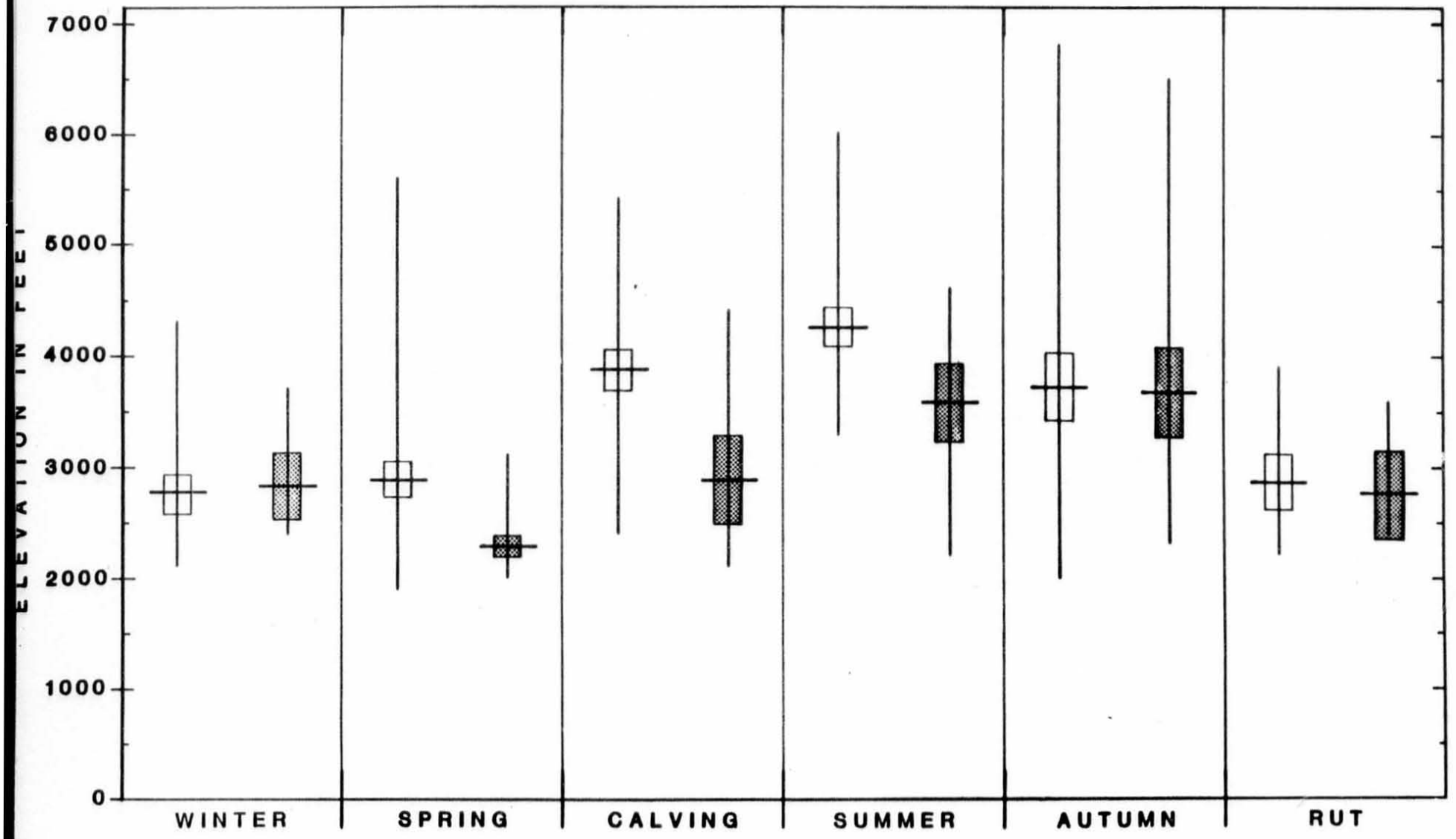

Figure 14. Seasonal elevation use by female (light box) and male (dark box) caribou from the main Nelchina herd. Horizontal line, mean; box, 95% confidence interval; vertical line, range.

ranging from the Oshetna River to the Little Nelchina River. The area was subdivided into three areas based on geographical features and apparent composition of animals. A total of 17,061 caribou was counted; 9,771 in area A, 2,383 in area B and 4,907 in area C. Composition data from the three areas (Table 8) indicated significant differences (X^2=143.15, P 0.001) in the proportions of males, females and calves. The composition sampling effort was not proportional to the numbers of caribou in each of the subareas therefore the data were weighted to provide the most accurate estimate of composition possible. An additional 244 caribou (including cows and calves) were found in peripheral areas and were assumed to have the same composition as the weighted estimate. Therefore the post-calving aggregation totaled 17,305 caribou with an estimated composition of 2,808 males ≥1 year, 9,285 females ≥1 year and 5,212 calves.

Fall composition data (Table 9) were collected on 14 October 1980 when the main Nelchina herd was distributed on the Lake Louise Flat during the rut. The ratio of males ≥1 year to 100 females ≥1 year was 61.9, the highest ever recorded for the Nelchina herd. While collecting the composition data I felt that sampling was probably biased towards males. Large males were easily identified and tended to catch my eye. Also, concentrations of males usually occurred at the back of groups where sampling began. Often the groups fragmented and animals towards the front were not fully sampled. An indication that the data may have been representative or that observer bias has been consistent over time was the near perfect fit (r^2=0.99) of this years ratio with the linear increase which has occurred since 1976. Indeed an increase in the proportion of males would be expected for a herd which is increasing and previously had a relatively low proportion of males. Bergerud (1980) pointed out that a herd with good recruitment and a young age structure will have large numbers of young bulls.

The estimated 1980 fall population was calculated as follows:

Table 8. Nelchina caribou postcalving sex and age composition data, 5 July 1980.

Area	MM per 100 FF ≥1 year	Calves per 100 FF ≥1 year	Calves N	Calves %	Cows ≥1 year N	Cows ≥1 year %	Bulls 1≥ year N	Bulls 1≥ year %
A	19.8	54.8	222	31.4	405	57.3	80	11.3
B	76.9	37.4	107	17.5	286	46.7	220	35.9
C	33.5	67.6	184	33.6	272	49.7	91	16.6
Weighted*	30.2	56.1		30.1		53.7		16.2

* Weighting was based on composition samples and numbers of caribou counted (see text) in each of the subareas.

Table 9. Nelchina caribou fall sex and age composition data, 14 October 1980.

MM per 100 FF ≥1 year	Calves per 100 FF ≥1 year	Calves N	Calves %	Cows ≥1 year N	Cows ≥1 year %	Bulls ≥1 year N	Bulls ≥1 year %
61.9	42.3	170	20.7	402	49.0	249	30.3

18,713 = (17,305 X 0.537) - 129 X (1+1.042) where 17,305 = the number of animals in the post-calving aggregation, 0.537 = proportion of females in the post-calving aggregation, 129 = mortality of females from the time of post-calving counts until fall and consists of reported hunter harvest, 1.042 = ratio of bulls and calves to females in the fall. The figure 18,713 is the fall population estimate.

1981: the census was conducted from 23 to 25 June 1981. On 23 June reconnaissance flights showed that the female:calf segment of the herd was in a band extending from the headwaters of Caribou Creek through the upper Oshetna River to Black Lake (Fig. 15) an area of about 170 mi^2. All 17 radio-collared females from the main Nelchina herd were included in this group. The area was divided into three areas based on geographic features for counting and composition. On 24 June a total of 19,264 caribou were counted; 6,554 in area A, 6,701 in area B and 6,009 in area C. Composition sampling from the three areas (Table 10) indicated significant differences (x^2=52.41, P 0.001) in the proportion of males, females and calves. The composition sampling was not directly proportional to the numbers in each of the subareas therefore the data were weighted (Table 10). The estimate of the post-calving aggregation was 19,264 caribou with 10,416 females ≥1 year, 3,035 males ≥1 year and 5,813 calves.

Fall composition sampling (Table 11) was conducted on 19 October between Ewan Lake and the Chistochina River. The ratios of males ≥1 year (60.4) and calves (42.9) per 100 cows ≥1 year were nearly identical to those obtained in October 1980 (Table 9). Because of poor weather the composition count was conducted about one week later than normal. It appeared that some bulls had separated from the cow-calf segment and therefore males may have been slightly underrepresented in the sampling.

I estimated that the herd was about evenly divided east and west of the Richardson Highway and the Trans-Alaska Pipeline at the

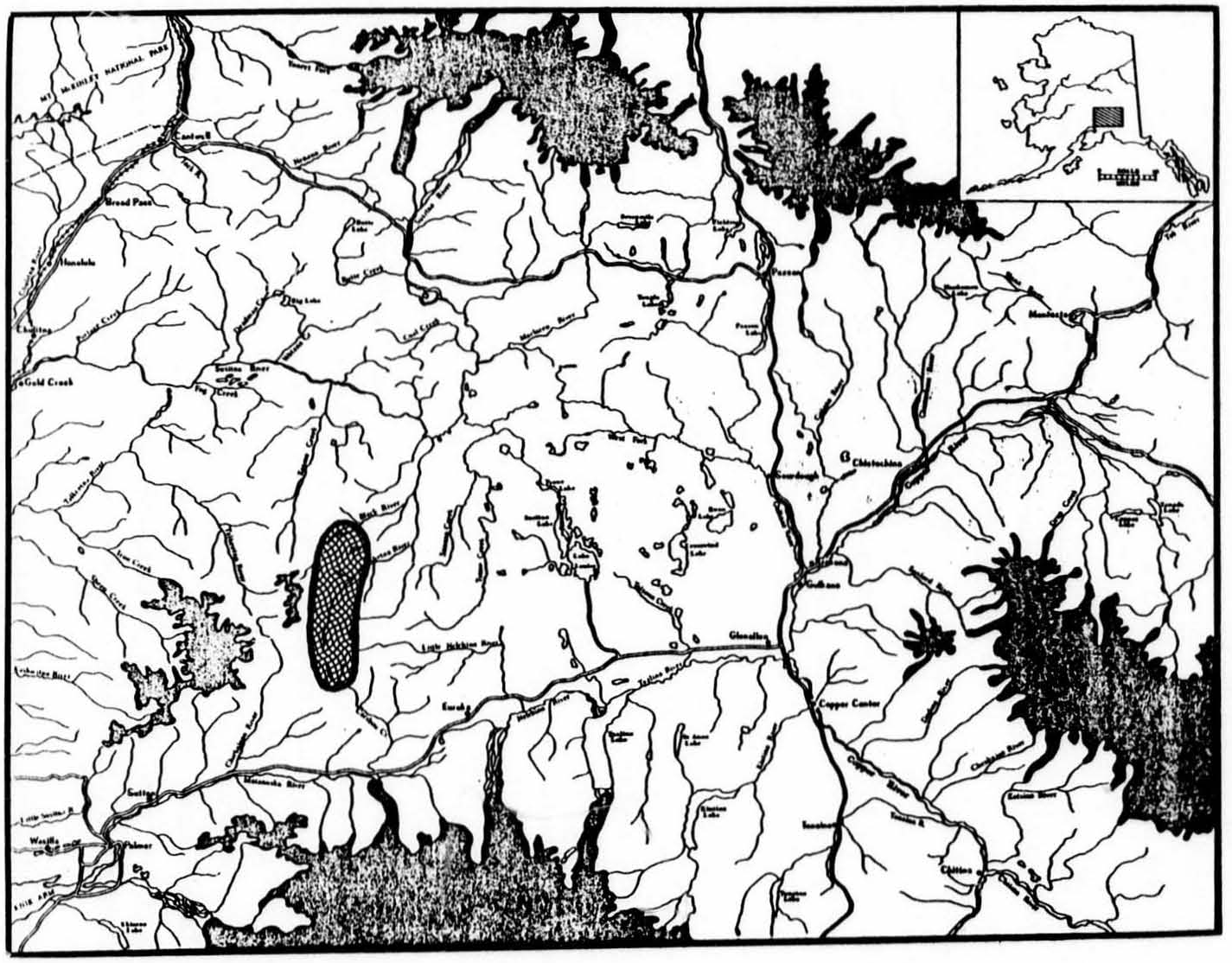

Figure 15. Location of female-calf postcalving aggregation during 24 June, 1981 census.

Table 10. Nelchina caribou postcalving sex and age composition data, 25 June 1981.

Area	MM per 100 FF ≥1 year	Calves per 100 FF ≥1 year	Calves N	Calves %	Cows ≥1 Year N	Cows ≥1 Year %	Bulls ≥1 year N	Bulls ≥1 year %
A	46.9	53.3	156	26.5	294	50.0	138	23.5
B	17.5	54.6	272	31.7	498	58.1	87	10.2
C	25.1	60.0	325	32.4	542	54.0	131	13.6
Weighted*	29.1	55.8		30.1		54.1		15.8

* Weighting was based on composition samples and numbers of caribou counted (see text) in each of the subareas.

Table 11. Nelchina caribou fall sex and age composition data, 19 October 1981.

MM per 100 FF ≥1 year	Calves per 100 FF ≥1 year	Calves N	Calves %	Cows ≥1 year N	Cows ≥1 year %	Bulls ≥1 year N	Bulls ≥1 year %
60.9	42.9	342	21.1	797	49.1	485	29.9

time of the composition counts based on the distribution of the radio-collared animals and observations of caribou numbers during the sampling. Segregation of herd components was apparent as the proportions of both calves and bulls ≥1 year were greater east of the highway and pipeline (Table 12). Composition data were not weighted as the sampling effort was approximately proportional to numbers present in each area.

The estimated 1981 fall population was calculated as follows: $\underline{20,730} = (19,264 \times 0.541) - 250 \times (1 + 1.038)$ where 19,264 = the number of caribou counted in the post-calving aggregation, 0.541 = the proportion of females in the post-calving aggregation, 250 = a preliminary estimate of hunter harvest of females and a 1% estimate for natural mortality of females ≥1 year between the time of the census and the fall composition counts and 1.058 = ratio of bulls and calves to cows in the fall. The figure 20,730 is the 1981 fall population estimate.

The presence of all radio-collared females from the main Nelchina herd in the census area in 1981 and all but one in 1980 added confidence to the population estimates. Assumption #1 (see methods) requires that all females be present in the post-calving aggregations included in the census area.

In recent years the herd has experienced a growth phase, 1950-60; a peak 1962-1967; a decline, 1967-1973; and then another growth phase, 1974-1981 (Table 13). The technique currently used to estimate herd size (aerial photo-direct count extrapolation caribou census technique) has not always produced precise estimates, however a trend of herd growth since about 1976 is apparent when the complete series of estimates is examined. The average annual rate of population growth (r) between the 1977 herd estimate and the 1981 herd estimate was 0.10. For the female ≥1 year segment of the herd the r estimate was 0.08. During this period an additional 3-4% of the herd (primarily males) has been harvested.

Table 12. Comparison of proportions of males ≥1 year, females ≥1 year and calves east and west of Richardson Highway during 19 October 1981 composition counts.

	West Richardson			East Richardson		
	N	(%)	per 100 Females	N	%	per 100 females
Males ≥1 yr	204	(281)	52.6	276	(31.4)	69.0
Calves	138	(18.5)	34.8	204	(23.2)	51.0
Females ≥1 yr	397	(53.4)		400	(45.5)	

Chi square = 10.69
Degrees Freedom = 2
Significance = P<0.01

Table 13. Nelchina caribou herd population estimates, in fall unless otherwise noted.

Year	Total Estimate	Female Estimate	Male Estimate	Calf Estimate
1955	40,000[1]	-	-	-
1962	71,000[2]	-	-	-
1967	61,000[3]	-	-	-
1972	7,842	4,800	1,622	1,420
1973	7,693	4,646	1,268	1,779
1976	8,081	4,979	1,663	1,439
1977	13,936	7,509	2,868	3,559
1978	18,981	9,866	4,429	4.686
1980	18,713	9,164	5,673	3,876
1981	20,730[4]	10,172	6,195	4,364

[1] Watson and Scott (1956), February census.
[2] Siniff and Skoog (1974), February census, perhaps should be adjusted downward by as many as 5,000 caribou due to presence of Mentasta herd.
[3] Felt by some to be an unreasonably high estimate.
[4] Preliminary estimate, awaiting final female harvest data.

Alaska Department of Fish and Game management objectives for the Nelchina herd include: (1) restricting the harvest until a population level of 20,000 animals older than calves is reached, (2) maintaining a minimum sex ratio of 25 males/100 females, (3) provide for the greatest opportunity to participate in hunting caribou, and (4) to provide for an optimum harvest of caribou. Harvest of the herd is currently restricted by a permit system to allow for continued herd growth.

Currently the Nelchina herd contains about 6% of the total statewide caribou population (325,000). It is exceeded in size by the large Western Arctic and Porcupine herds located in Northern Alaska and is comparable in size to the Alaska Peninsula and Mulchatna herds in southwestern Alaska. Historically the Fortymile herd has been much larger than the Nelchina herd but currently is somewhat smaller.

Mortality

Natural mortality: three radio-collared caribou died of natural causes. On 14 October 1980 a bull was relocated with a bleeding wound on the rump. This was during the rut and fighting between bulls was seen on several occasions so it was possible the wound was a result of an encounter with another bull. During the next survey (2 December 1980) the transmitter was on mortality mode indicating cessation of movement. The carcass was examined on 15 April 1981 and was largely intact. Transmitters on two females were detected on mortality mode on 11 February 1981. When examined on 15 April 1981 they both appeared to have been killed by predators, probably wolves.

Estimates of x annual survival rates were 0.935 (0.9821-0.8351; 80% confidence interval) for females ≥1 year and 0.870 (0.9857-0.5777; 80% confidence interval) for males ≥1 year based on the number of observed natural mortalities of radio-collared caribou and number of animal months monitored (Trent and Rongstad 1974).

These estimates were probably somewhat low as only one winter-spring period, when most mortality of caribou older than calves normally occurs (Skoog 1968), was included while two summer periods when natural mortality is minimal, were included.

Calf survival from birth to 11 months of age (May 1980 to April 1981) was estimated from a theoretical birth rate of 0.66 calves per cow ≥1 year (Skoog 1968, Bergerud 1978) and an observed ratio of 0.30 calves per cow ≥1 year in April which was corrected for survival of females (0.95) between May and April (Fuller and Keith 1981). Estimated calf survival was $\frac{0.30 \times .95}{0.66} = 043.$

Hunter mortality: Reported hunter harvest for the Nelchina caribou herd has averaged about 670 animals over the past 10 years (Table 14). Females have composed about 25% of the reported harvest. Hunter numbers have been controlled by permit since 1977.

Potential Impacts of Project Construction

Construction of the proposed Watana dam would create an impoundment which would intersect a major historical migratory route(s) of the Nelchina caribou herd (Figure 16). During most years between 1950 and 1973 most or all of the female-calf segment of the herd crossed from the calving grounds in the Talkeetna Mountains to summer in the greater Deadman-Butte Lakes area (Skoog 1968, Hemming 1971, Bos 1974). This movement sometimes occurred in June after calving but more commonly took place in late July (Skoog 1968). Hemming (1971) stated that most crossings of the Susitna in the proposed impoundment area occurred between Deadman Creek and the big bend of the Susitna.

Varying proportions of the herd have wintered north of the proposed impoundment in drainages of the upper Susitna, Nenana and Chulitna Rivers in many years. Between 1957 and 1964 this was the major wintering area (Hemming 1971). Spring migration routes

Table 14. Reported hunter harvest of the Nelchina caribou herd, 1972 - 1981.

Regulatory Year	Total Harvest	Females		Males	
		No.	(%)	No.	(%)
1972-73	555	153	(28)	338	(72)
1973-74	629	203	(33)	411	(67)
1974-75	1,036	343	(34)	656	(66)
1975-76	669	201	(31)	441	(69)
1976-77	776	201	(26)	560	(74)
1977-78	360	77	(22)	275	(78)
1978-79	539	111	(21)	416	(79)
1979-80	630	90	(14)	509	(81)
1980-81	621	117	(21)	453	(79)
1981-82*	856	144	(18)	675	(82)

*Preliminary data.

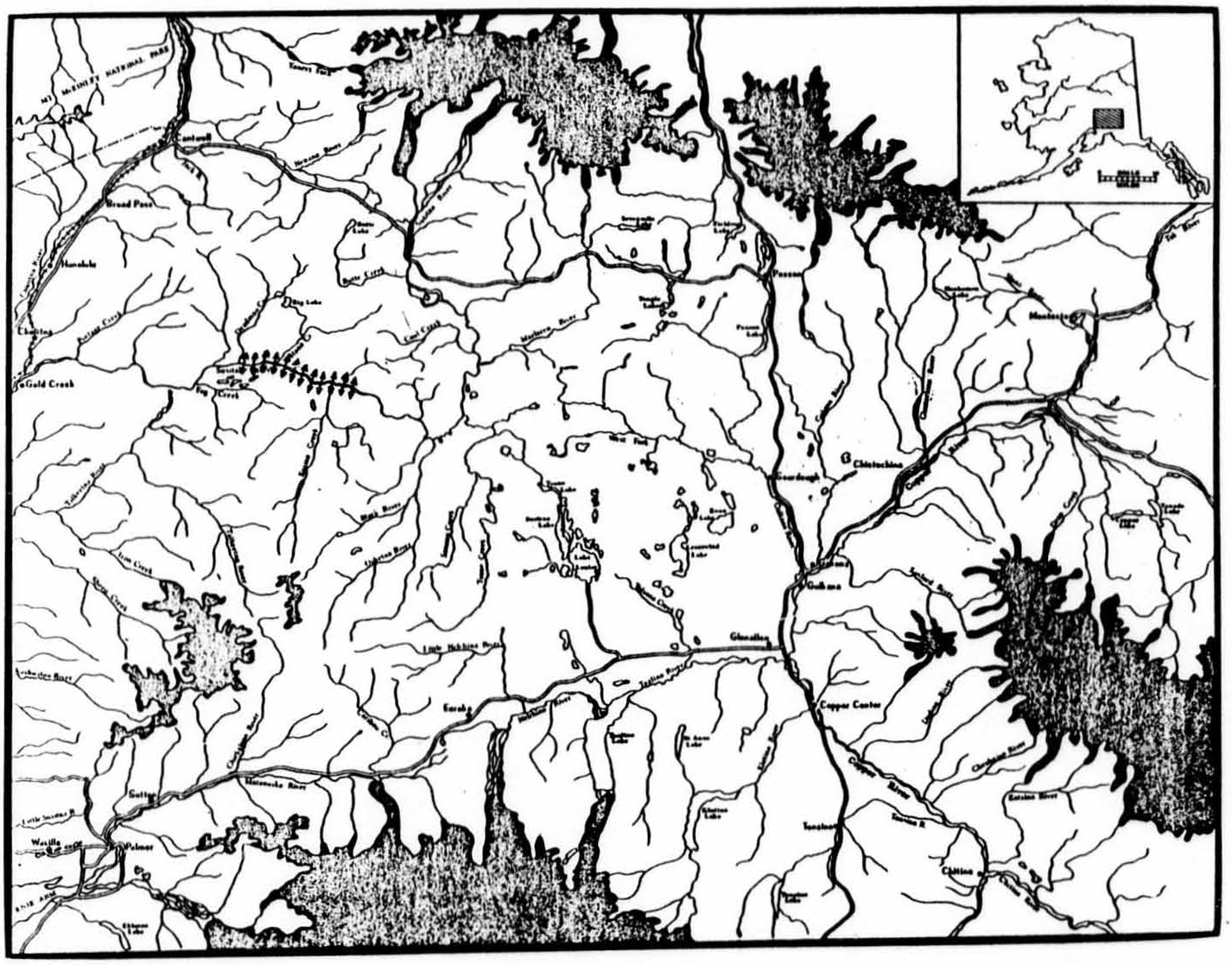

Figure 16. Area where historically the Nelchina caribou herd crossed the proposed impoundment area.

during these years would have undoubtedly crossed the impoundment area apparently between Deadman Creek and Jay Creek.

Some use of the proposed impoundment also occurred during the autumn dispersal period as animals moved from the Talkeetna Mountains north across the Susitna or vice versa. Some crossings by bulls which summered at various locations throughout the Nelchina Range and moved towards the female-calf segment prior to the rut occurred every year.

Large movements of caribou across the proposed impoundment have not occurred during the study period, nor have they been recorded since about 1976 (Eide pers. comm.). Sixteen of 32 radio-collared caribou from the main Nelchina herd (Appendix I: 31, 62, 122, 142, 150, 161, 170, 182, 192, 251, 370, 411, 431, 441, 466, 480) were either located in the proposed impoundment area or locations of sequential sightings indicated a high probability that they had been in the area a total of 22 times. Radio-collared caribou were found in the impoundment area during two periods, spring (about 10 April - 31 May) and autumn (1 August - 30 September); fourteen sightings were in spring while eight were in the fall. During spring 1981 it appeared from both relocations of radio-collared animals and sightings of tracks and caribou that many animals were using the Susitna River as a travel route. They apparently traveled the river from its confluence at the Tyone and Oshetna Rivers to Kosina Creek and Watana Lake where they moved west into the Talkeetna Mountain foothills. Nine crossings of the proposed Watana impoundment by six radio-collared caribou were documented (six were north to south and three south to north). Five occurred in spring and four in autumn. The uppermost portion of the Watana impoundment received the most use by radio-collared animals in both spring and autumn.

Even though crossings of the proposed Watana impoundment by Nelchina caribou have been relatively infrequent (when compared to historical records when virtually the entire herd crossed two

or more times per year) it seems inevitable that they will again cross in large numbers. The area north and west of the Watana impoundment was used extensively as summer and winter range in the past and Skoog (1968) considered some of the area as the most important habitat for year around use in the Nelchina range.

It appears that major herd crossing of the impoundment area usually occurred when population levels were relatively high (Tables 1, 14). During recent years when major crossings have not occurred the herd has been at low to moderate population levels (Table 14) and has only used about a third of its historical range (7,000 mi^2/20,000 mi^2). Hemming (1972) suggested that the range use, frequency of shifts in range and seasonal splitting were positively correlated with herd size. It appears likely that the probability of major crossings of the impoundment area and increased use of the northwestern portion of the range will increase as herd size increases.

The reactions of caribou to the sudden creation of a large impoundment intersecting a major migratory route cannot be predicted with confidence. Movements across the impoundment would largely occur during three periods. Spring migration from the winter range to the calving grounds would occur from late April through May. This would be a period of transition from an ice-covered reservoir at maximum drawdown with ice shelving and ice-covered shores to an open reservoir rapidly filling from spring run off. Post-calving movements from the calving grounds to summer range north of the Susitna would occur in late June or July at which time the impoundment would be ice free and nearing maximum water level. Additional movements throughout August and September would occur but would likely involve smaller, dispersed groups of animals. At this time the impoundment would be at maximum water level and ice free.

A possible reaction to the impoundment by caribou is complete avoidance and refusal to even attempt crossing. This could re-

duce use of the northwestern corner of the Nelchina range or change and extend the migration route to avoid the impoundment.

Another possible reaction would be avoidance by some components of the herd and attempted crossing by other segments. Cameron et al. (1979) documented avoidance of the Trans-Alaska Pipeline corridor by females and calves during summer. They also suggested avoidance by large groups, group fragmentation and/or decreased group coalescence near the pipeline corridor. Should animals attempt to cross the impoundment; spring migration would appear to pose the most serious problems. Pregnant females are often in the poorest condition of the annual cycle at this time (Skoog 1968) and migratory barriers which normally could be easily circumvented could become sources of mortality. Klein (1971) suggested that when animals are in poor physical condition seasonal migrations are easily disrupted. The potential for injury or death to migrating caribou appears greater in spring than during other periods. Skoog (1968) mentioned several instances of injuries and death resulting from falls on or through ice. Ice covered shores, ice sheets and steep ice shelves formed by winter draw-down of the reservoir could present formidable obstacles to movement (Hanscom and Osterkamp 1980). Both Klein (1971) and Vilmo (1975) mention ice shelving as a mortality factor of reindeer on reservoirs in Scandinavia. Spring breakup would probably occur during the migration in many years posing additional hazards such as floating ice floes, overflow and wet ice shelves.

Crossings during summer and fall when the reservoir would be ice free appear to pose considerably less hazard. Caribou are excellent swimmers and are known to cross much larger bodies of water than the proposed impoundment (Skoog 1968). Young calves might have problems with this distance if migrations occurred shortly after calving. Water crossings have been reported as mortality factors but usually involved rivers rather than more placid bodies of water such as a reservoir (Skoog 1968). Banfield and Jakimchuk (1980) suggest that open water may pose a barrier, par-

ticularly during post-calving movements and mid-summer migration. Large lakes are often crossed at traditional sites, often narrow points or where islands provide interim stopping points. They state "caribou prefer to avoid open water."

Relocations of radio-collared caribou demonstrated that at least during the study period three relatively discrete subherds occurred in the western portion of the Nelchina range. Two of these subherds, the Chunilna Hills and Susitna-Nenana groups, would probably become even more isolated from the main Nelchina herd by construction of the Susitna hydroelectric project although the extent probably would depend on locations of access corridors. The importance of periodic infusions of animals from the main herd for long-term persistence of these smaller groups is unknown.

Developments which would accompany construction and operation of the hydroelectric project such as roads, railroads and air fields and associated human activity might also negatively impact Nelchina caribou although the extent is virtually impossible to predict. Roads and railroads and resulting traffic have been suspected in obstructing movements of caribou and reindeer (Klein 1971, Vilmo 1975, Cameron et. al. 1979). However Nelchina caribou continue to cross the Richardson Highway, often in large numbers and have done so during many years since about 1960 (Hemming 1971). Several studies (Miller and Gunn 1979, Calef et al. 1976) have recorded responses of caribou to aircraft disturbance and speculated on deleterious impacts. Cows and calves were most responsive to disturbance (Miller and Gunn 1979). Caribou showed increased sensitivity during the rut and calving (Calef et al. 1976).

Electrical transmission lines have been reported to disrupt movements of reindeer in Scandinavia (Klein 1971, Vilmo 1975) because of associated noises (hum) and because they are foreign objects in otherwise familiar surroundings. If electrical transmission

lines are downstream from the proposed Watana dam site they should have little impact on caribou as long as they are routed near the river. Few caribou occur in this area. Several papers have been recently published dealing with caribou behavior and reactions to development and human activity (Cameron et al. 1979, Miller and Gunn 1979, Jakimchuk 1980, Hanson 1981, Horejsi 1981). These studies provide guidelines which may help design developmental activities to minimize adverse impacts.

The proximity of the Nelchina calving grounds to the proposed Watana impoundments (Fig. 6) is of concern. According to Skoog (1968) the calving ground is the "focal point" of a caribou herd. The Nelchina herd has shown nearly complete fidelity to its calving ground since record keeping began in about 1950. The calving grounds are in one of the most remote and inaccessible regions within the Nelchina range. Development of the Susitna hydroelectric project would change this. Expanded human access and activity would likely occur which have been shown to adversely impact caribou use of calving areas. Cameron et al. (1979) documented abandonment of a portion of the calving grounds of the central Arctic herd concurrent with development of the Prudhoe Bay oil fields.

Bergerud (1978) presented a somewhat different view and suggested that caribou are quite adaptable and will adjust to human construction and development. He stated that the impacts of human development and harassment have been overstated and no good evidence is available indicating that development has caused abandonment of ranges. However, he did state that calving areas may be an exception and should be protected from both development and disturbance.

The Watana impoundment appears to have the potential to negatively impact Nelchina caribou although the extent cannot be predicted. The Devil Canyon impoundment would occur in an area which both presently and historically has received little caribou

use and would probably be of minor significance to the Nelchina caribou herd.

Perhaps in the long run the major impact of the Susitna hydroelectric development on the Nelchina caribou herd will a contribution towards gradual, long term cumulative habitat degradation rather than immediate catastrophic results. The proposed hydroelectric project is only one (although the major one) of a number of developments which will probably occur in the Nelchina range. Considerable mining activity already is taking place in the southeastern Talkeetna mountains, traditional summer range. A state oil and gas lease sale is planned for the Lake Louise Flat, a major wintering area. Considerable land is passing from public to private ownership through the Alaska Native Claims Settlement Act and through state land disposal programs. While no single action may have a catastrophic impact it seems likely that long-term cumulative impacts will result in a lessened ability for the Nelchina range to support large numbers of caribou. Habitat destruction, increased access, disturbance, and partial barriers to movement will all probably contribute to this.

Recommendations for Phase II Studies

It appears that certain questions regarding impacts of the proposed hydroelectric project on caribou, particularly the reactions of caribou to the creation of an impoundment and the effect of the development on population dynamics, cannot be answered before project construction. The changeable nature of caribou movements further complicates impact prediction as movement patterns documented during the study period may well change before project construction. However the location of the calving grounds, a relatively permanent feature of a caribou herd, in relation to the proposed impoundments and summer and winter ranges virtually assures that some use of the impoundment area will occur. I recommend that a pool of about 25 radio-collared caribou from the main Nelchina herd be maintained through project

construction to document use of the area. Status of the herd should be monitored with annual censuses and sex and age composition sampling.

Population growth of caribou herds appears to be largely regulated by the rate of survival of calves to one year of age. One of the potential impacts of project construction could be increased juvenile mortality (through impoundment crossing and extended migrations of parous females to the calving grounds). Access roads to the dam sites may increase susceptibility to predators (Roby 1978). Therefore it seems appropriate to study preconstruction calf mortality, both causes and extent.

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REFERENCES

Alaska Department of Fish and Game. 1970-1980. Annual Survey and Inventory Reports, Caribou. Juneau, AK.

Banfield, A. W. F., and R. D. Jakimchuk. 1980. Analyses of the characteristics and behavior of barren ground caribou in Canada. Polar Gas Project. 281 pp.

Bergerud, A. T. 1978. Caribou. Pages 83-101 In J. L. Schmidt and D. L. Gilbert, eds. Big Game of North America (Ecology and Management). Stackpole Books, Harrisburg, PA.

_____. 1980. A review of the population dynamics of caribou and wild reindeer in North America. Pages 556 - 581 In E. Reimers, E. Gaare, and S. Skjenneberg, eds. Reindeer/Caribou Symposium II, Roros. Norway.

Bos, G. N. 1973. Nelchina caribou report. Alaska Dept. Fish and Game, Fed. Aid. in Wildl. Rest., Proj. W-17-4 and W-17-5. Juneau, AK. 25pp.

_____. 1974. Nelchina and Mentasta caribou reports. Alaska Dept. Fish and Game, Fed. Aid. in Wildl. Rest., Proj. W-17-5 and W-17-6. Juneau, AK. 50pp.

Calef, G. W., E. A. DeBock, and G. M. Lortie. 1976. The reaction of barren-ground caribou to aircraft. Arctic 29:201-212.

Cameron, R. D., K. R. Whitten, W. T. Smith, and D. D. Robey. 1979. Caribou distribution and group composition associated with construction of the Trans-Alaska Pipeline. Canadian Field-Naturalist 93:155-162.

Davis, J. L. 1978. History and current status of Alaska caribou herds. Pages 1-8 In D. R. Klein and R. G. White, ed. Parameters of caribou population ecology in Alaska. Biological papers of the University of Alaska Special Report Number 3.

_____., P. Valkenburg, and S. J. Harbo, Jr. 1979. Refinement of the aerial photo-direct count-extrapolation caribou census technique. Alaska Department of Fish and Game, Fed. Aid in Wildl. Rest., Proj. W-17-11. Juneau, AK. 23pp.

Doerr, J. 1979. Population dynamics and modeling of the Western Arctic Caribou Herd with comparisons to other Alaskan *Rangifer* populations. Unpubl. M.S. Thesis, Univ. of Alaska, Fairbanks. 341pp.

Eide, S. H. 1980. Caribou Survey-Inventory Progress Report. Pages 31-34 In R. A. Hinman, ed. Annual Report of Survey-Inventory Activities. Alaska Fed. Aid in Wildl. Rest. Proj. W-17-11.

Fuller, T. K. and L. B. Keith. 1981. Woodland caribou population dynamics in northeastern Alberta. J. Wildl. Manage. 45: 1970213.

Glenn, L. P. 1967. Caribou report. Alaska Dept. Fish and Game, Fed. Aid in Wildl. Rest. Proj. W-15-T-1,2. Juneau, AK. 36pp

Hanscom, J. T., and T. E. Osterkamp. 1980. Potential caribou-ice problems in the Watana reservoir, Susitna hydroelectric project. The Northern Engineer 12:4-8.

Hanson, W. C. 1981. Caribou (*Rangifer tarandus*) encounters with pipelines in northern Alaska. Canadian Field-Naturalist 95: 57-62.

Hemming, J. E. 1971. The distribution and movement patterns of caribou in Alaska. Alaska Dept. Fish and Game, Wildl. Tech. Bull. No. 1. 60pp.

_____. 1972. Population growth and movement patterns of the Nelchina caribou herd. Pages 162-169 In J.R. Luick,

P. C. Lent, D. R. Klein, and R. G. White, eds. Proc. First Int'l. Reindeer/caribou symposium, Univ. of Alaska, Fairbanks, Ak. 551 pp.

_____., and L. P. Glenn. 1968. Caribou report. Alaska Dept. Fish and Game, Fed. Aid in Wildl. Rest., Proj. W-15-R-2. Juneau, AK. 41pp.

_____. 1969. Caribou report. Alaska Dept. Fish and Game, Fed. Aid in Wildl. Rest., Proj. W-15-R-3 and W-17-1. Juneau, AK. 37pp.

Horejsi, B. L. 1981. Behavioral response of barren ground caribou to a moving vehicle. Arctic 34: 180-185.

Klein, D. R. 1971. Reaction of reindeer to obstructions and disturbances. Science 173:343-398.

Lentfer, J. 1965. Caribou report. Alaska Dept. Fish and Game, Fed. Aid in Wildl. Rest., Proj. W-6-5-5 and W-6-R-6. Juneau, AK. 20pp.

McGowan, T. A. 1966. Caribou report. Alaska Dept. Fish and Game, Fed. Aid in Wildl. Rest., Proj. W-6-R-6 and W-15-R-1. Juneau, AK. 19pp.

Miller, F. L., and A. Gunn. 1979. Responses of Peary caribou and muskoxen to helicopter harassment. Canadian Wildlife Service Occasional Paper Number 40. 90pp.

Neiland, K. A. 1972. Caribou disease studies. Alaska Dept. Fish and Game, Fed. Aid in Wildl. Rest. Proj. W-17-2 and W-17-3. Juneau, AK. 42pp.

Pegau, R. E., and G. N. Bos. 1972. Caribou report. Alaska Dept. Fish and Game, Fed. Aid in Wildl. Rest., Proj. W-17-3 and W-17-4. Juneau, AK. 32pp.

_____ and J. E. Hemming. 1972. Caribou report. Alaska Dept. Fish and Game, Fed. Aid in Wildl. Rest., Proj. W-17-2 and W-17-3. Juneau, AK. 221pp.

_____., G. N. Bos, and K. A. Neiland. 1973. Caribou report. Alaska Dept. Fish and Game, Fed. Aid in Wildl. Rest., Proj. W-17-4 and W-17-5. Juneau, AK. 70pp.

Robey, D. D. 1978. Behavioral patterns of barren-ground caribou of the Central Arctic herd adjacent to the Trans-Alaska Oil pipeline. M.Sc. Thesis, Univ. Alaska. 199 pp.

Skoog, R. O. 1968. Ecology of the caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. Dissertation, Univ. of California, Berkeley, CA. 699pp.

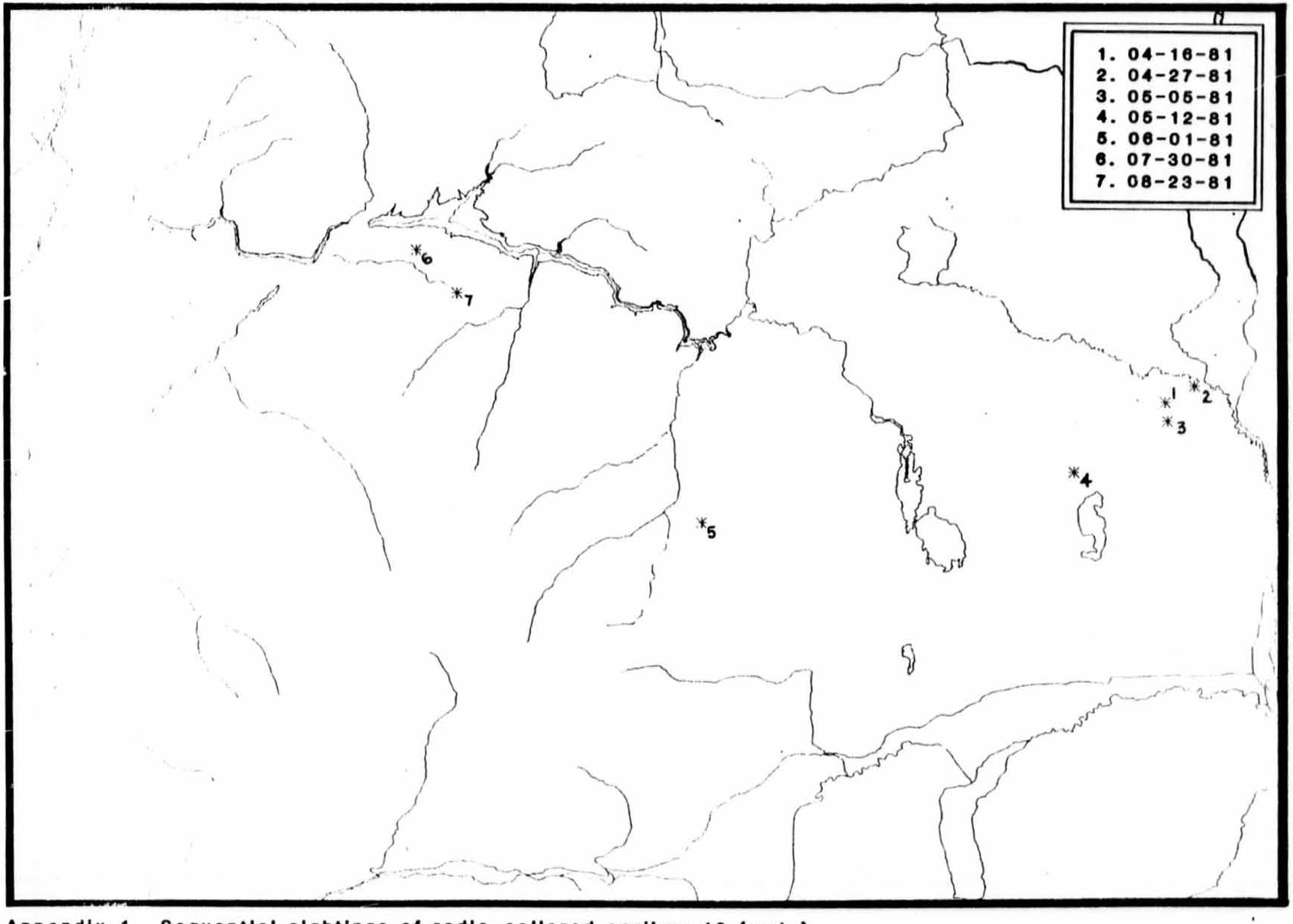
Siniff, D. B., and R. O. Skoog. 1964. Aerial censusing of caribou using random stratified sampling. J. Wildl. Manage. 28:391-401.

Trent, T. T., and O. J. Rongstad. 1974. Home range and survival of cottontail rabbits in southwestern Wisconsin. J. Wildl. Manage. 38: 459-471.

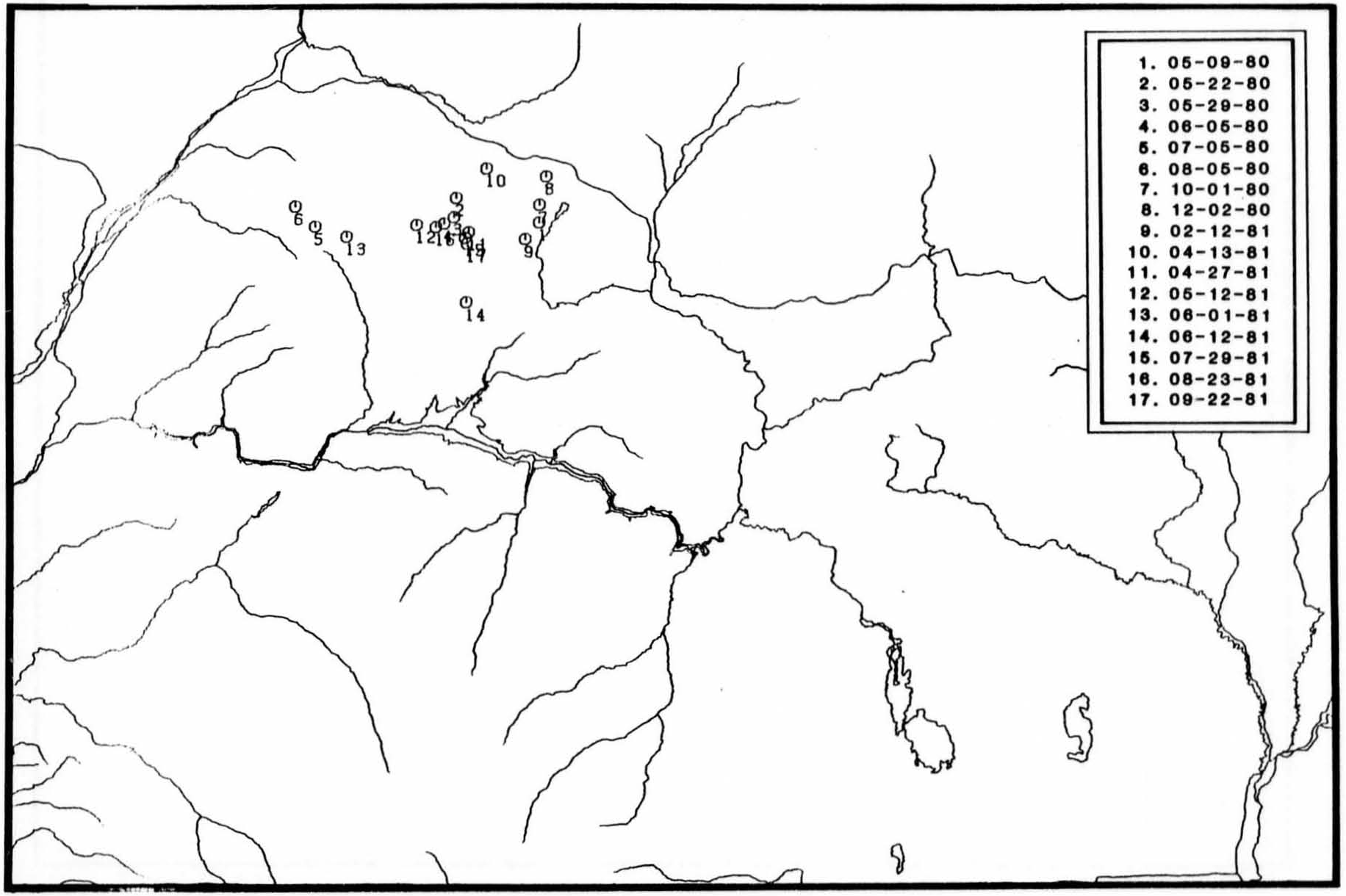
Viereck, L. A., and C. T. Dyrness. 1980. A preliminary classification system for vegetation of Alaska. U.S. Forest Service General Technical Report PNW-106. 38pp.

Vilmo, L. 1975. The Scandinavian viewpoint. Pages 4-9 In J. R. Luick et al., ed. Proceedings of the First International Reindeer and Caribou Symposium. Biological Papers of the University of Alaska Special Report No. 1.

Watson, G. W., and R. F. Scott. 1956. Aerial censusing of the Nelchina caribou herd. Trans. N. Am. Wildl. Conf. 21:499-510.



Appendix 1. Sequential sightings of radio-collared caribou 13 (male).



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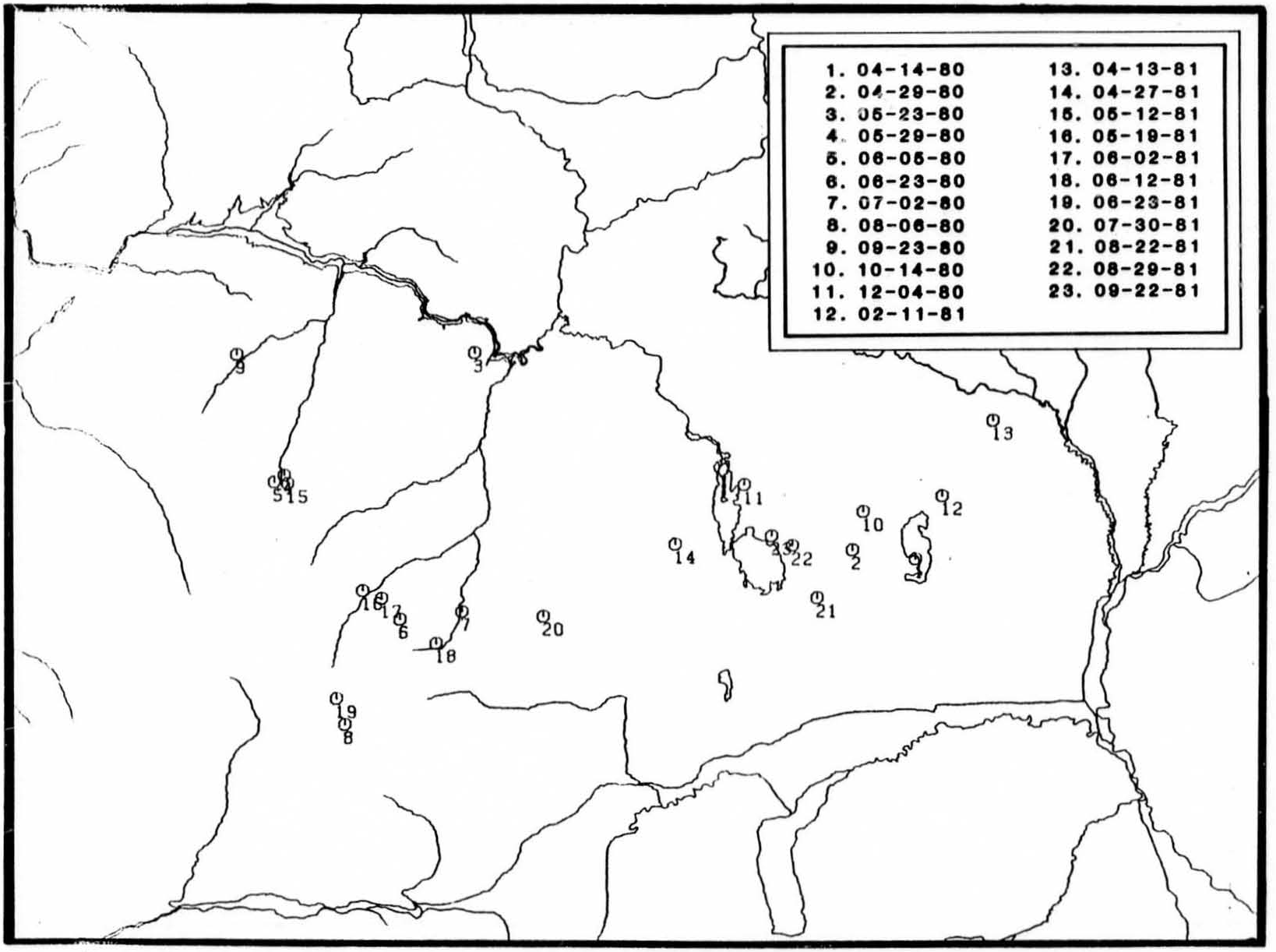

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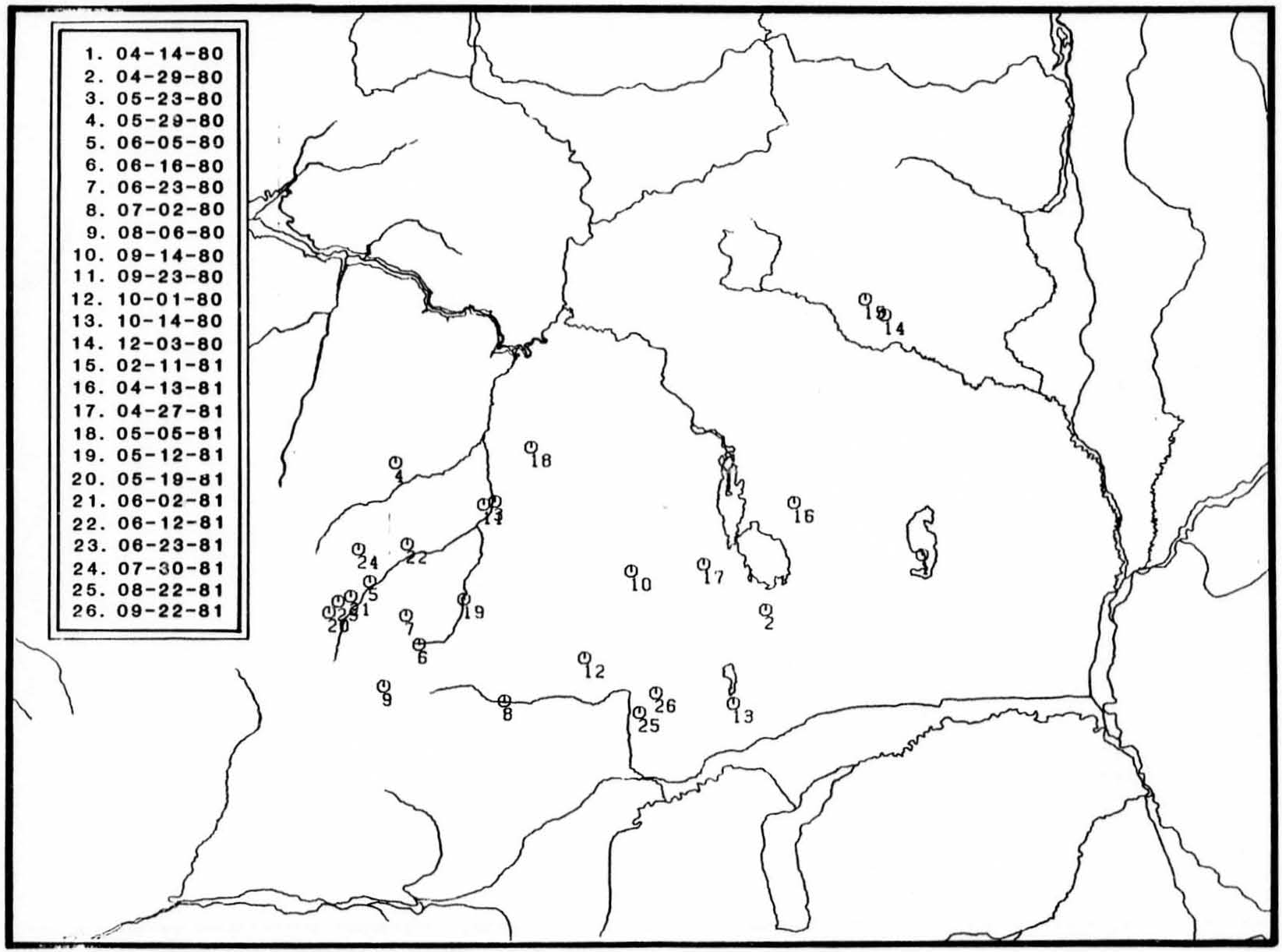

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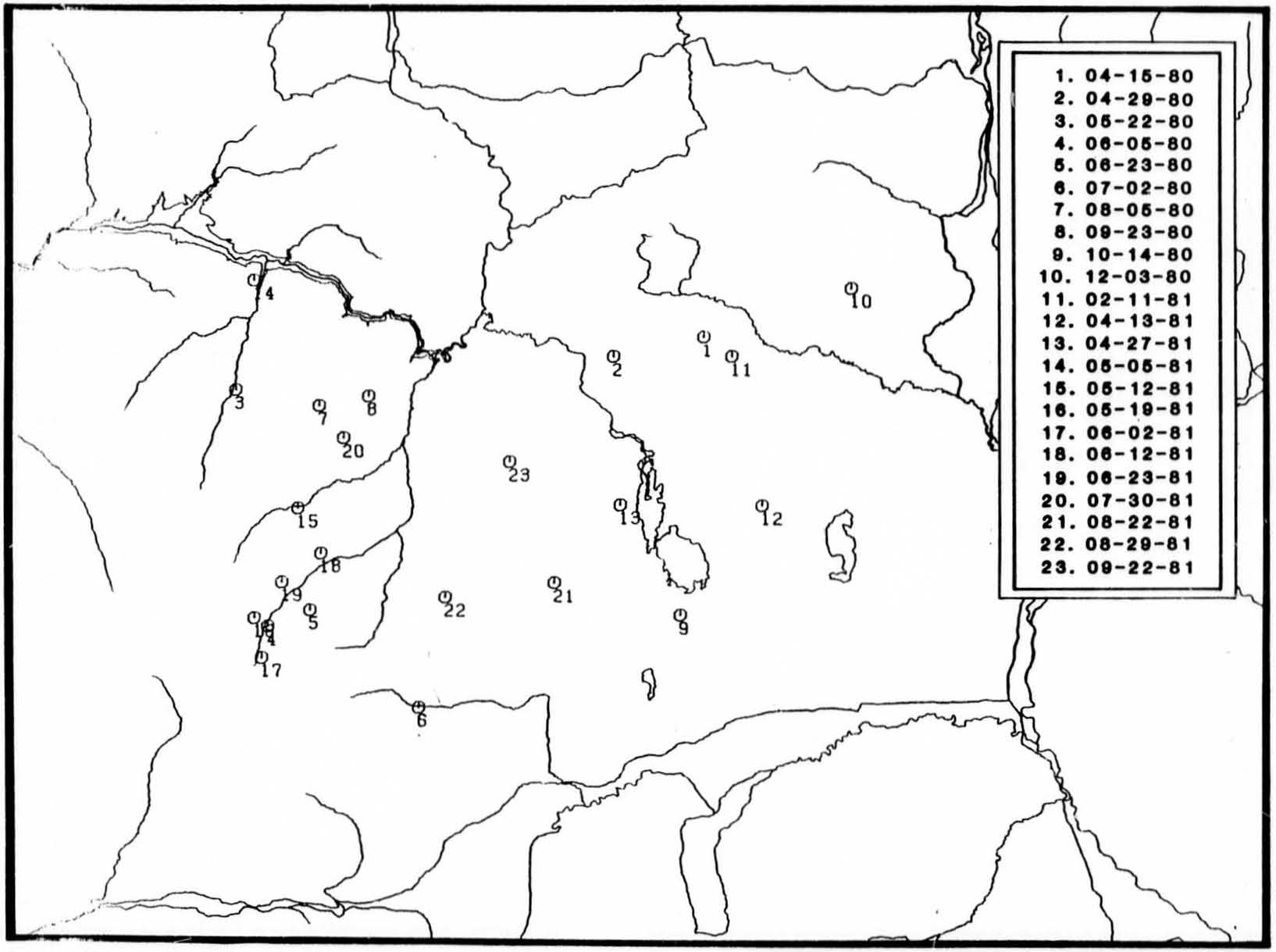

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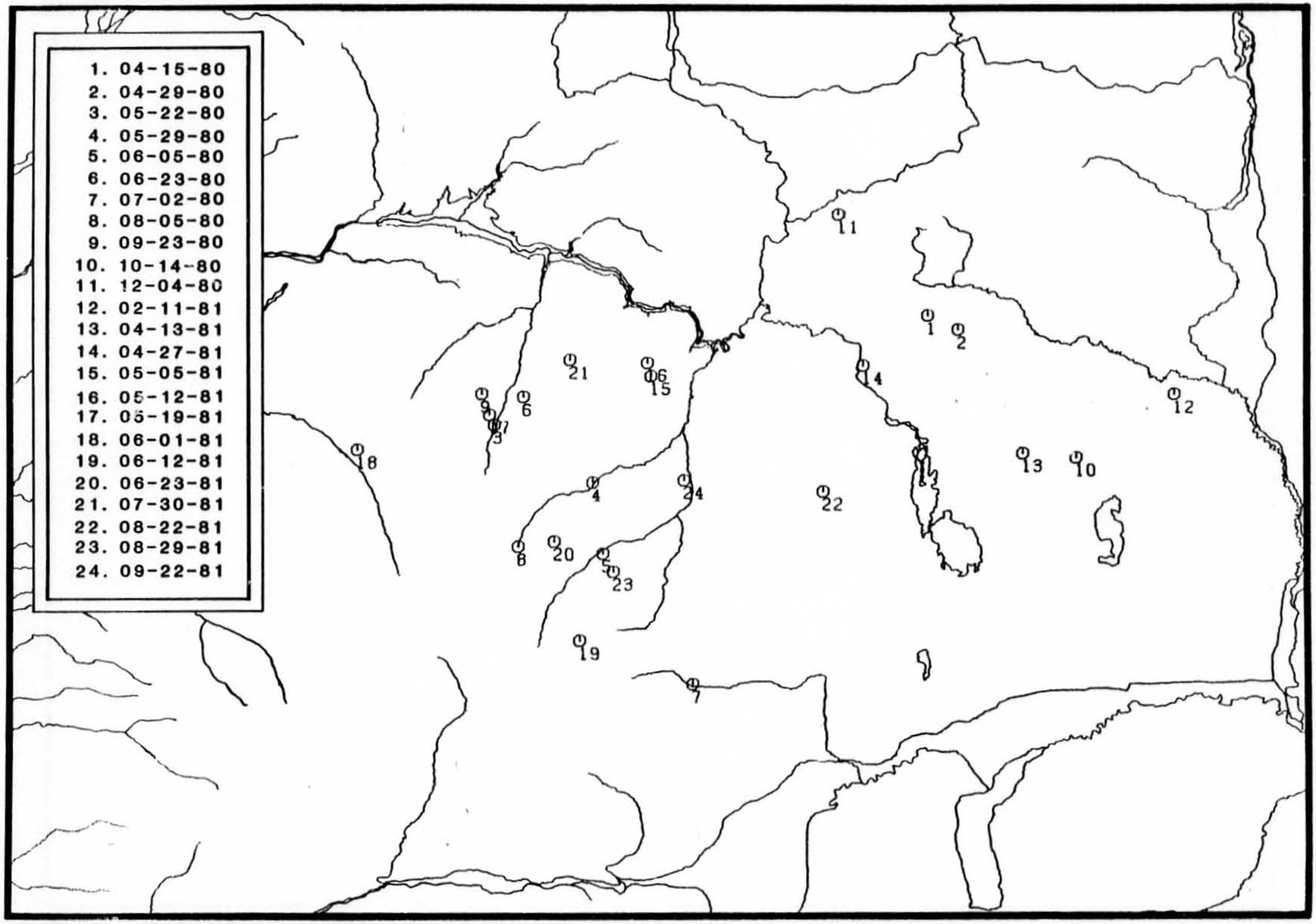

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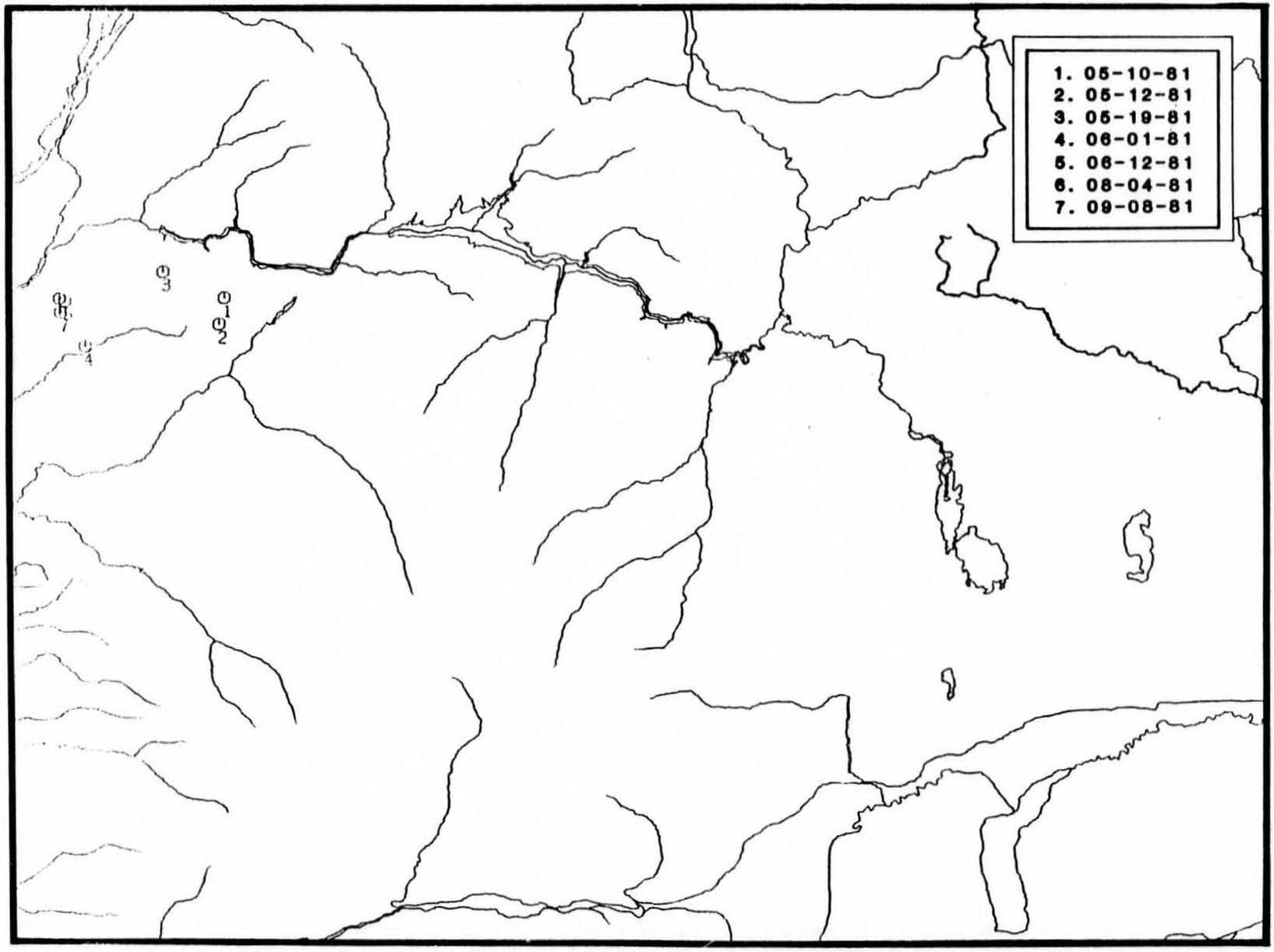

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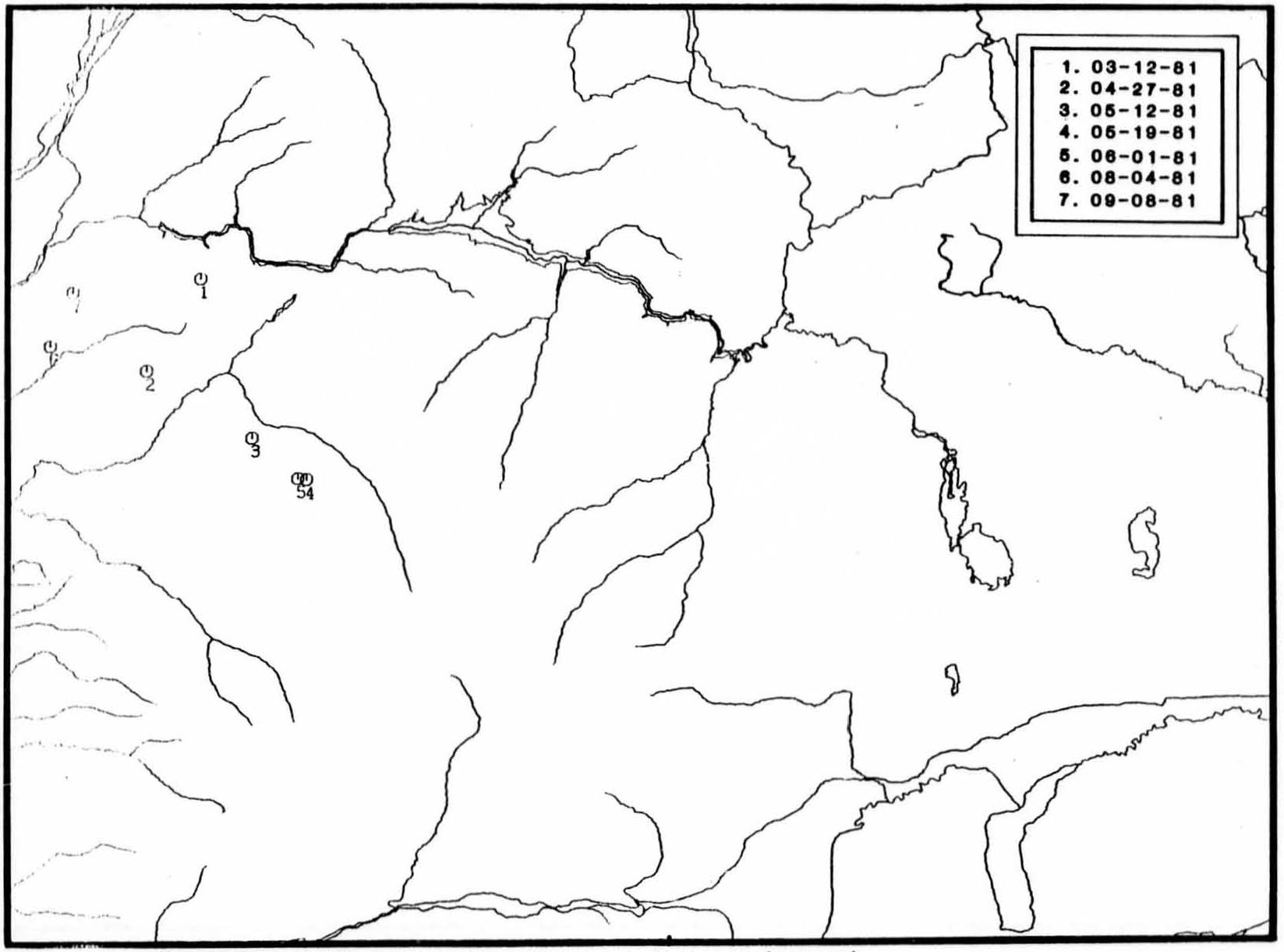

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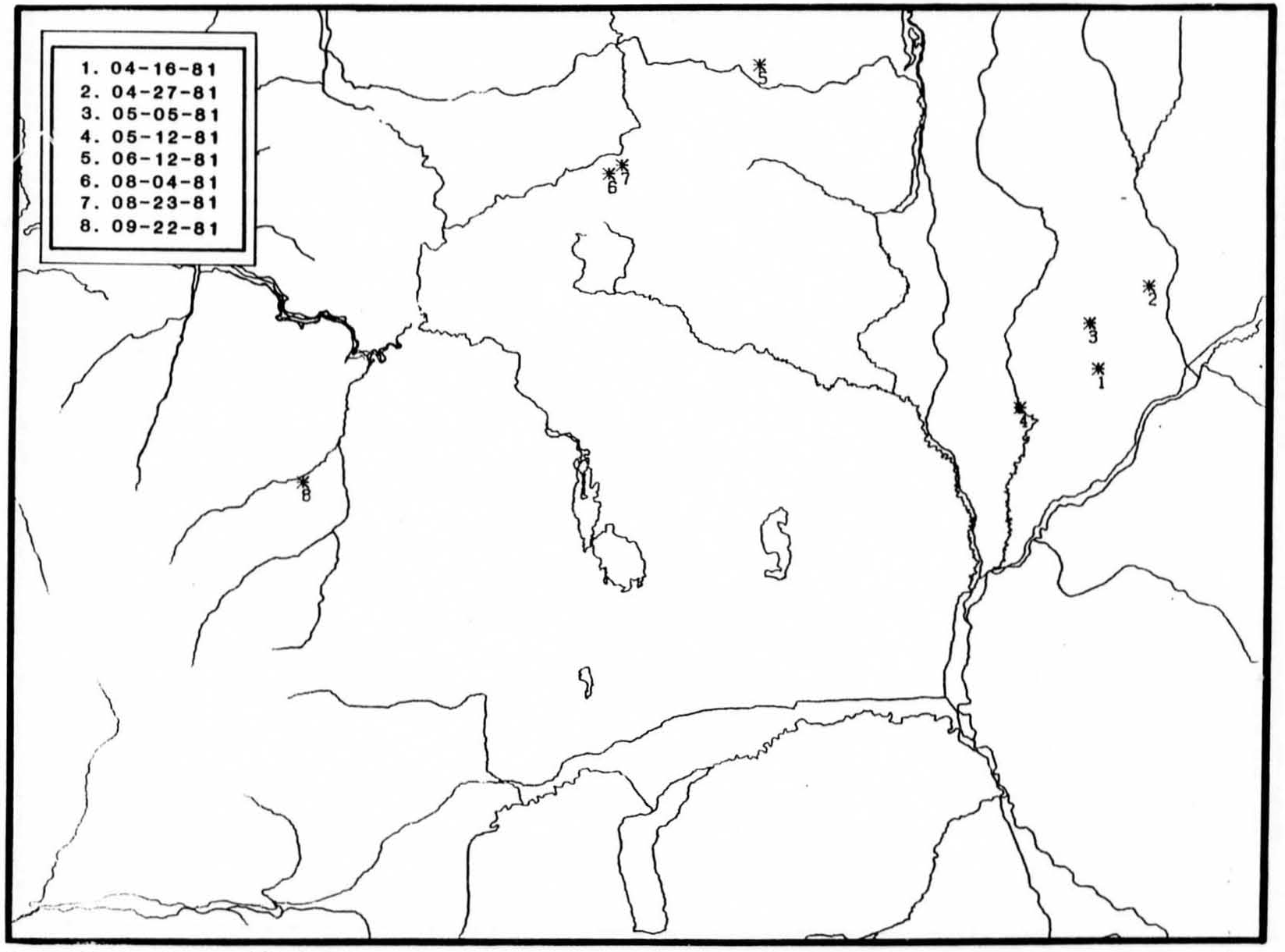

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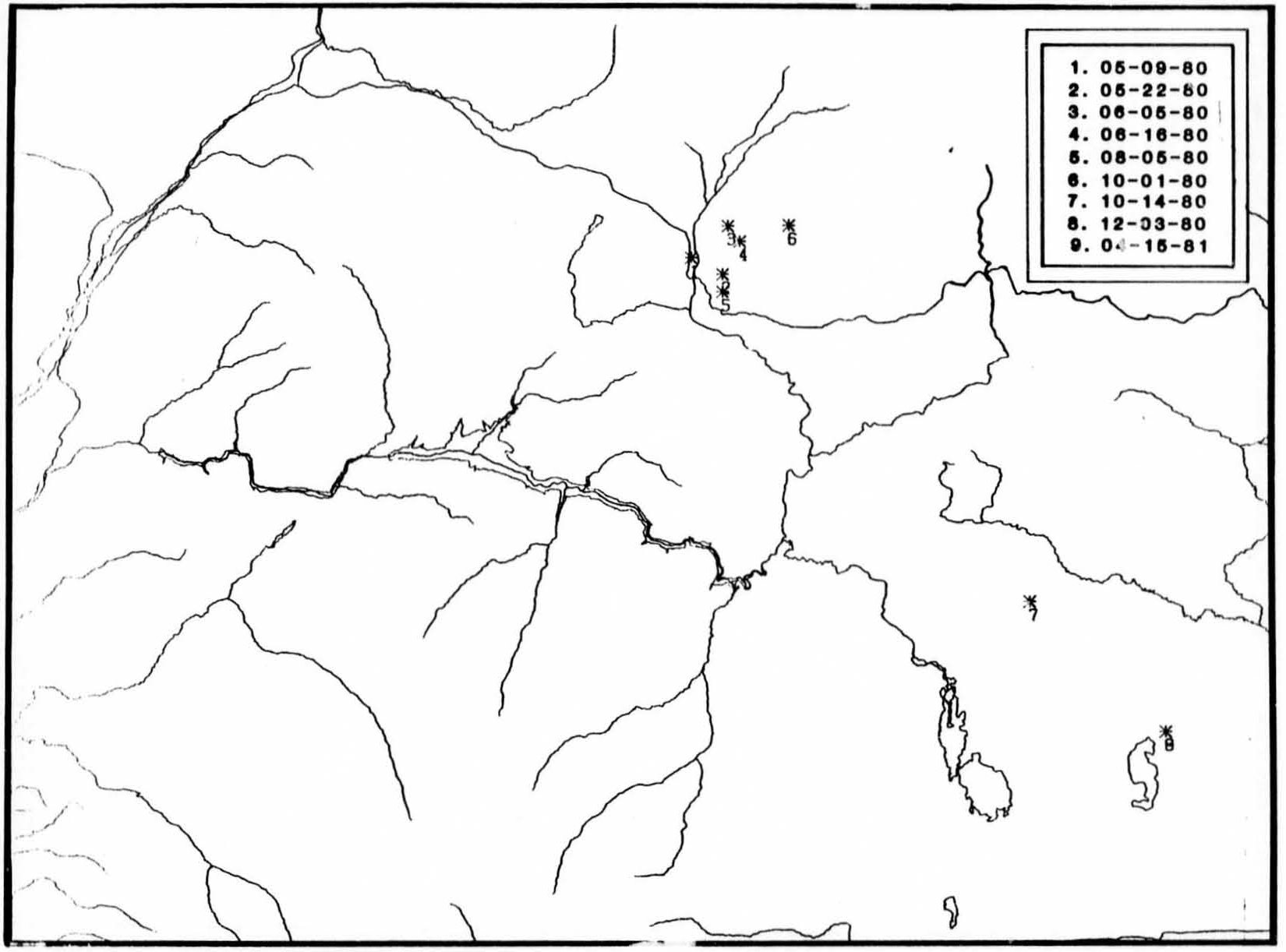

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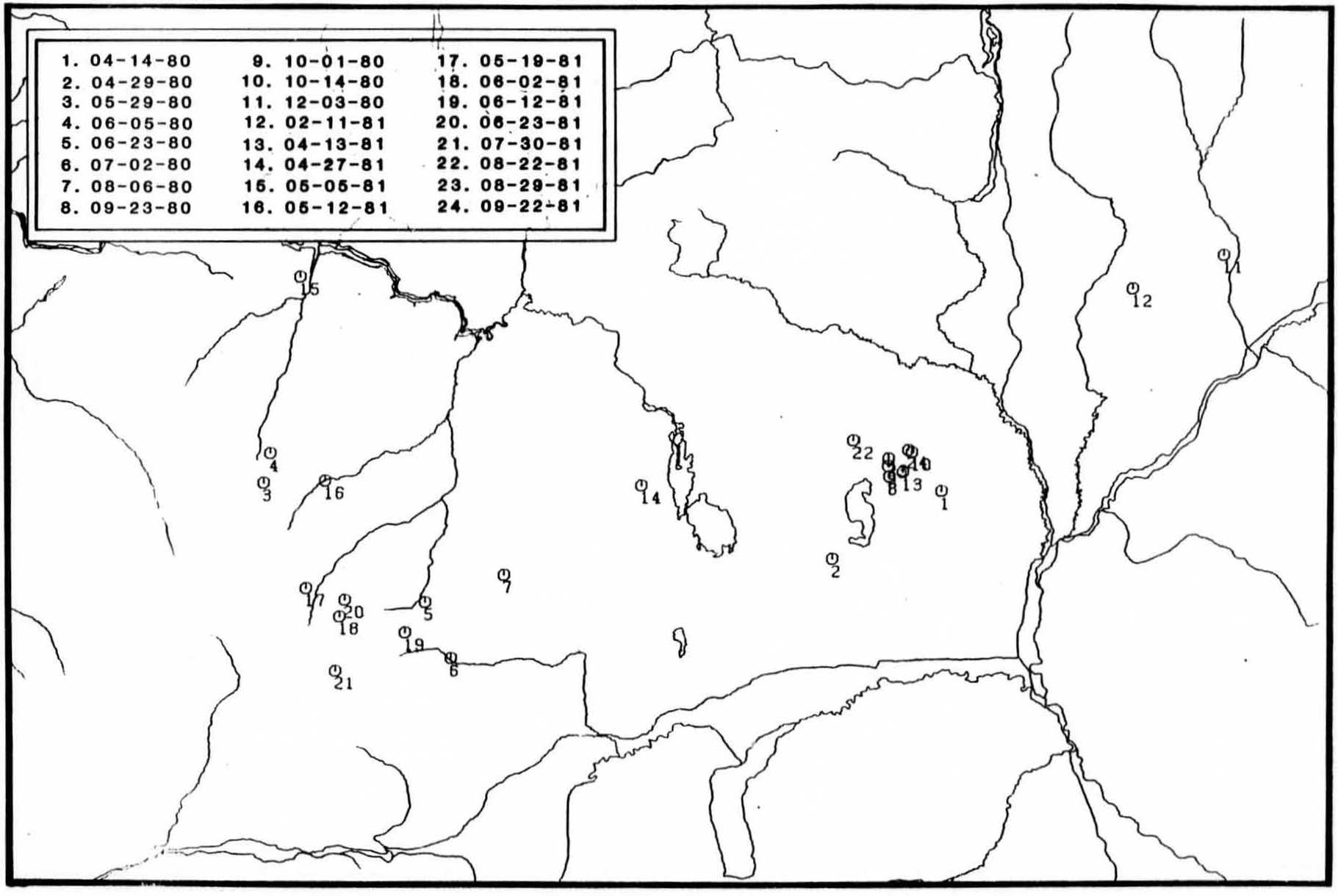

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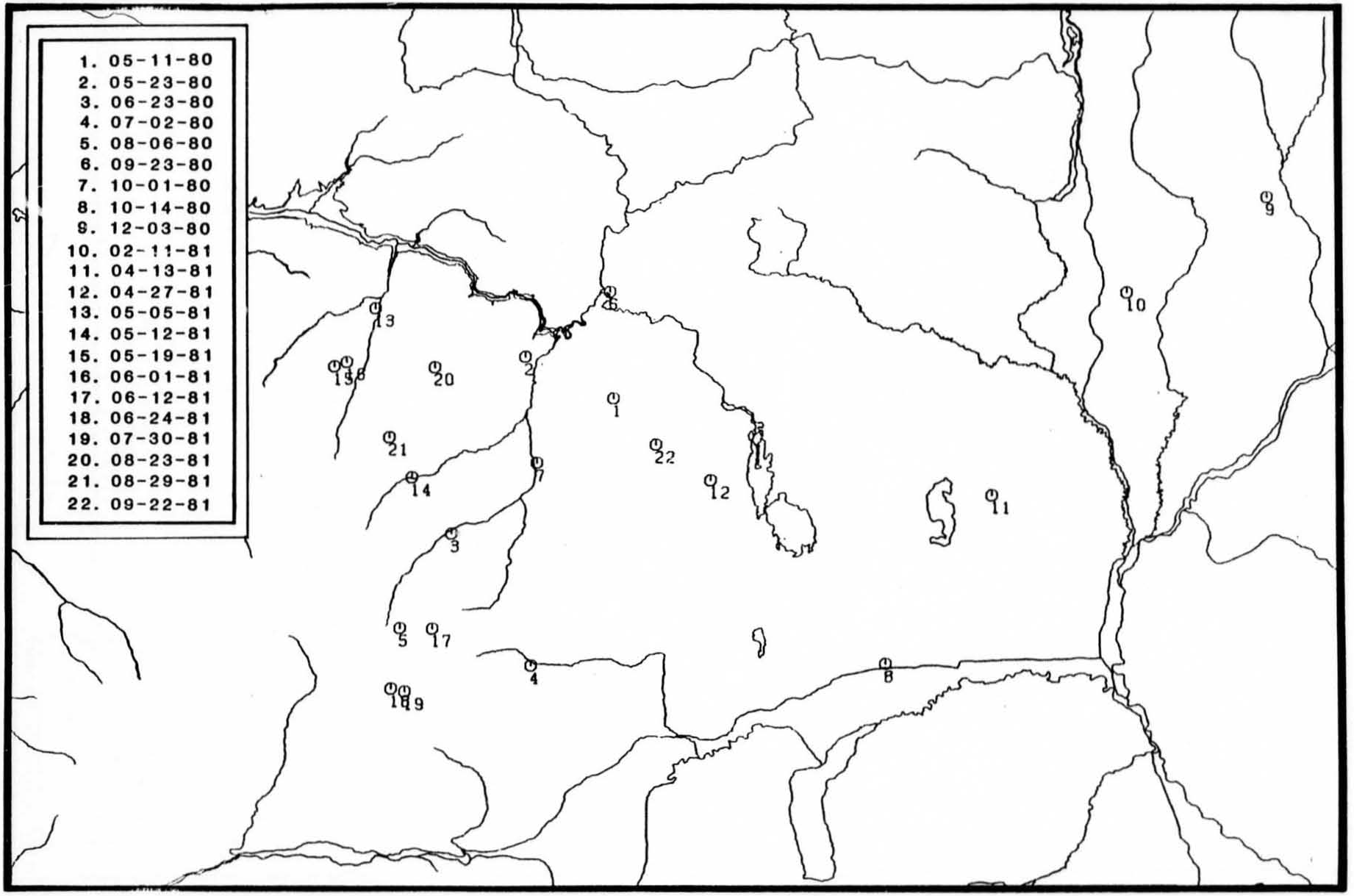

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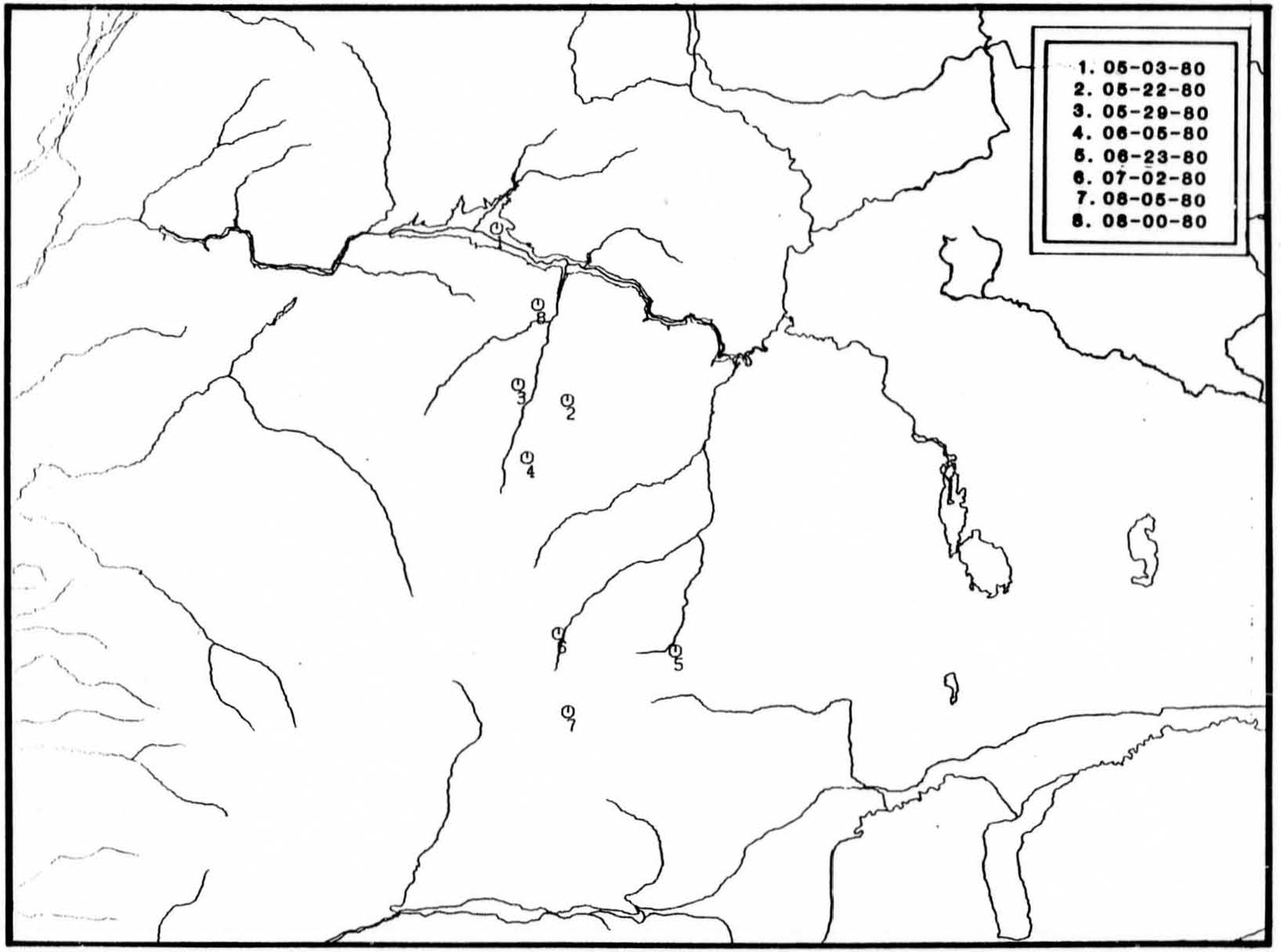
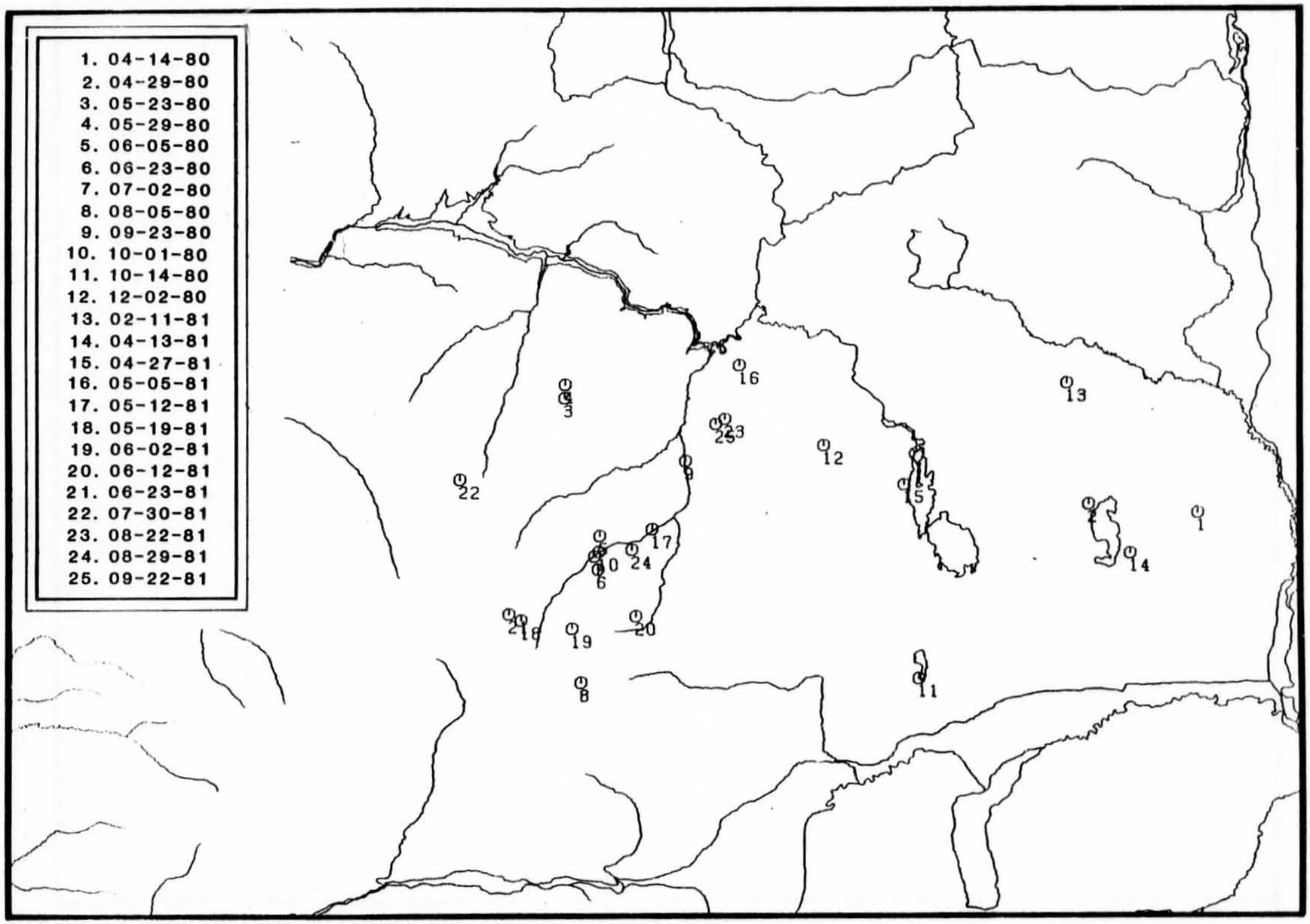
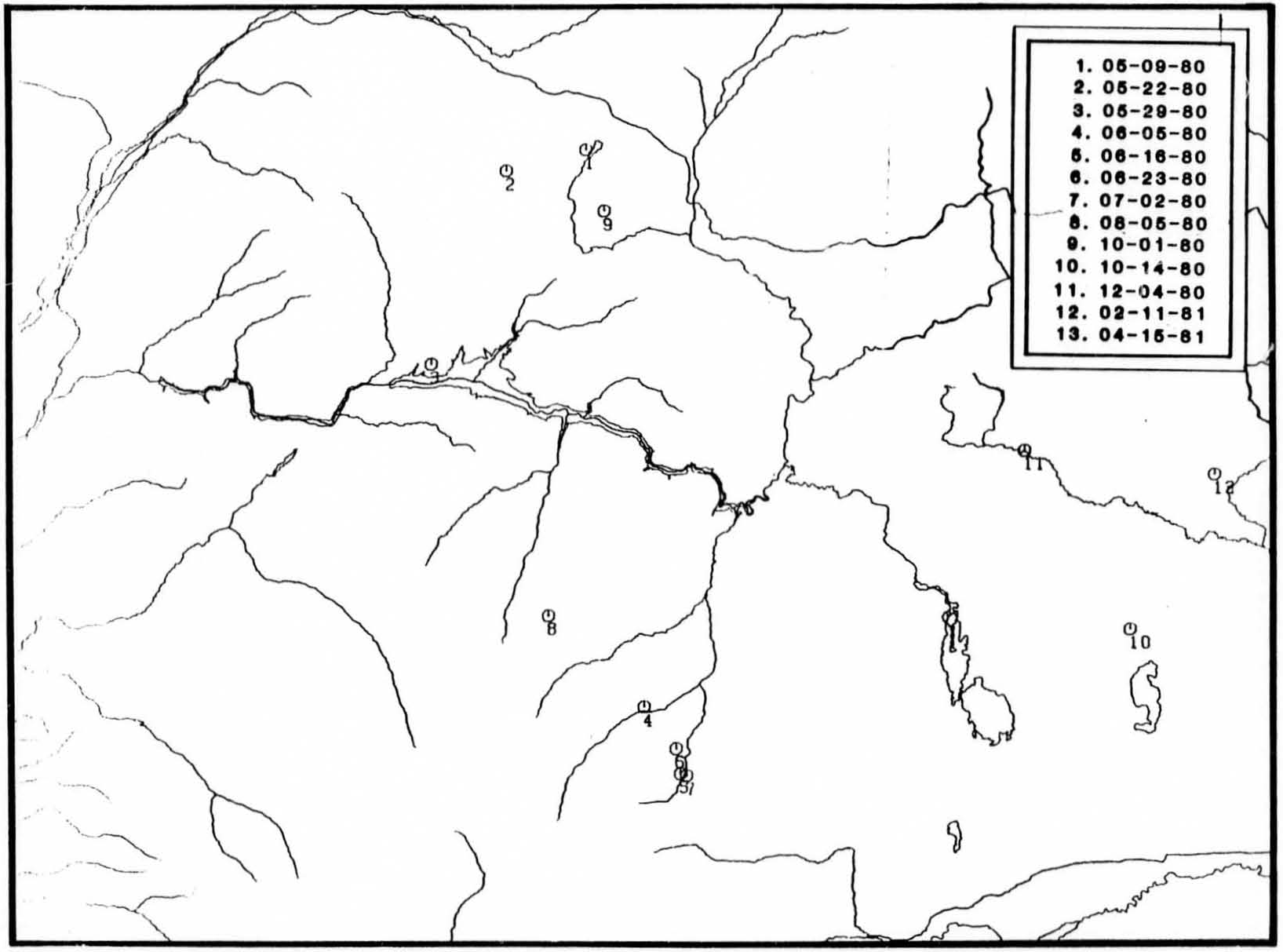


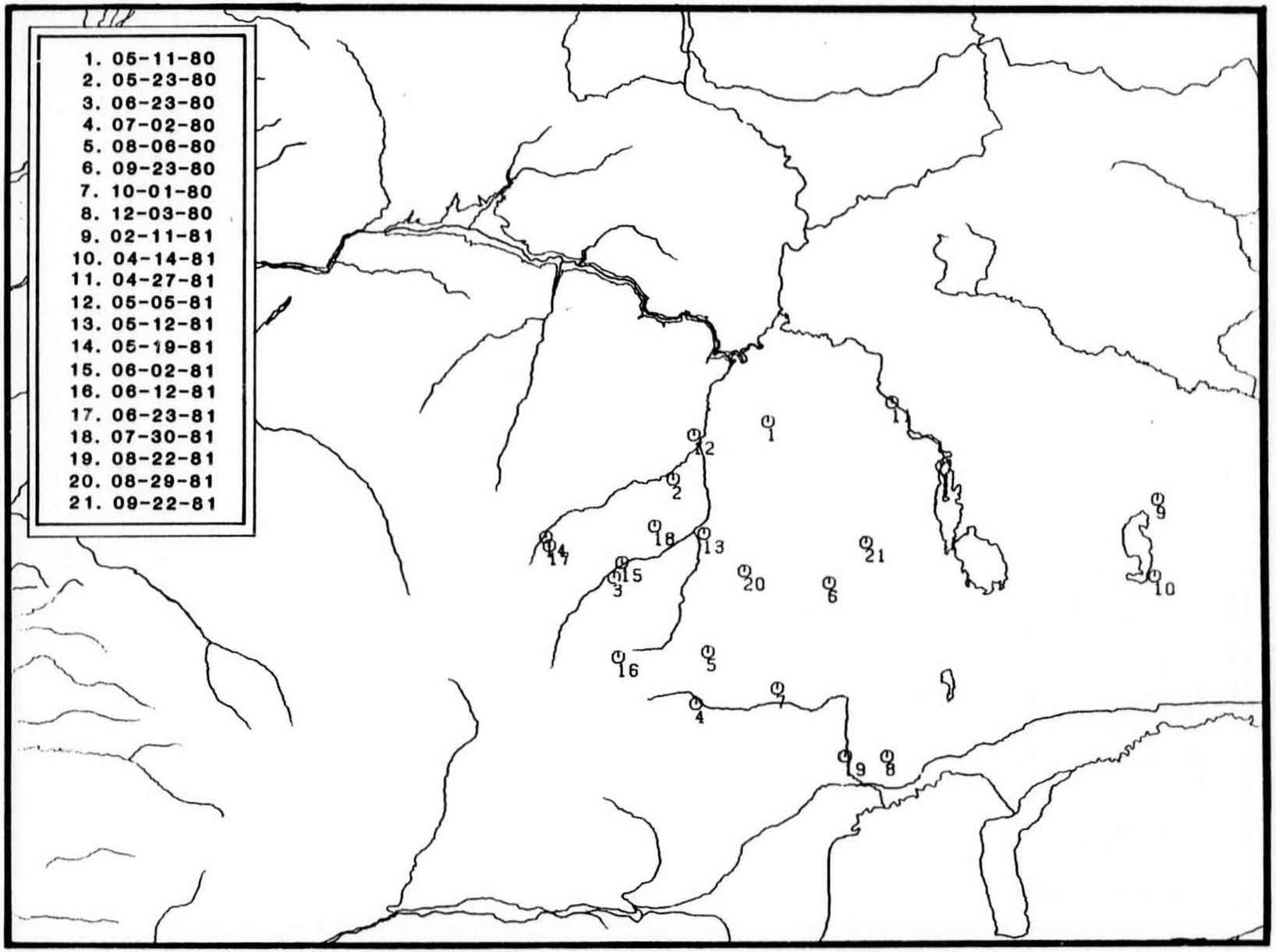
Appendix 1. Sequential sightings of radio-collared caribou 161 (female).



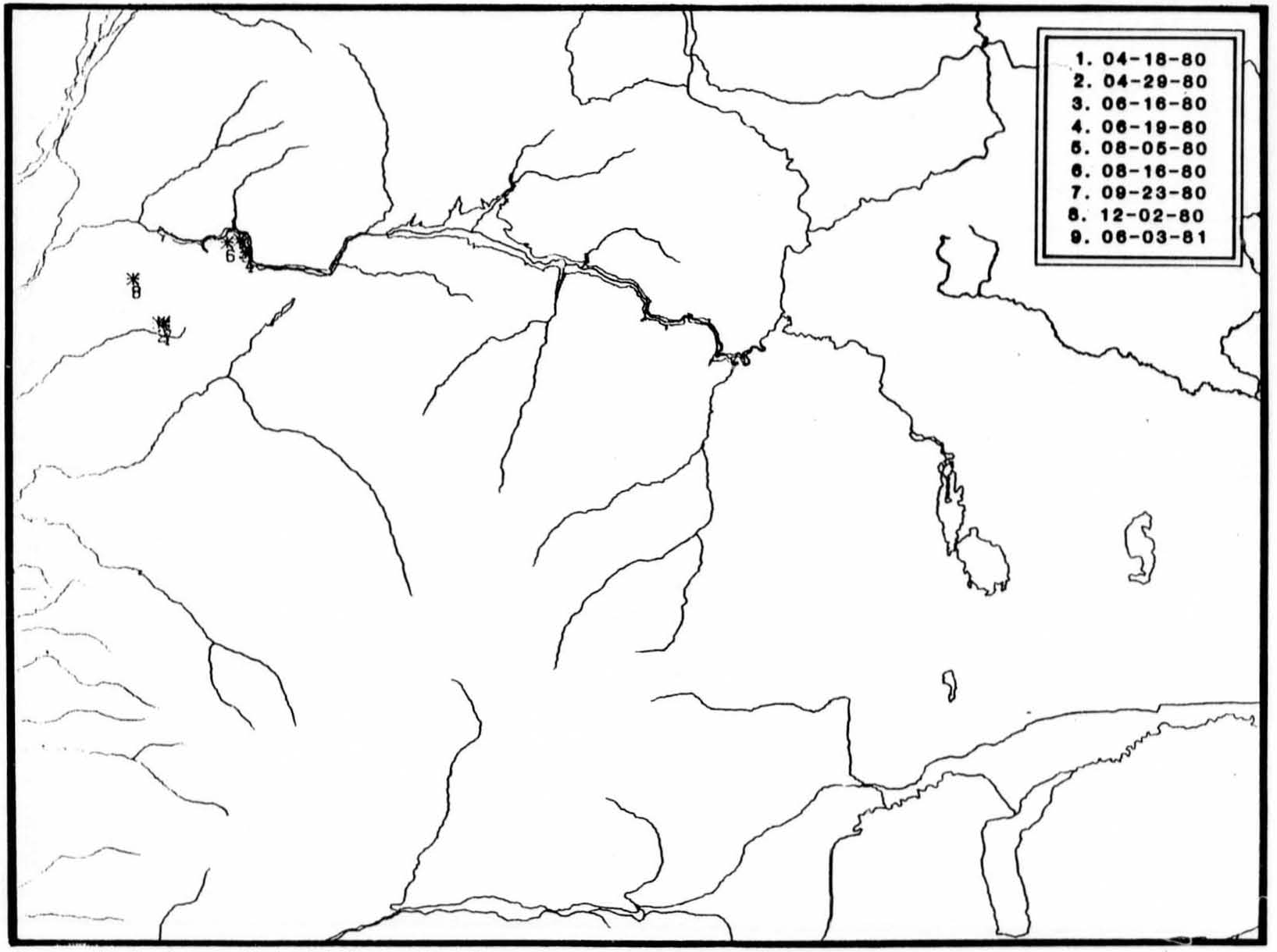
Appendix 1. Sequential sightings of radio-collared caribou 170 (female).



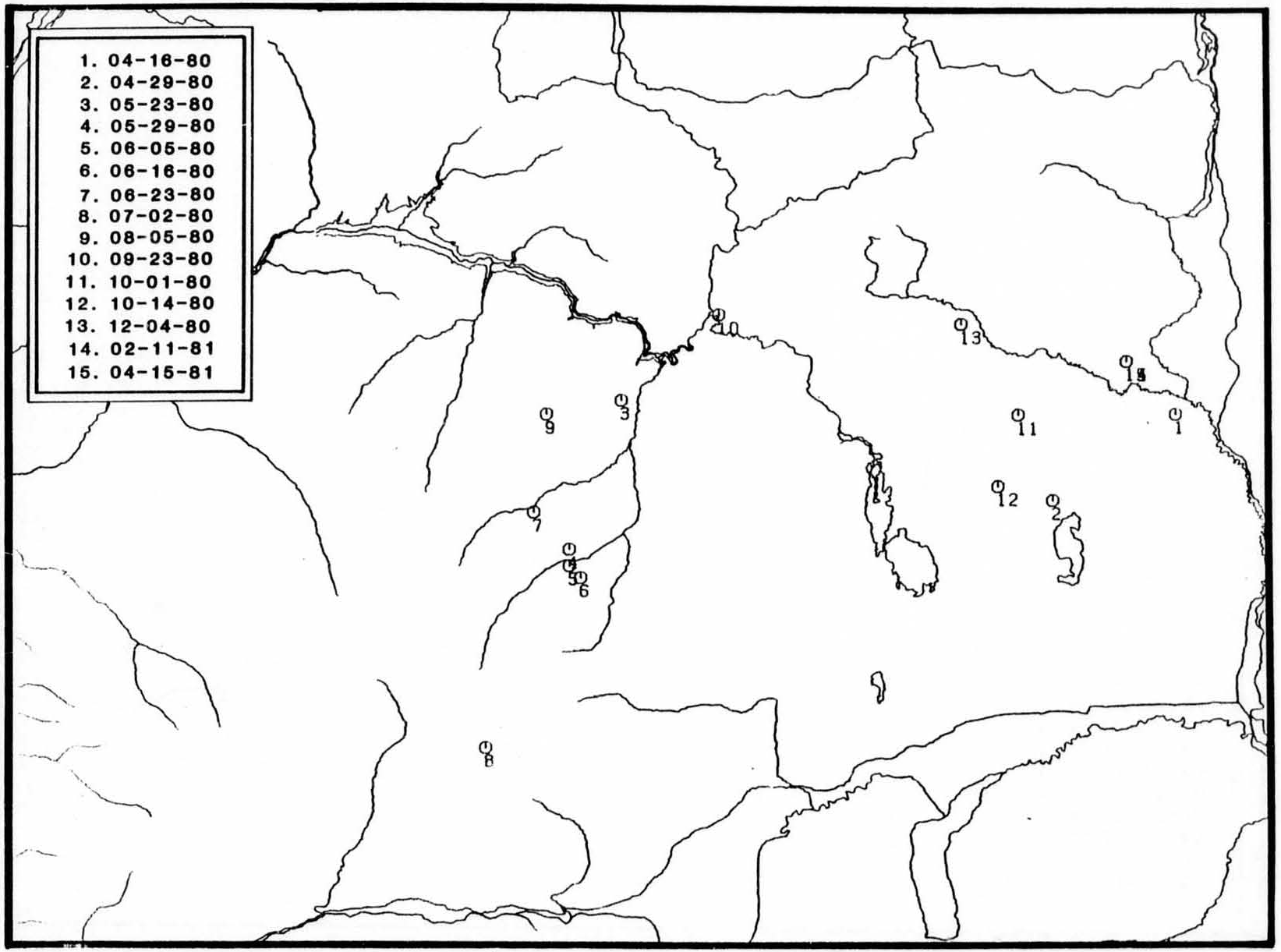
Appendix 1. Sequential sightings of radio-collared caribou 182 (female).



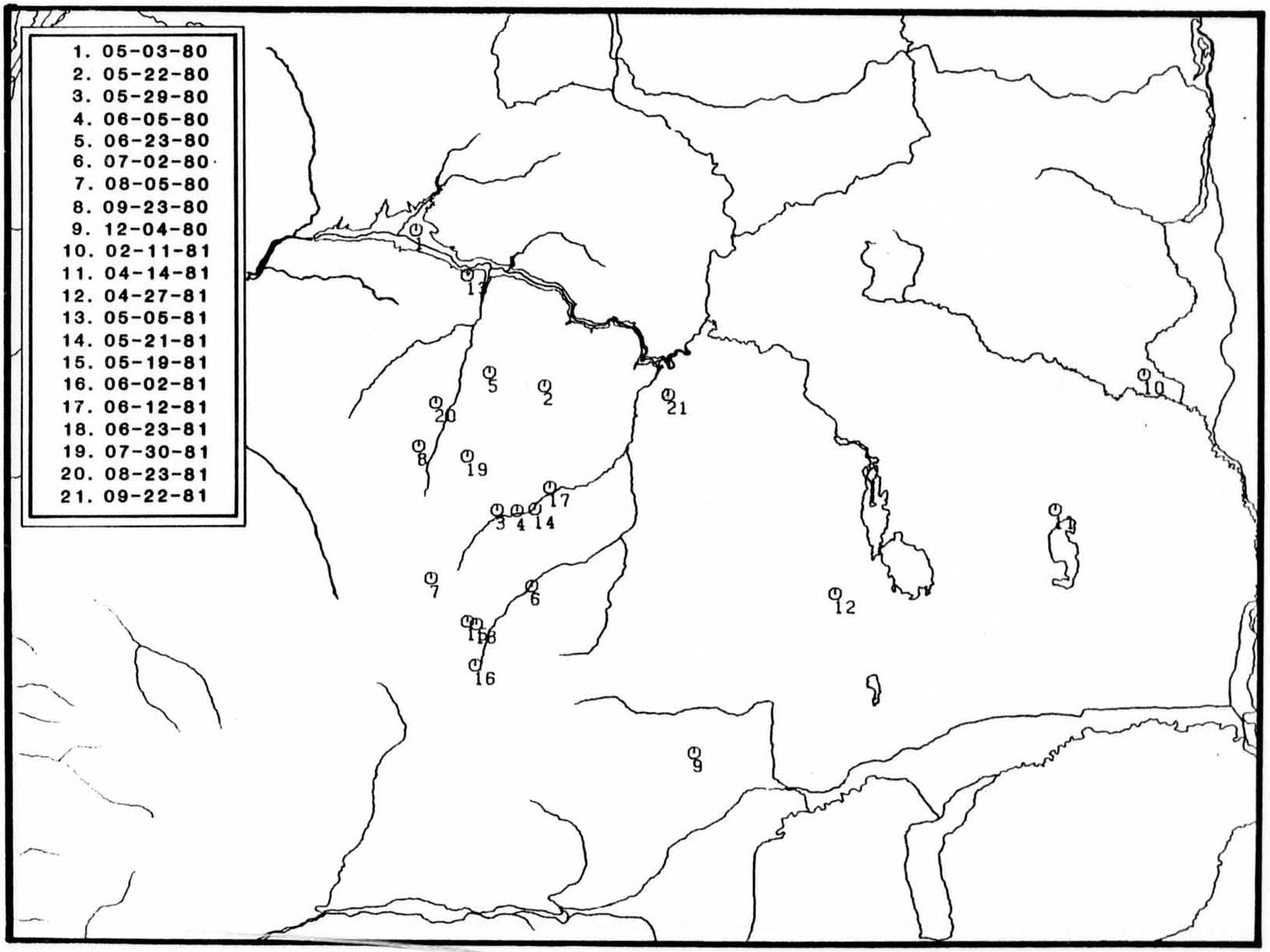
Appendix 1. Sequential sightings of radio-collared caribou 202 (female).



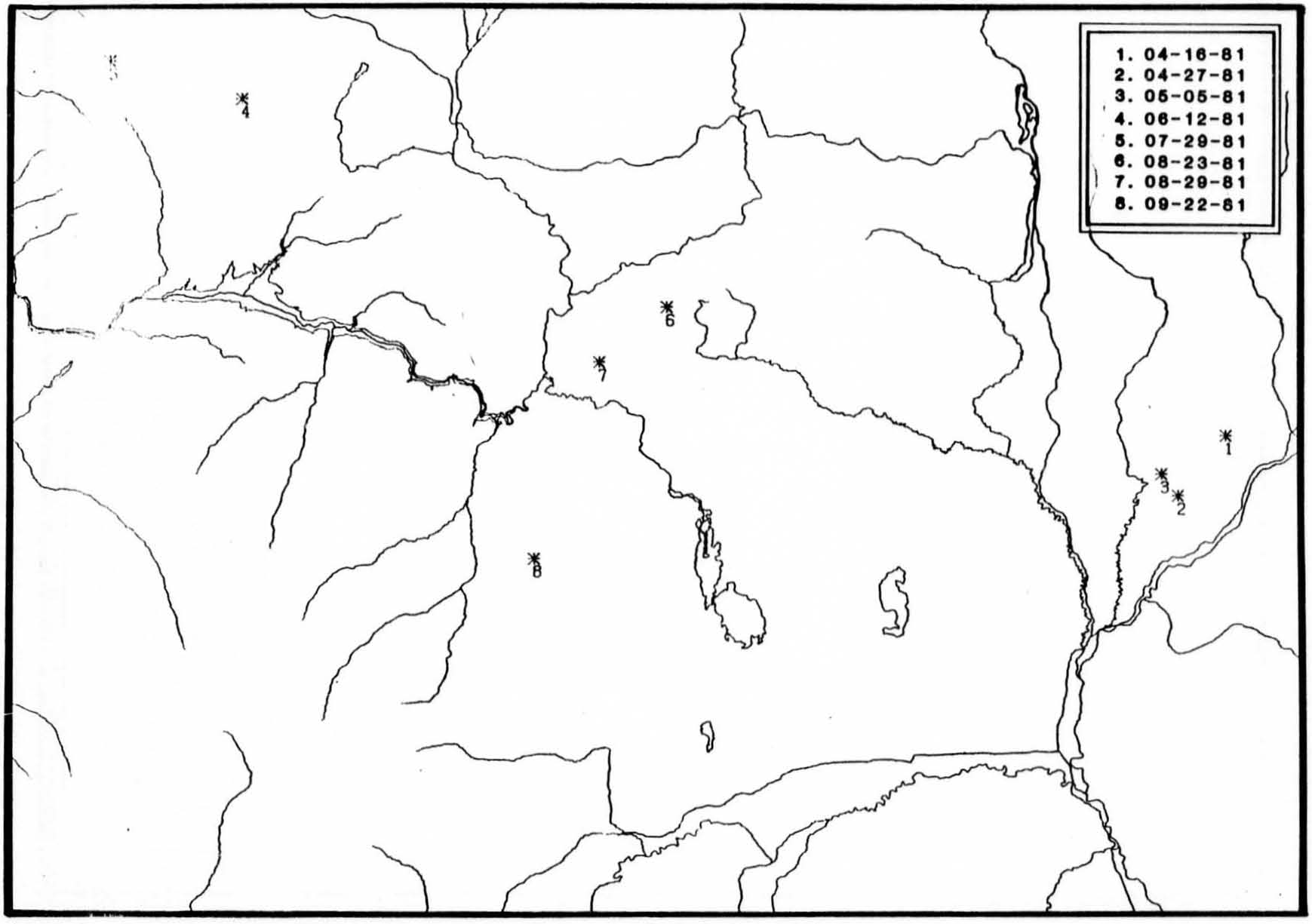
Appendix 1. Sequential sightings of radio-collared caribou 222 (male).



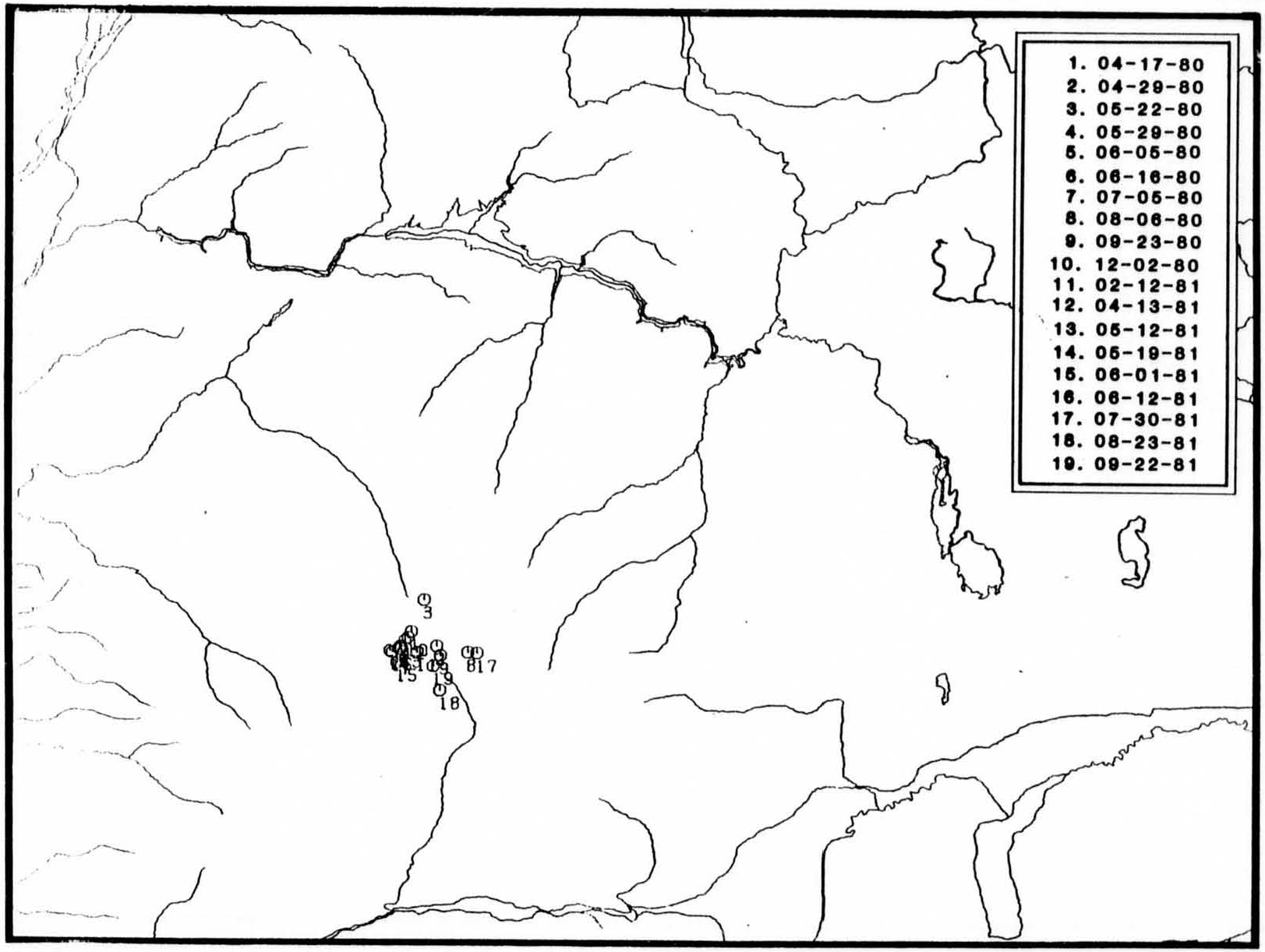
Appendix 1. Sequential sightings of radio-collared caribou 231 (female).



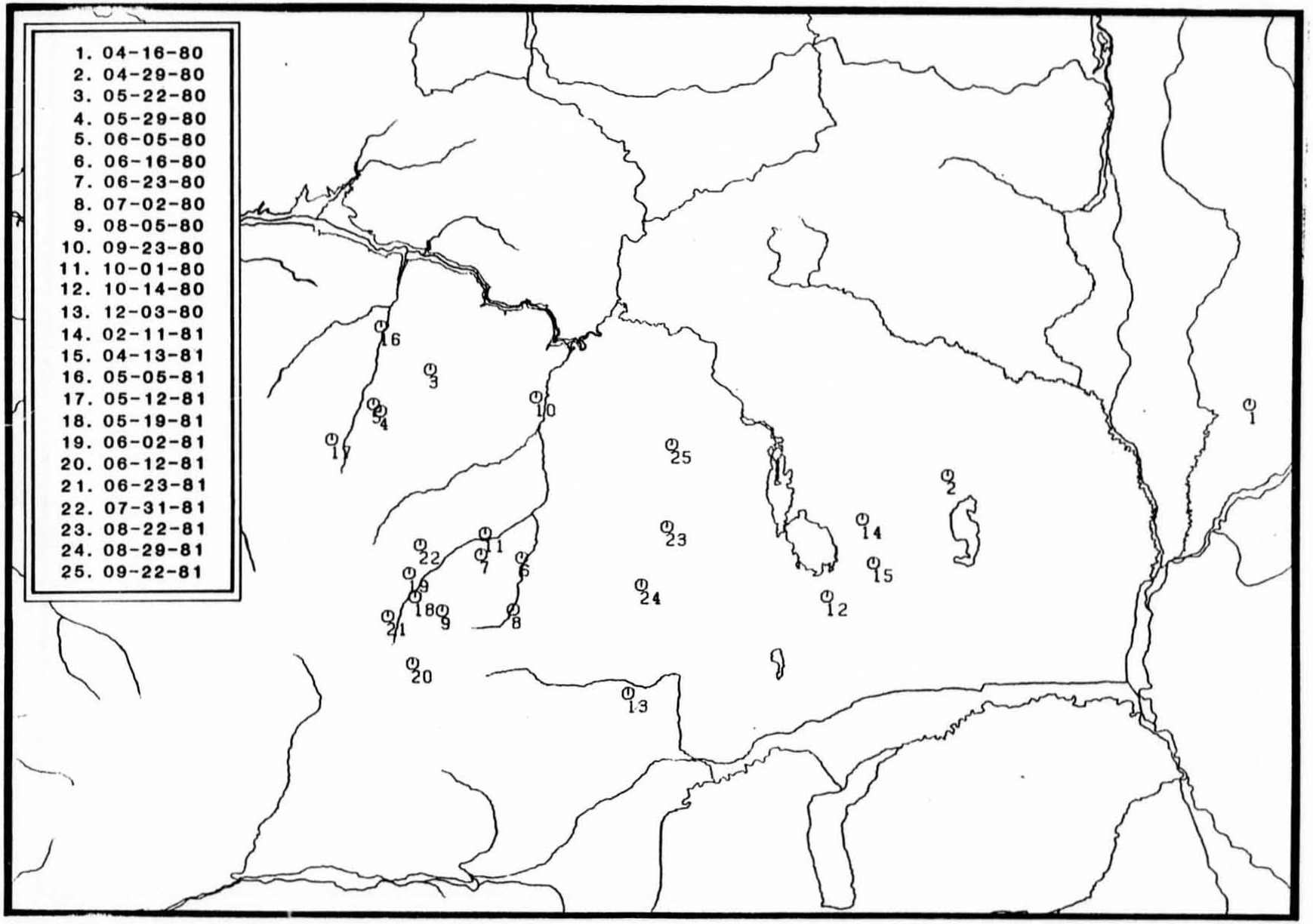
Appendix 1. Sequential sightings of radio-collared caribou 252 (female).



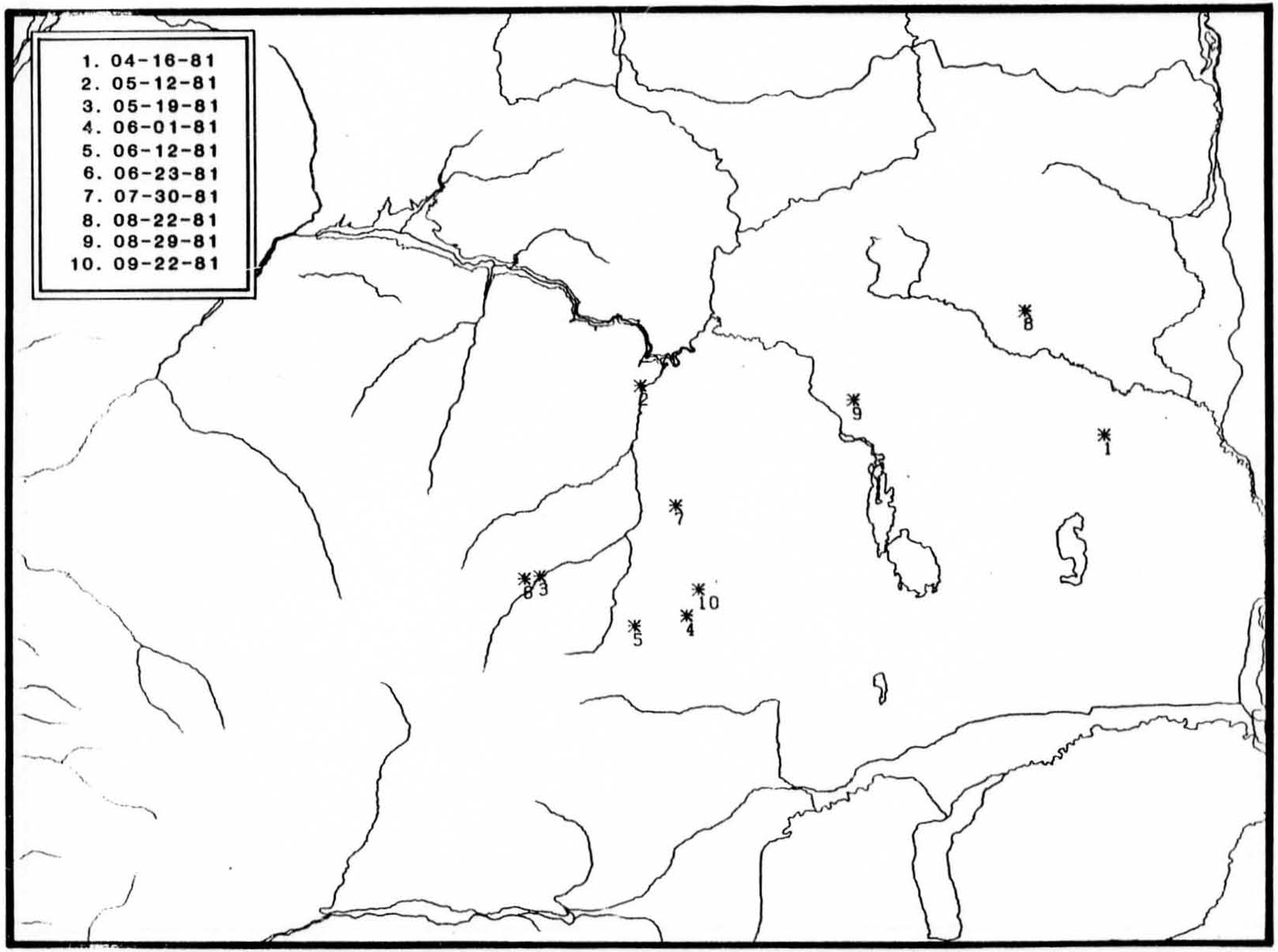
Appendix 1. Sequential sightings of radio-collared caribou 262 (male).



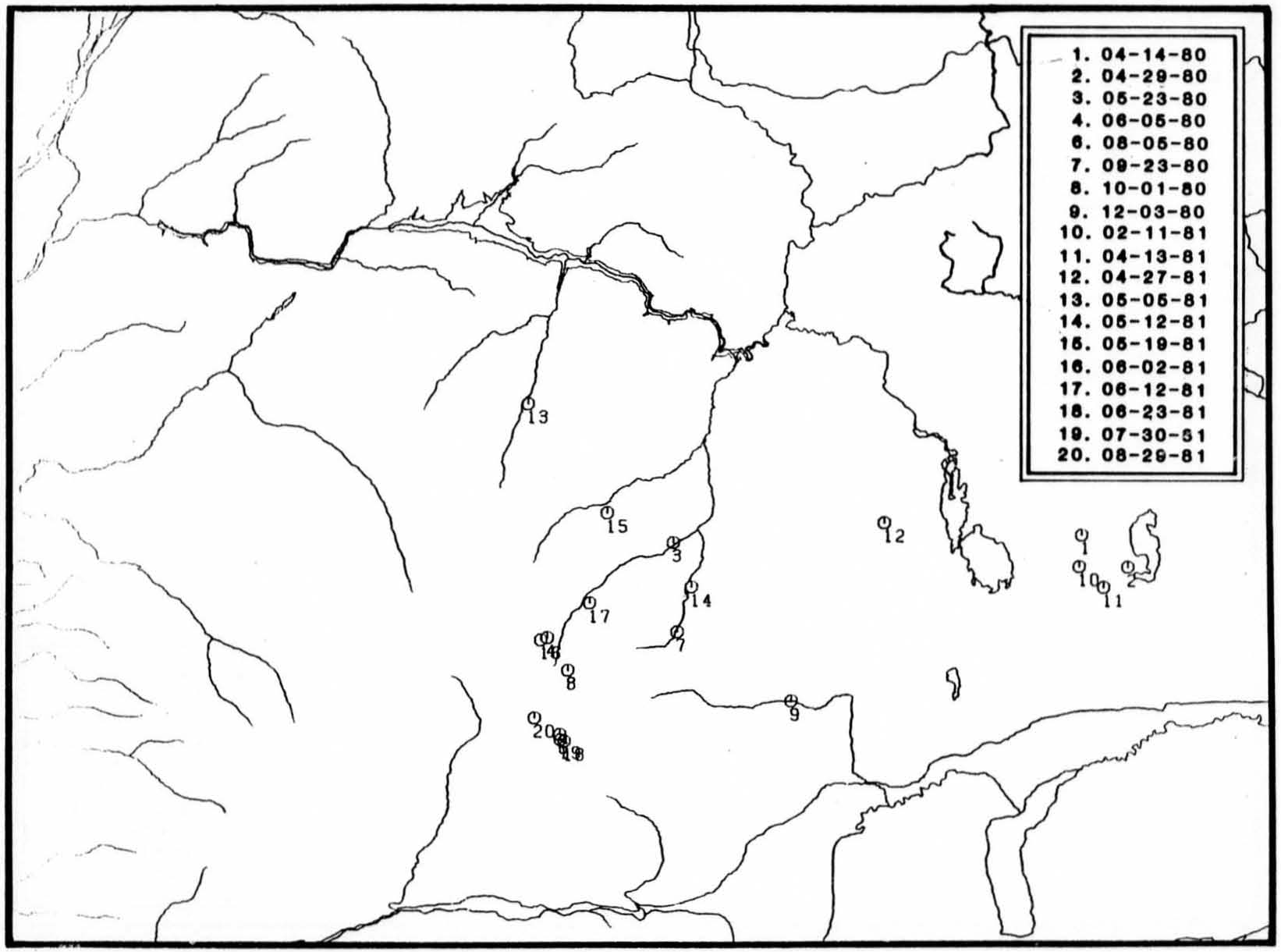
Appendix 1. Sequential sightings of radio-collared caribou 271 (female).



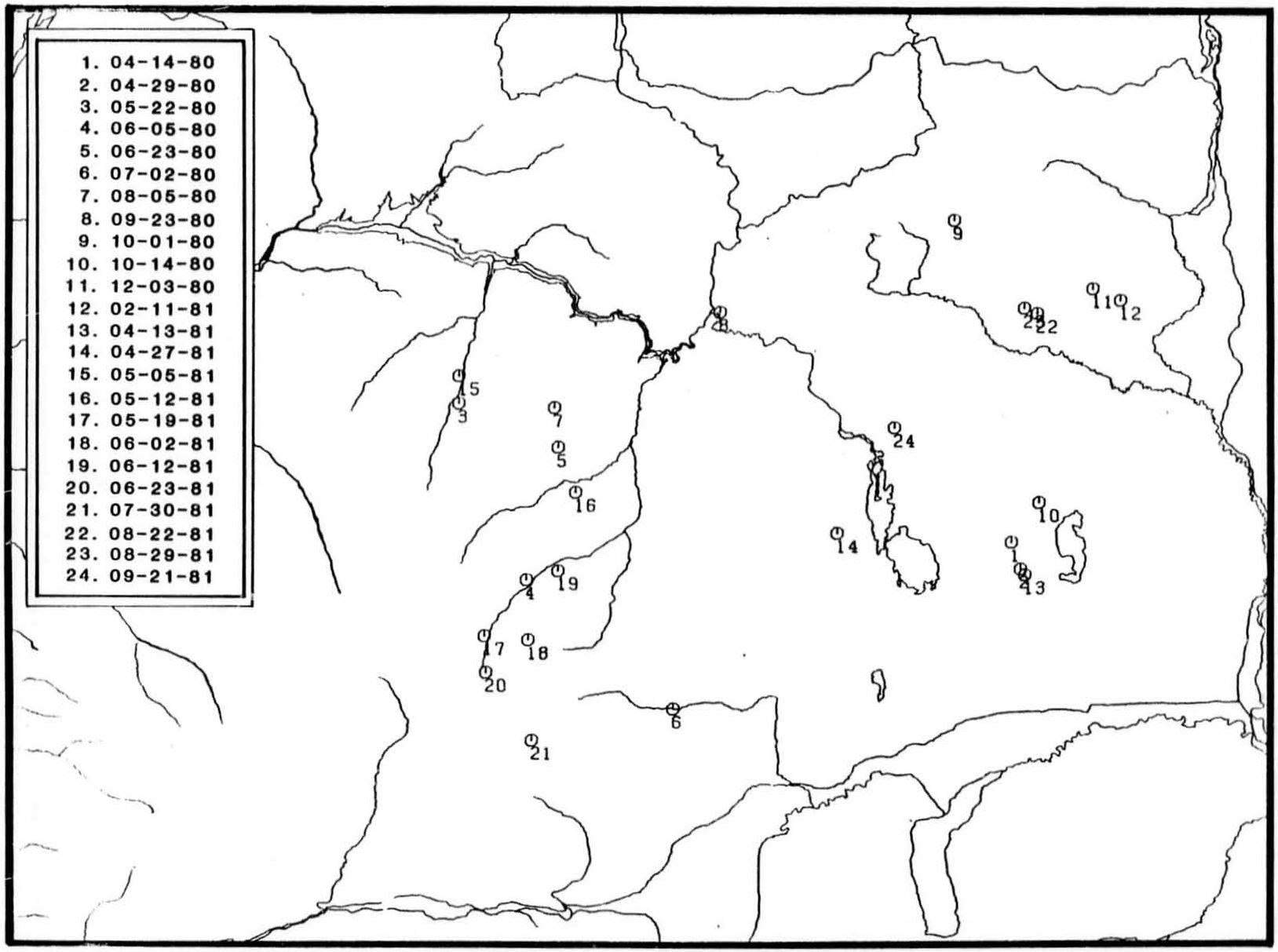
Appendix 1. Sequential sightings of radio-collared caribou 291 (female).



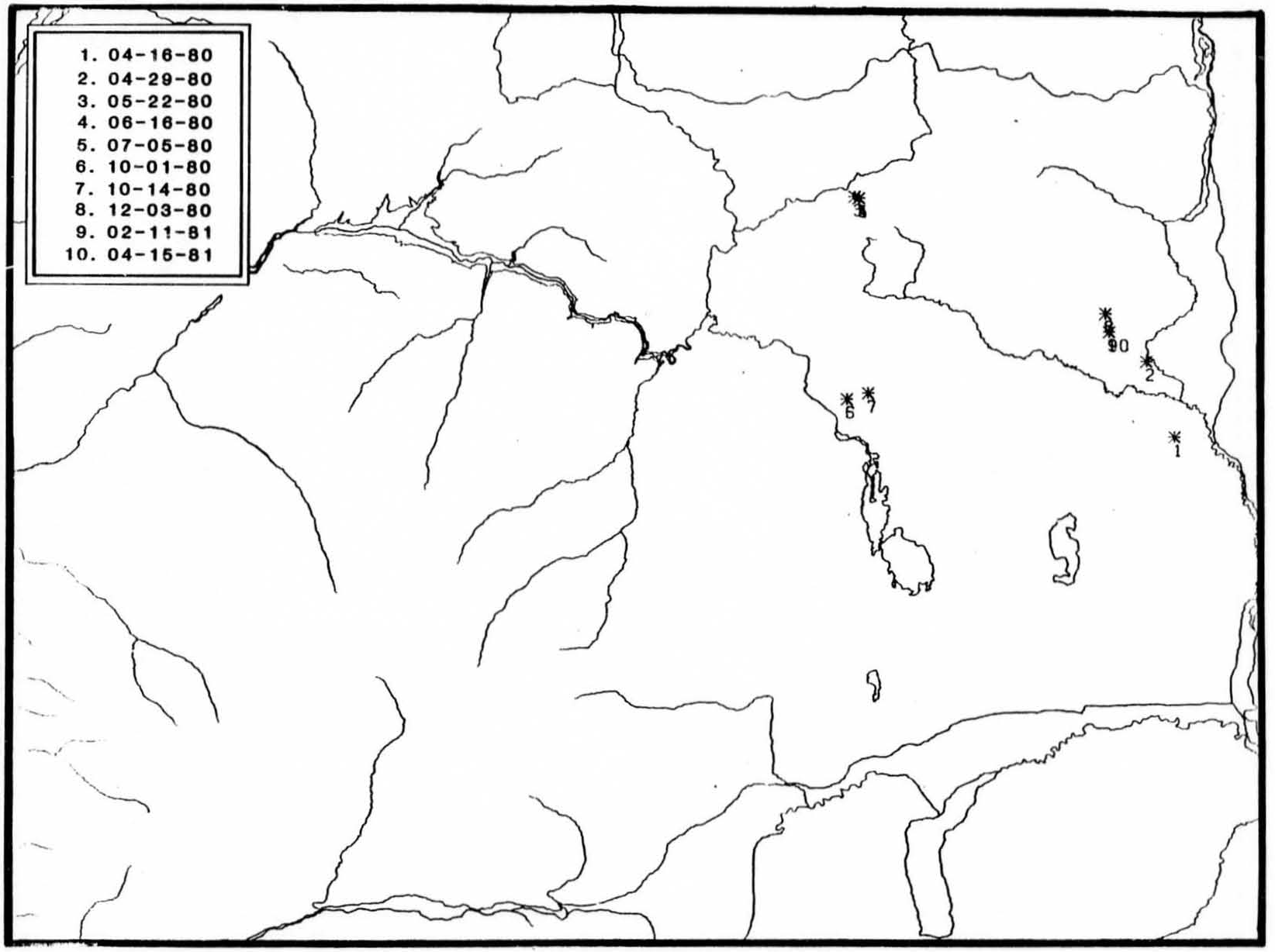
Appendix 1. Sequential sightings of radio-collared caribou 301 (male).



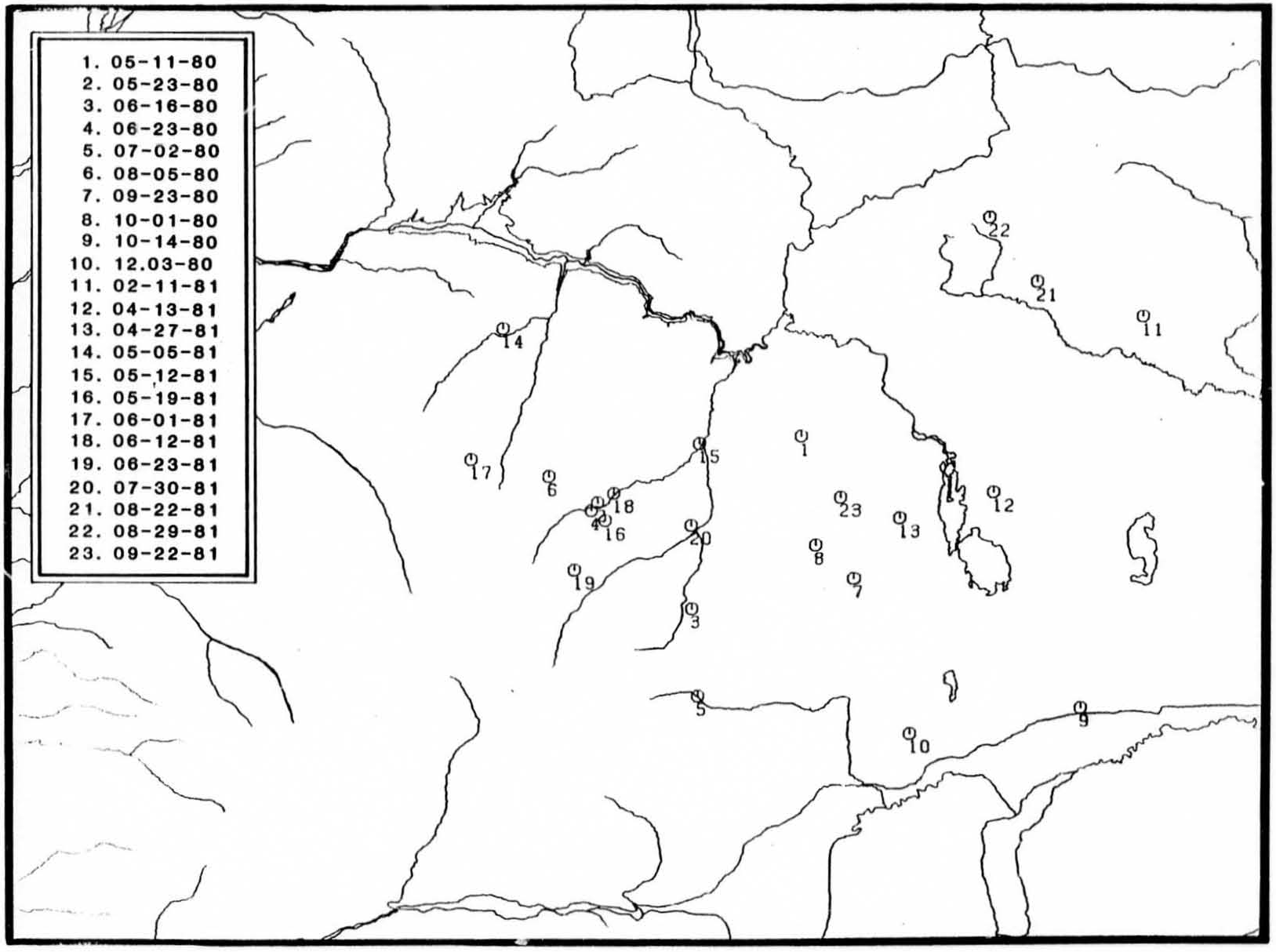
Appendix 1. Sequential sightings of radio-collared caribou 311 (female).



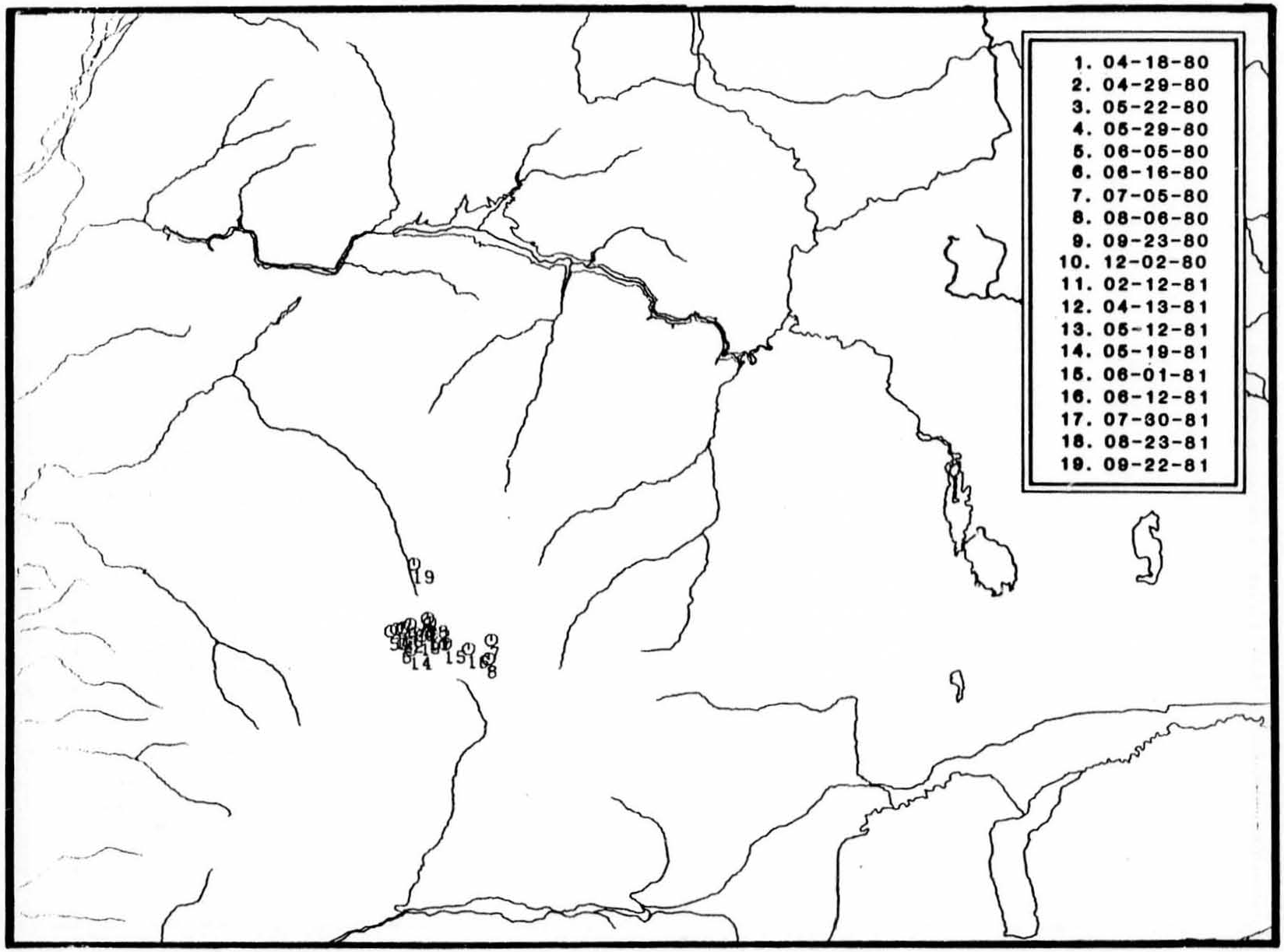
Appendix 1. Sequential sightings of radio-collared caribou 322 (female).



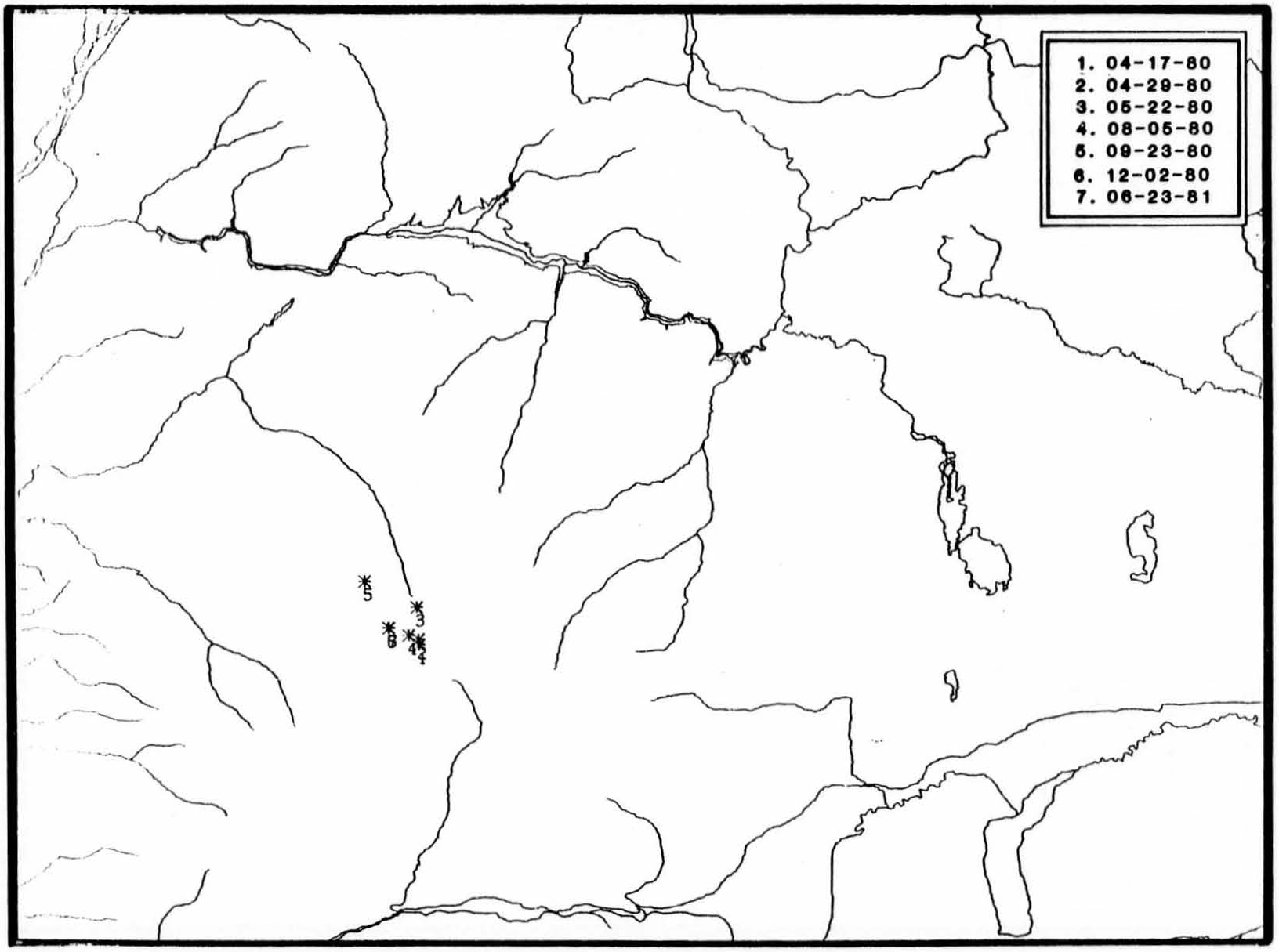
Appendix 1. Sequential sightings of radio-collared caribou 332 (male).



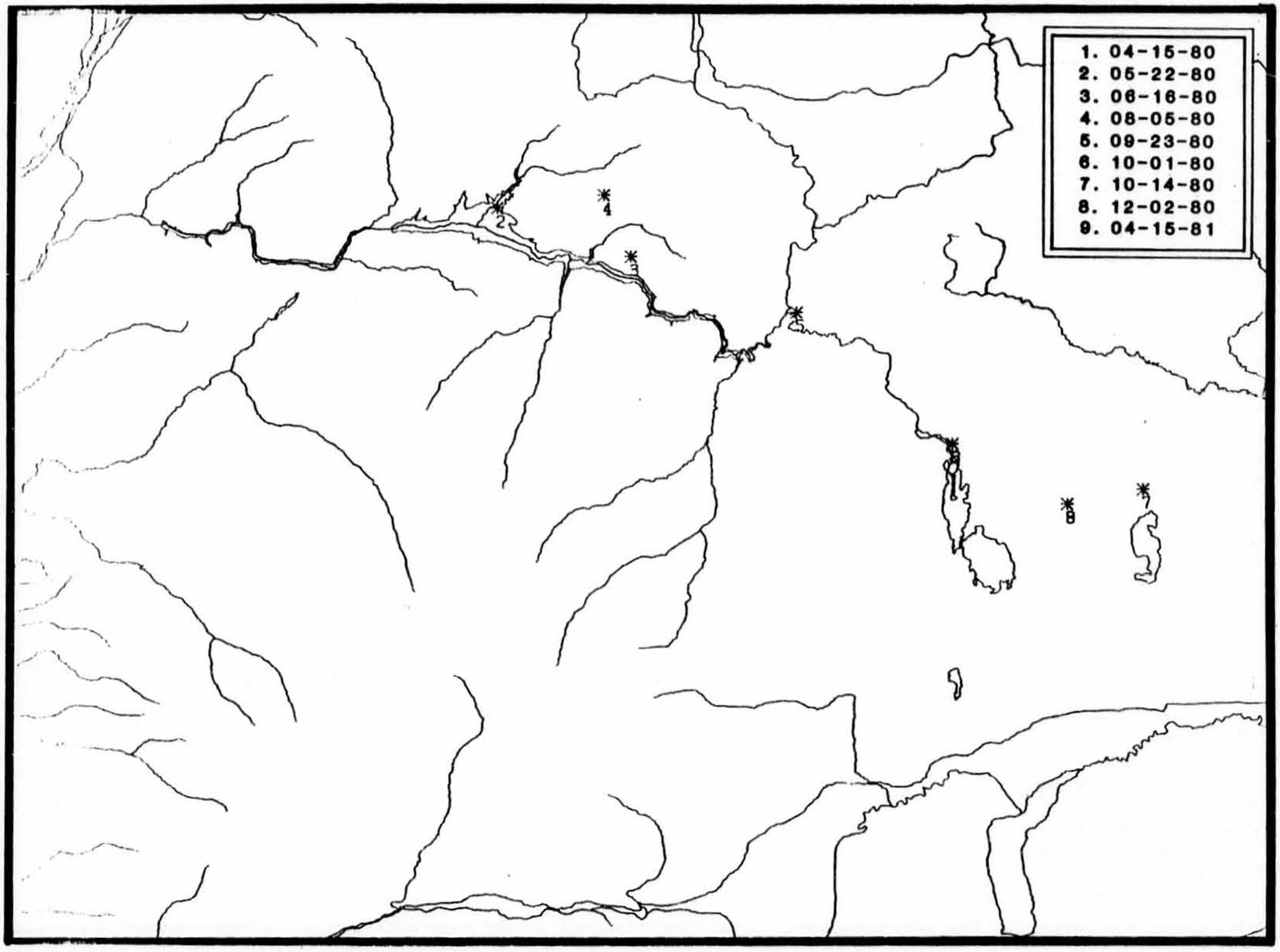
Appendix 1. Sequential sightings of radio-collared caribou 341 (female).



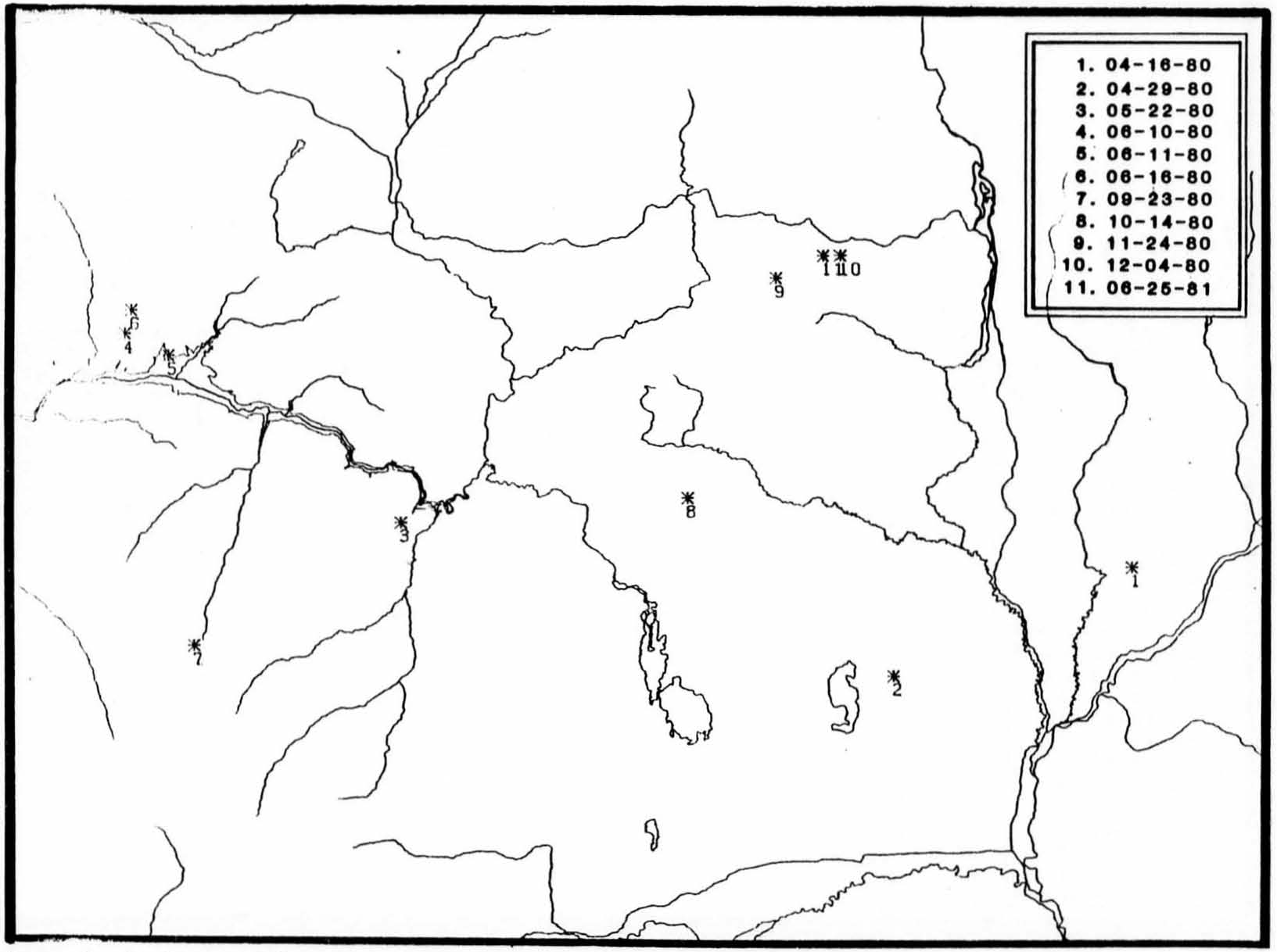
Appendix 1. Sequential sightings of radio-collared caribou 351 (female).



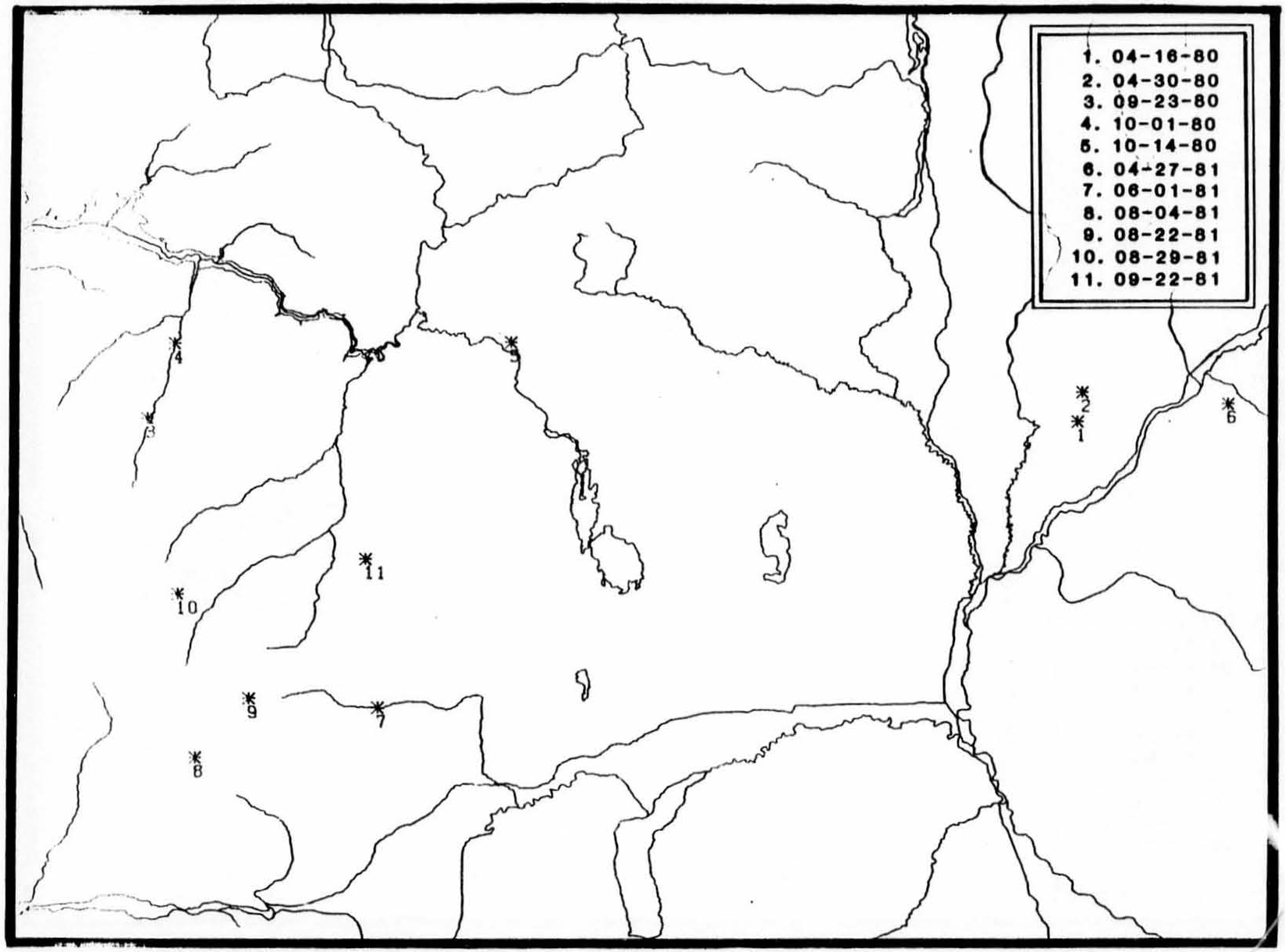
Appendix 1. Sequential sightings of radio-collared caribou 371 (male).



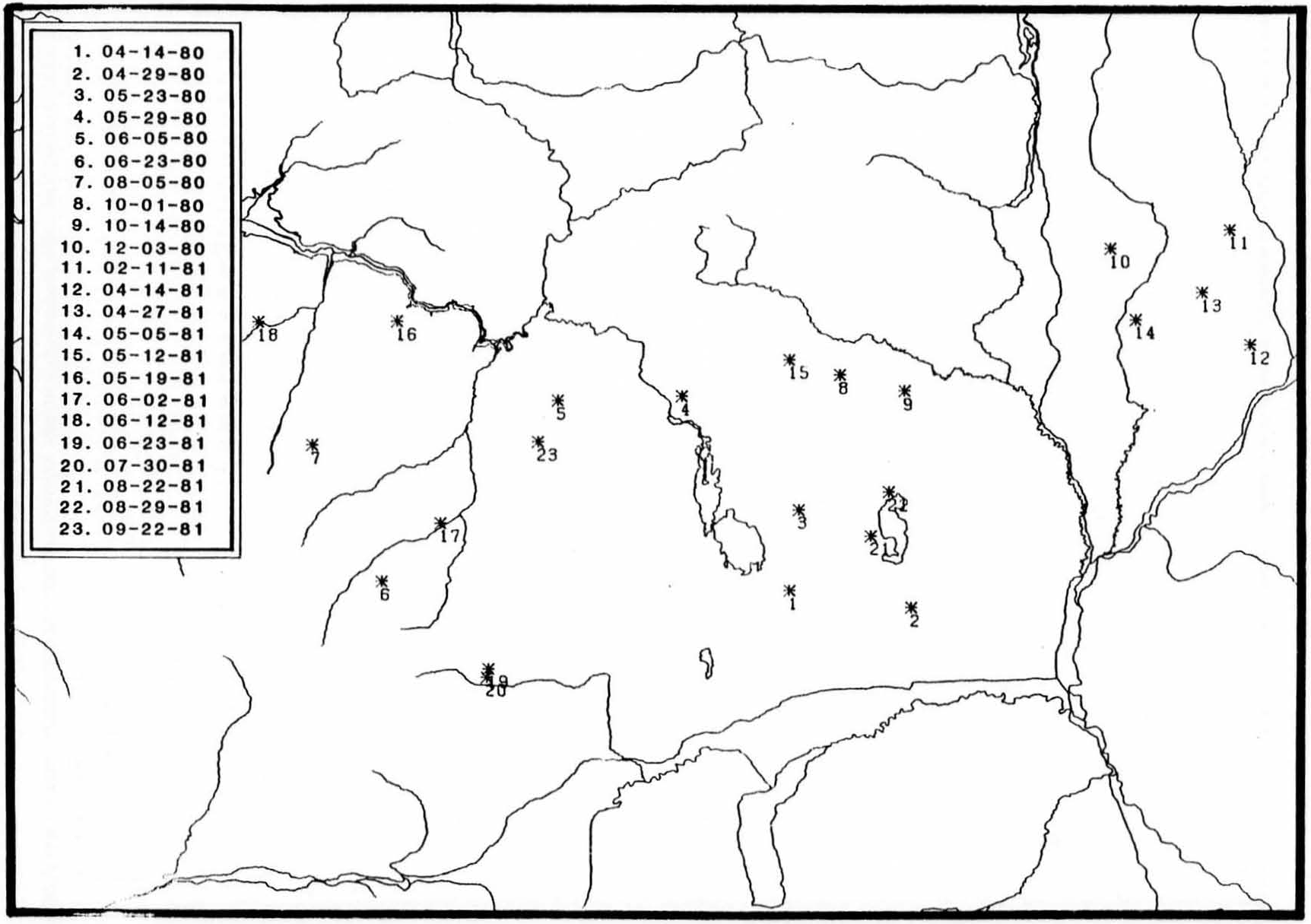
Appendix 1. Sequential sightings of radio-collared caribou 382 (male).



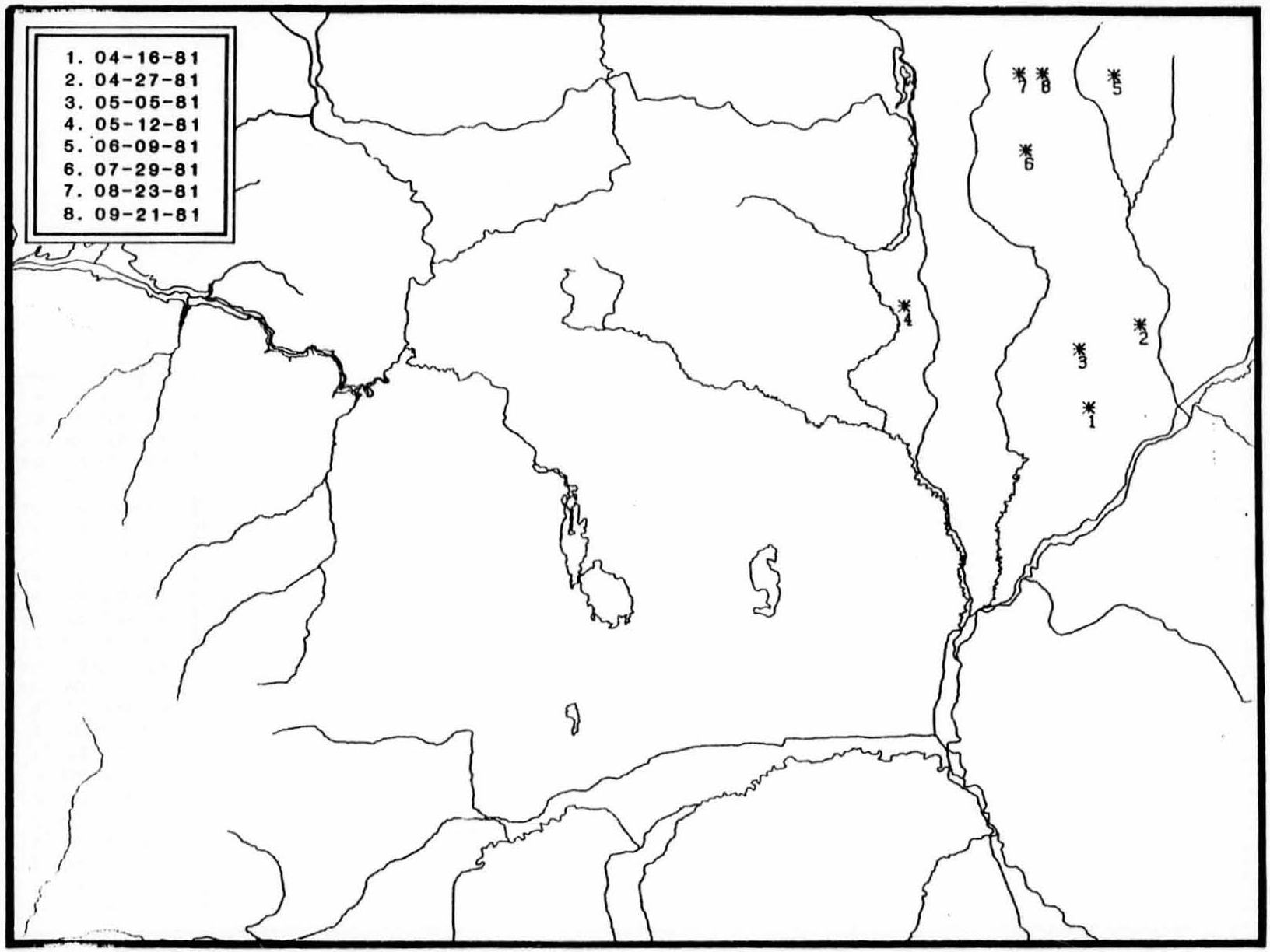
Appendix 1. Sequential sightings of radio-collared caribou 390 (male).



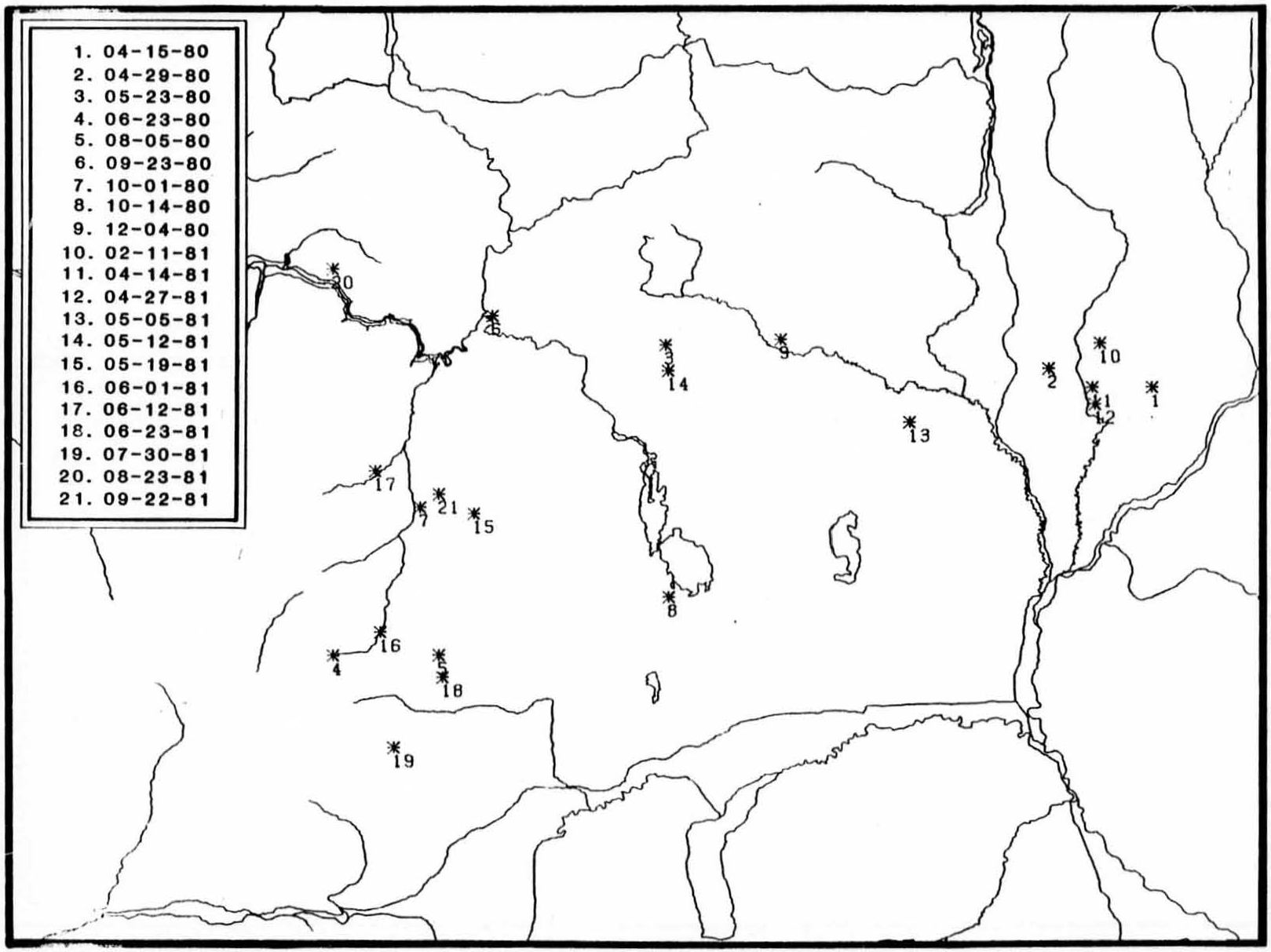
Appendix 1. Sequential sightings of radio-collared caribou 401 (male).



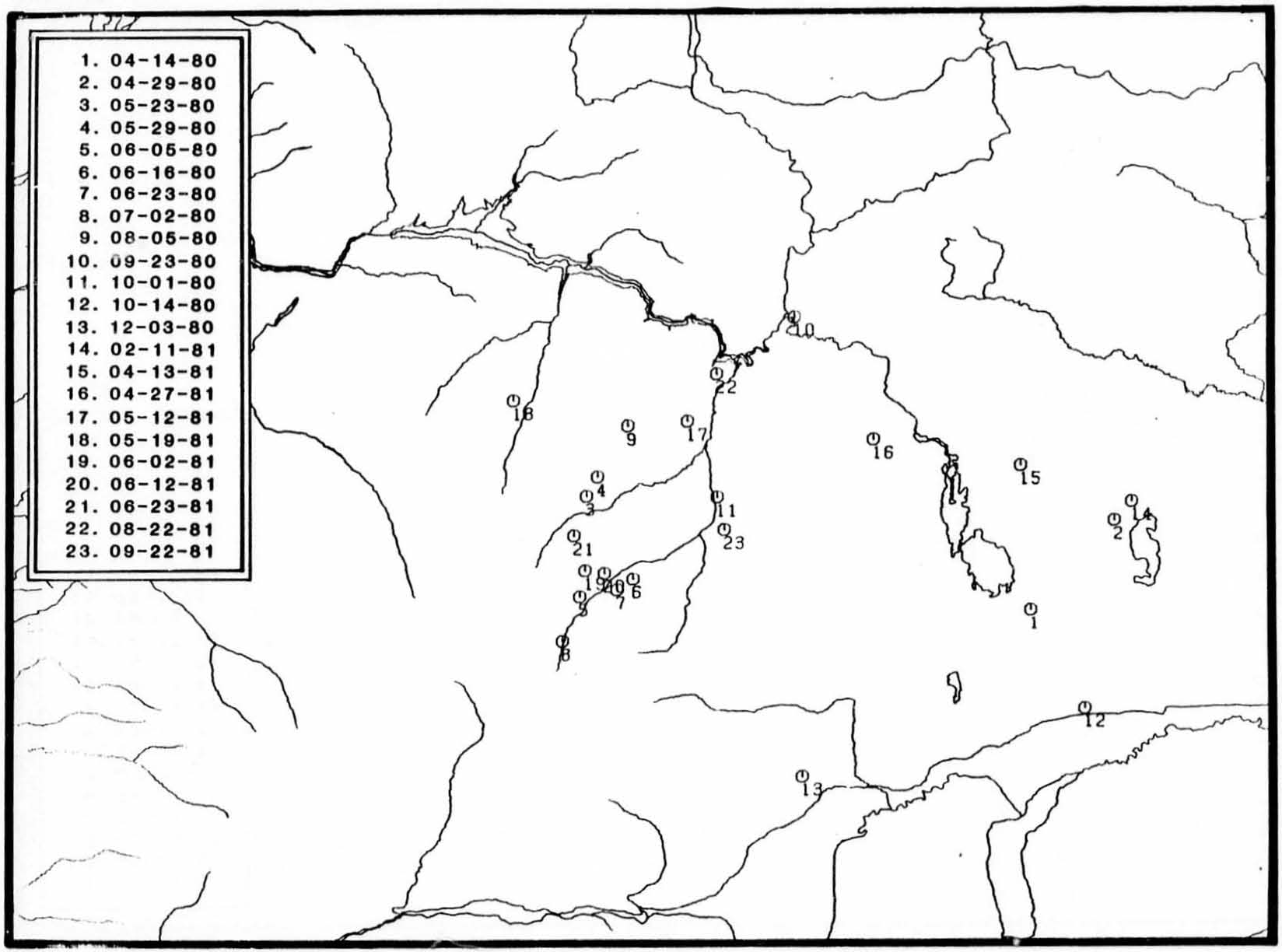
Appendix 1. Sequential sightings of radio-collared caribou 411 (male).



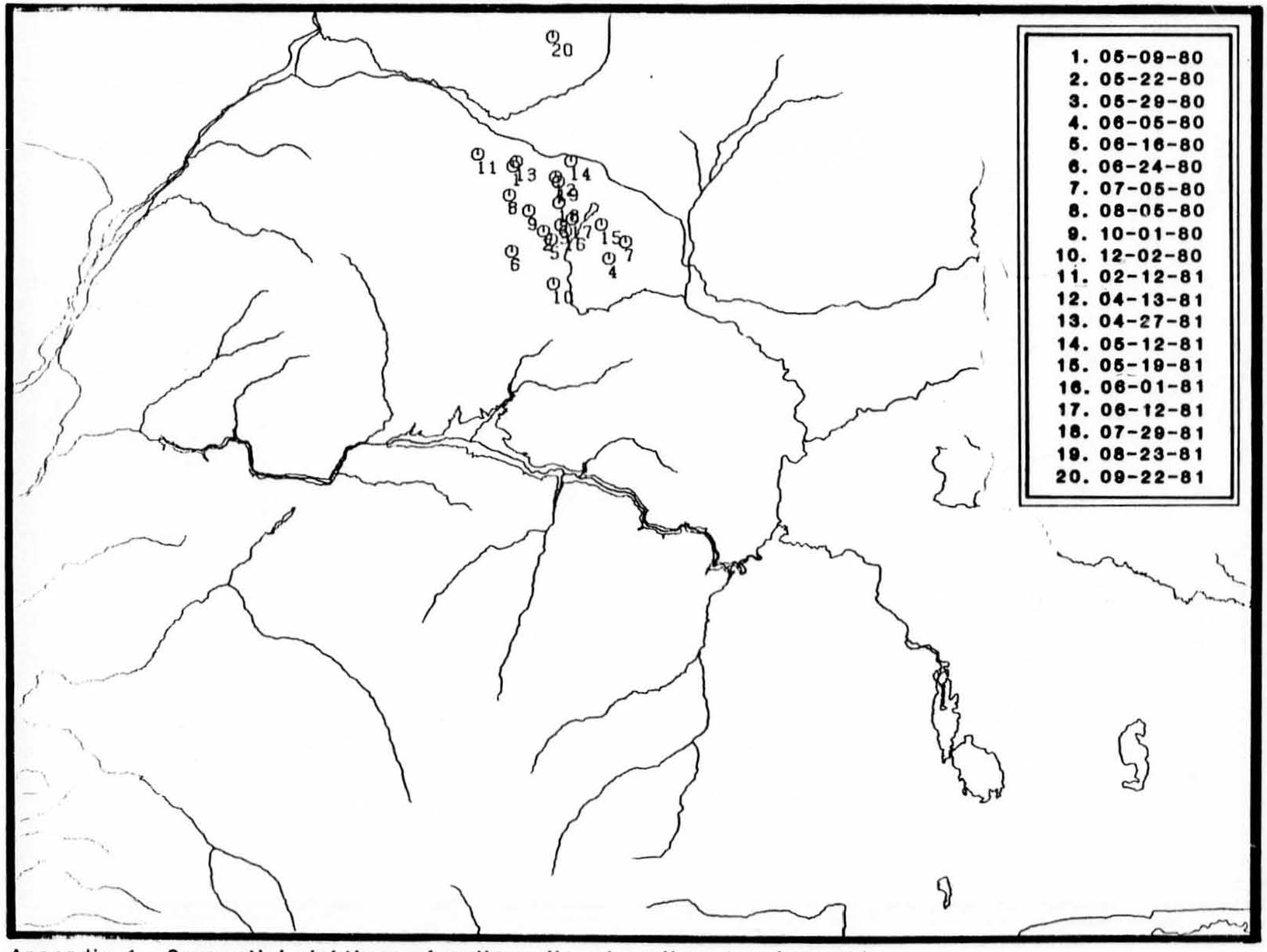
Appendix 1. Sequential sightings of radio-collared caribou 422 (male).



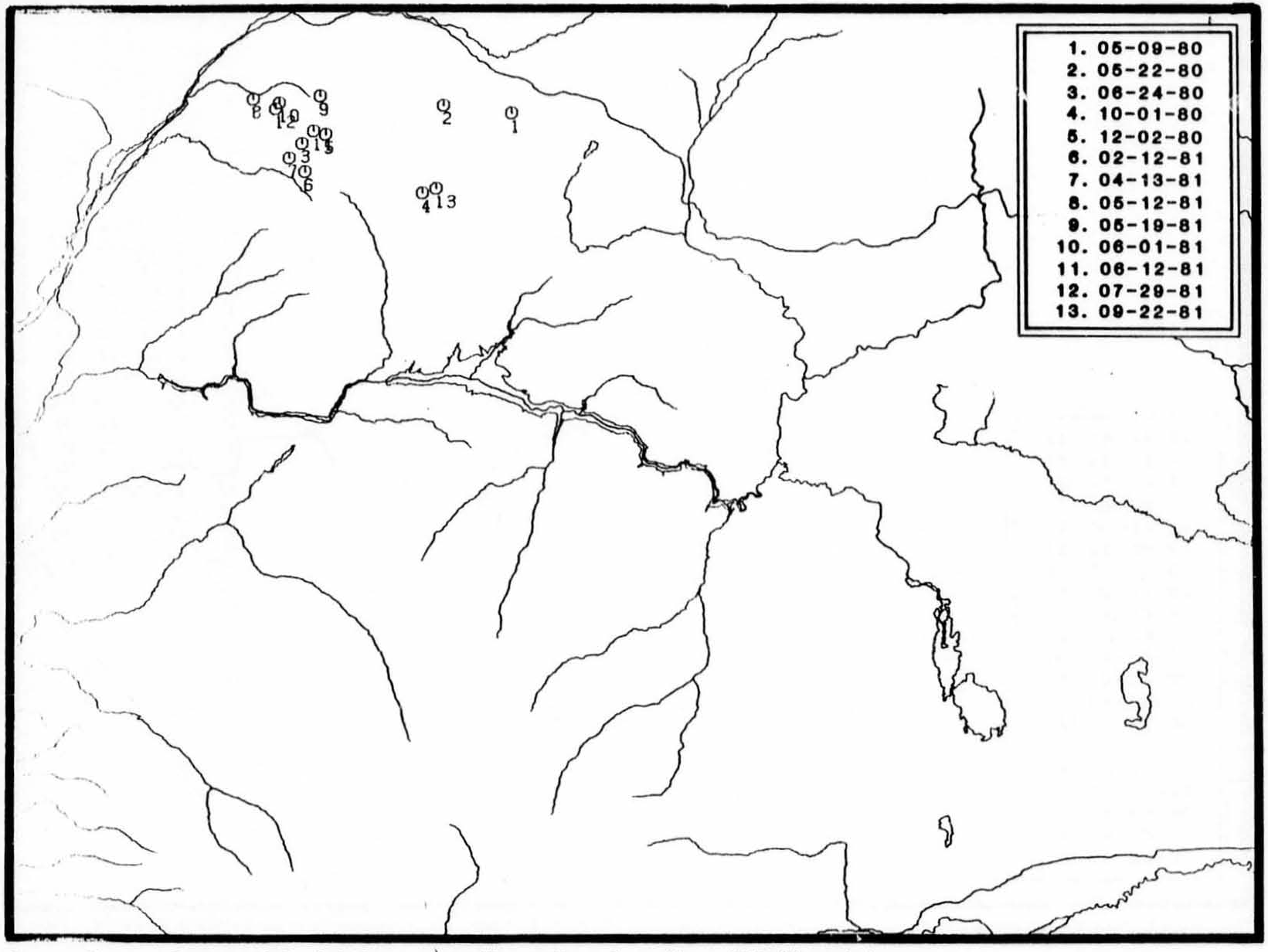
Appendix 1. Sequential sightings of radio-collared caribou 431 (male).



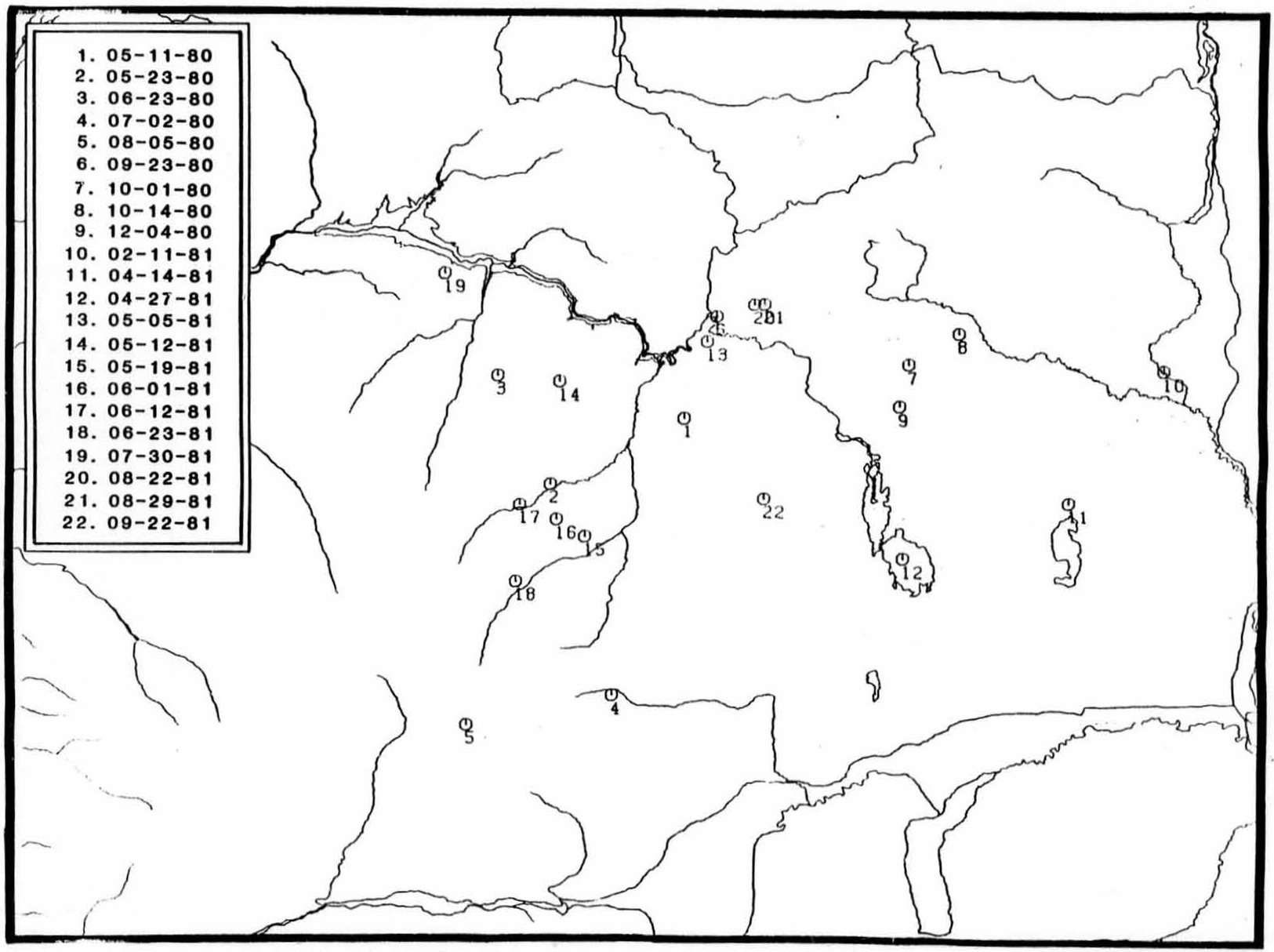
Appendix 1. Sequential sightings of radio-collared caribou 441 (female).



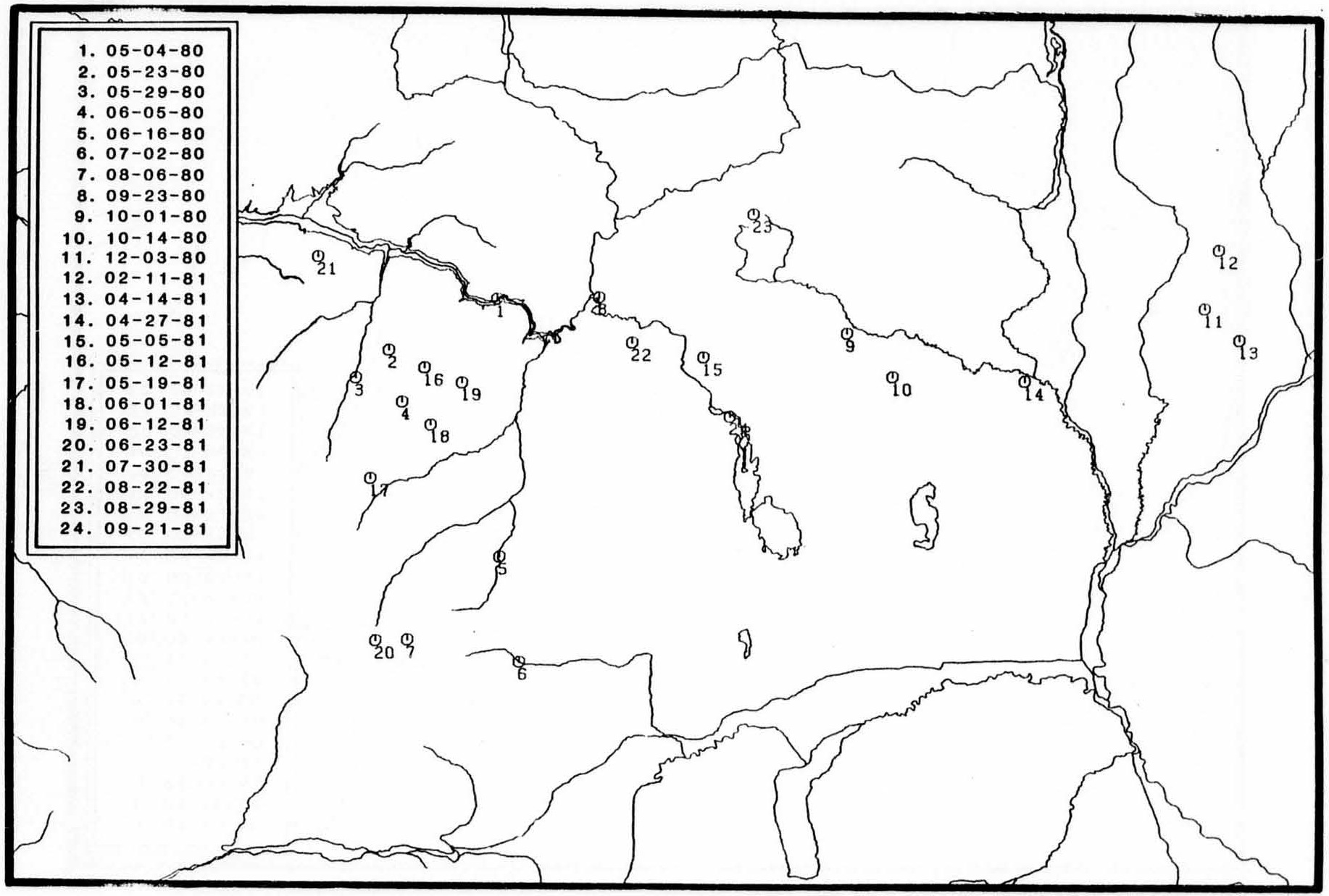
Appendix 1. Sequential sightings of radio-collared caribou 453 (female).



Appendix 1. Sequential sightings of radio-collared caribou 456 (female).



Appendix 1. Sequential sightings of radio-collared caribou 466 (female).



Appendix 1. Sequential sightings of radio-collared caribou 801 (female).