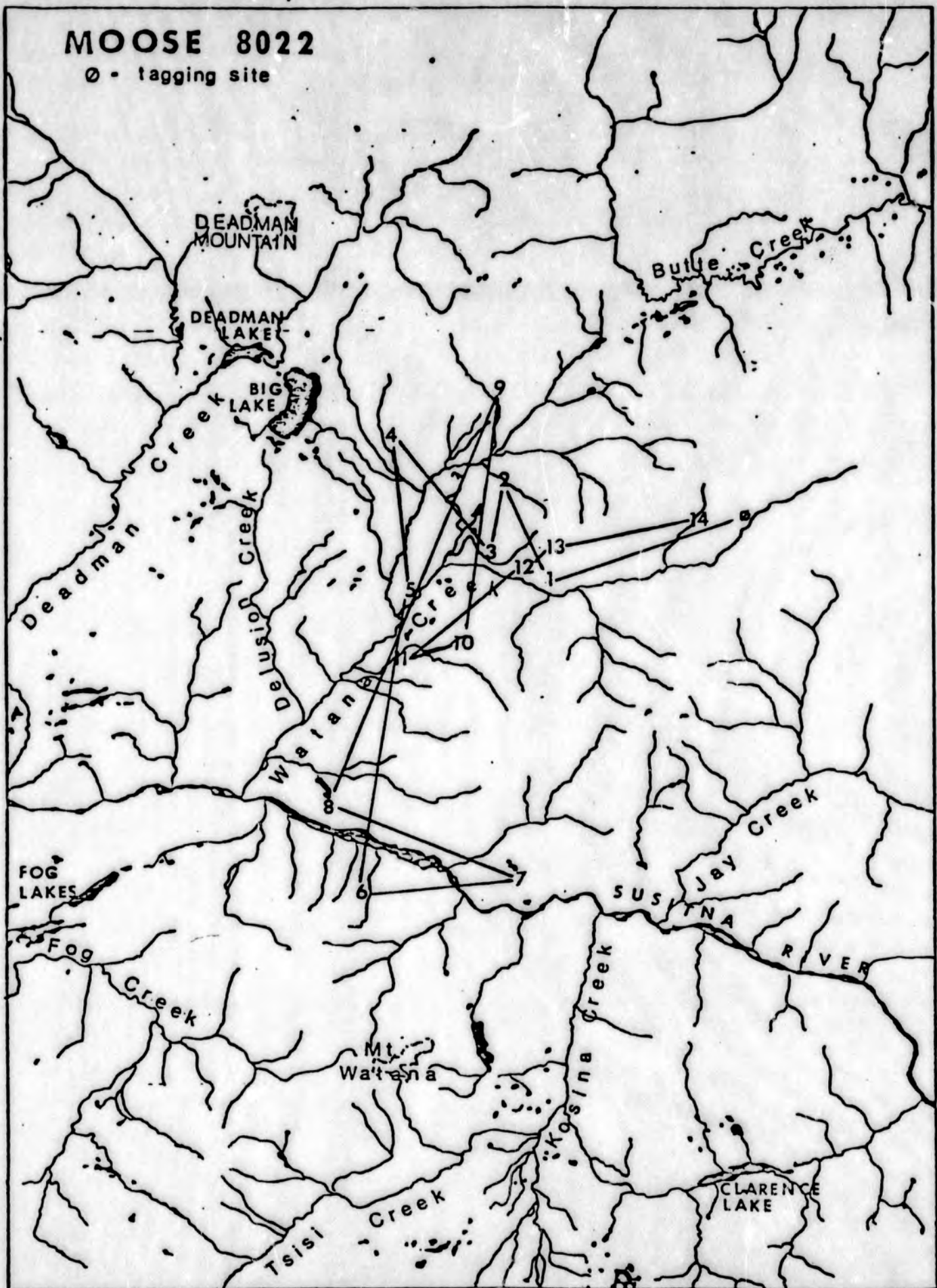


ALASKA LEGISLATURE SPECIAL COMMITTEE / SUBJECT FILES 86/2

1008 SCOMM44: HOUSE POWER ALTERNATIVES STUDY COMM. 1979-8008

MOOSE 8022

○ - tagging site



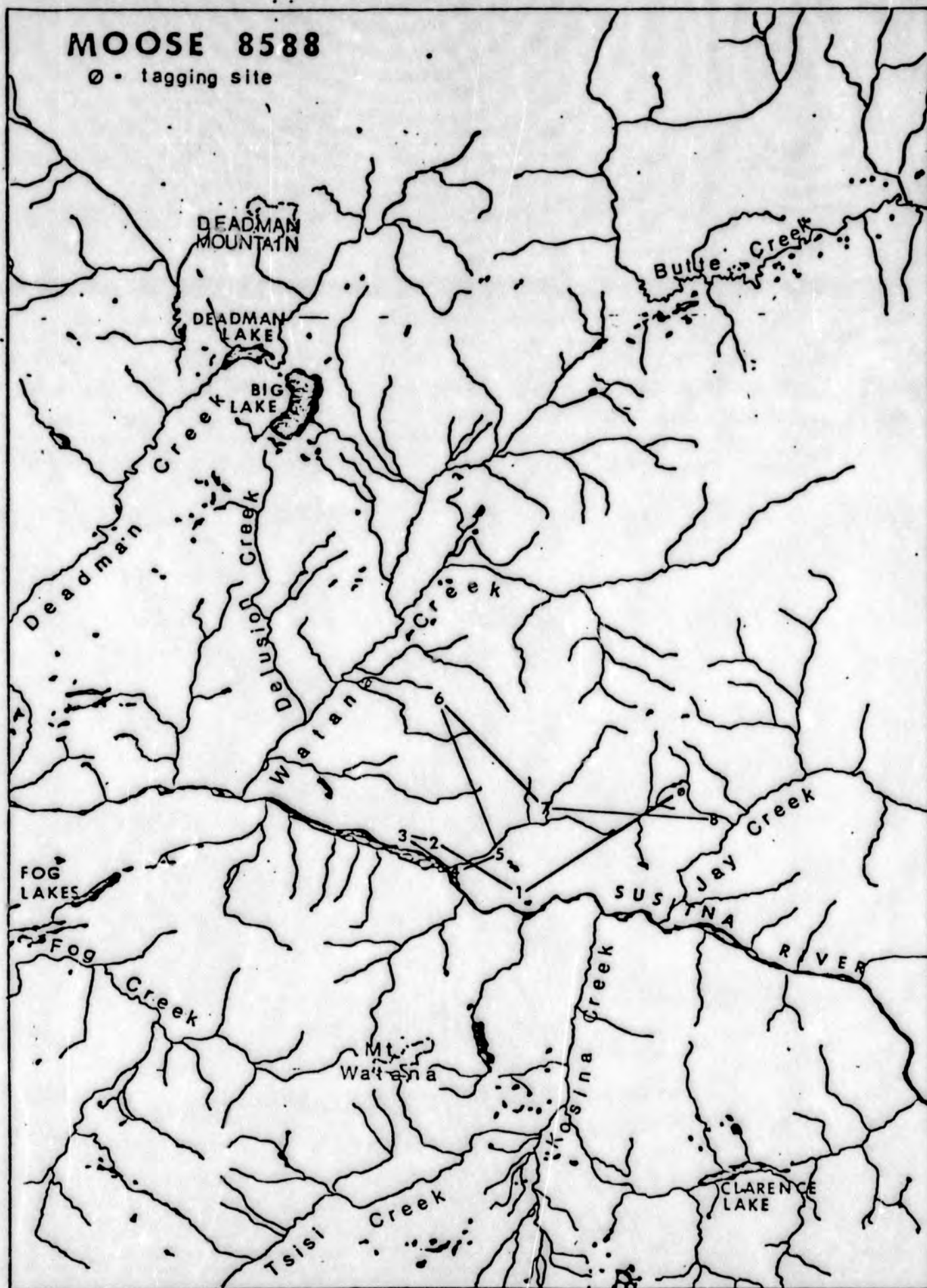
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8022	Red	NA	28 October 1976	Artificial respiration for 10-15 min.

Observations

1 (1:30 PM)	22 November 1976	Unable to observe due to poor snow conditions and dense vegetation
2 (1:45 PM)	3 December 1976	With 1 cow
3 (11:00 AM)	24 December 1976	With 1 cow
4	19 January 1977	Alone
5 (11:00 AM)	4 February 1977	Not visually observed due to high winds
6	3 March 1977	Alone, standing, sparse medium spruce
7 (4:05 PM)	6 April 1977	With 2 moose
8 (9:00 AM)	22 April 1977	Alone, medium medium spruce
9	25 May 1977	Alone, riparian willow
Ø	1 June 1977	No visual observation, in steep wall canyon, near radio 8040
10	8 June 1977	Alone, medium medium spruce
11	16 June 1977	Alone
Ø	28 June 1977	Couldn't locate
12	5 July 1977	Not observed, alder
13 (11:00 AM)	5 August 1977	With 1 cow, tall alder
14	5 October 1977	With radio 8040, alder
15	30 November 1977	With 1 cow, willow

MOOSE 8588

○ - tagging site



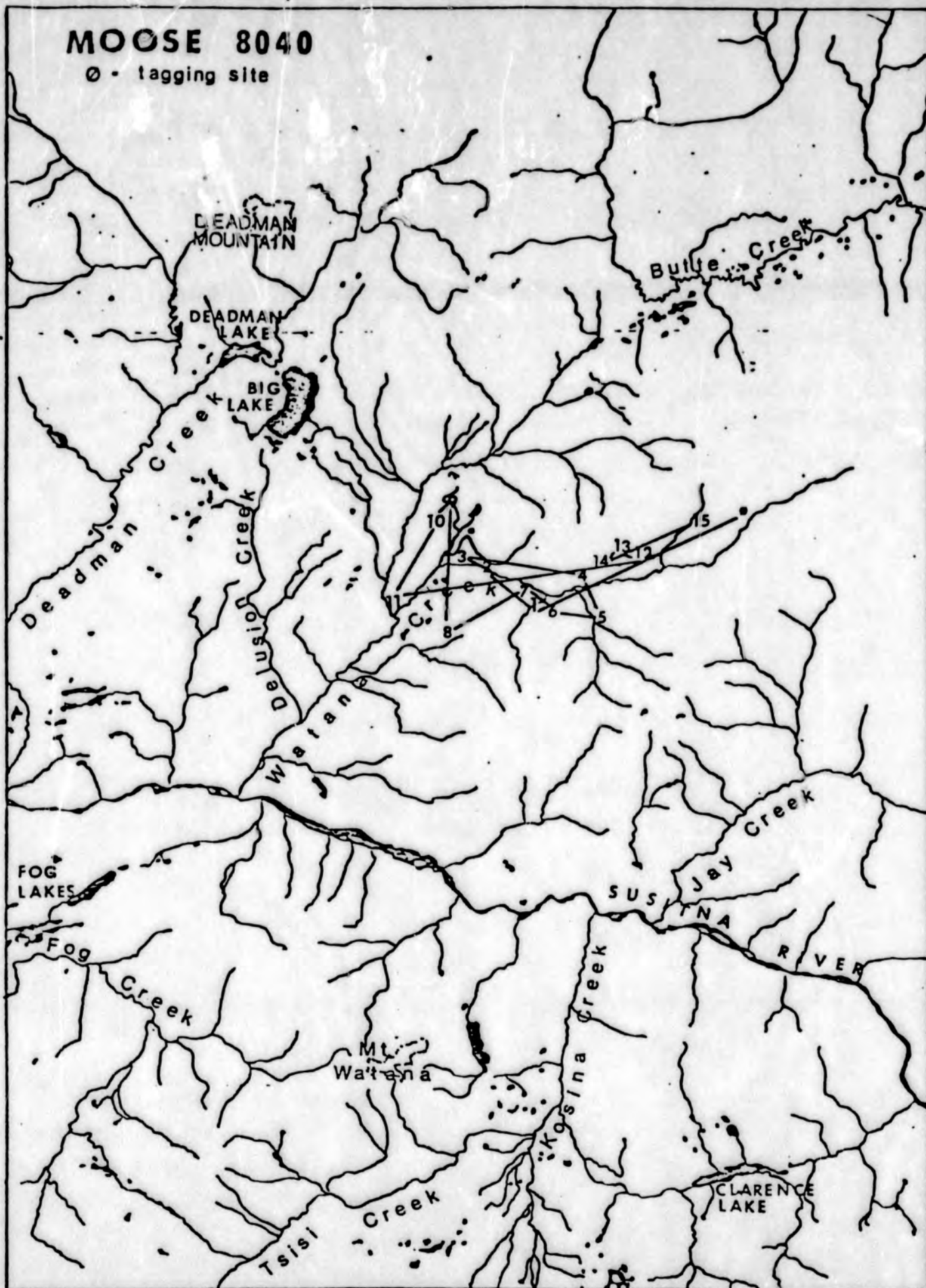
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8588	Orange	16	19 March 1977	none

Observations

1 (4:05 PM)	6 April 1977	Close to radio 8022, medium medium spruce
2	22 April 1977	With 2 cows, sparse short spruce
3	27 May 1977	With 1 yearling and 1 cow, sparse short spruce
Ø	31 May 1977	Not visually observed
4	3 June 1977	Not visually observed on island, dense tall spruce
5	8 June 1977	Alone, spruce (KT)
6	16 June 1977	Alone, willow-alder
Ø	5 July 1977	Alone
7	21 August 1977	Alone, sparse tall spruce
Ø	5 October 1977	Could not locate
8	3 November 1977	With one bull and 3 cows
9	30 November 1977	With one yearling, willow

MOOSE 8040

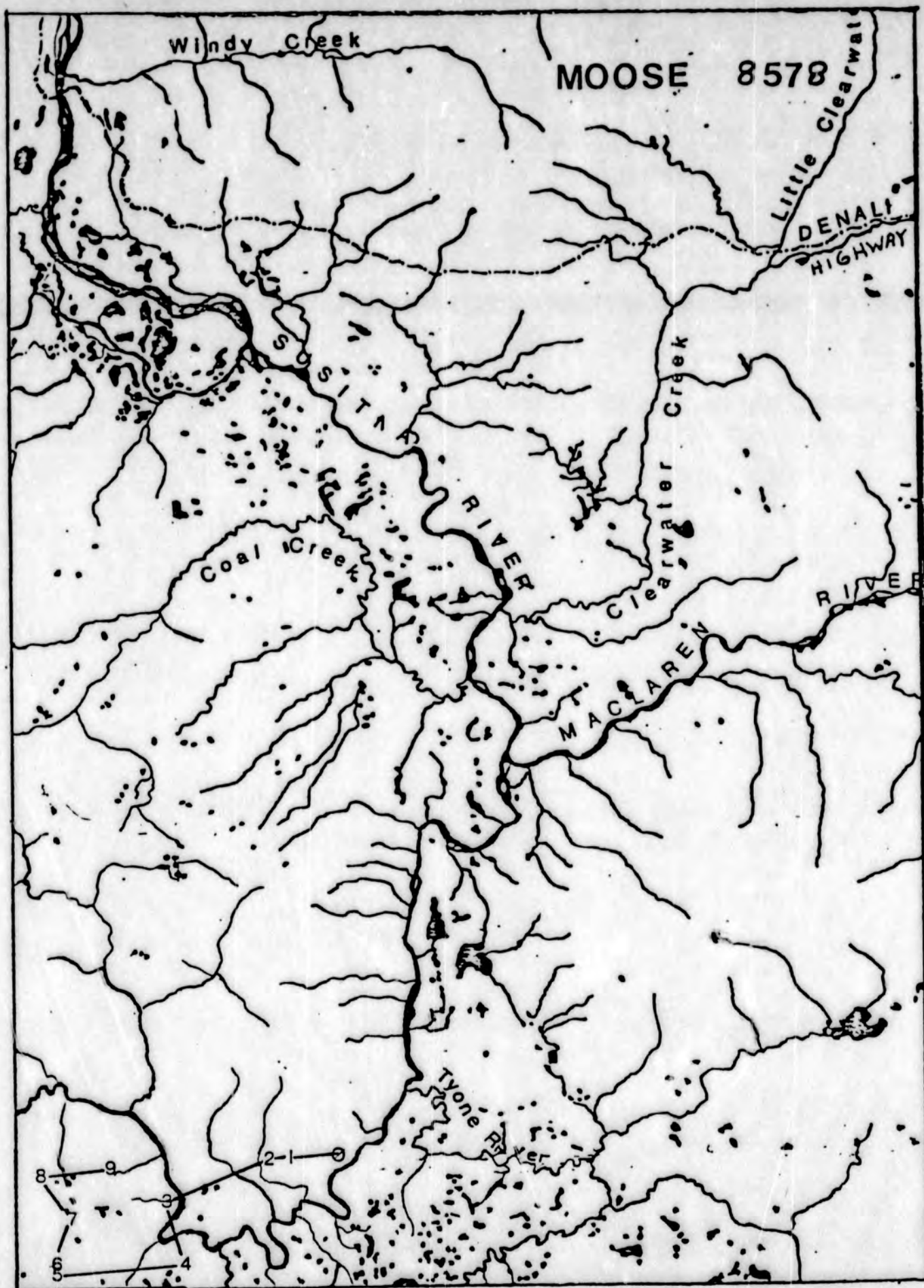
Ø - tagging site



<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8040	Green	NA	28 October 1976	Lone cow, old moose (10+), artificial respiration-5 minutes

Observations

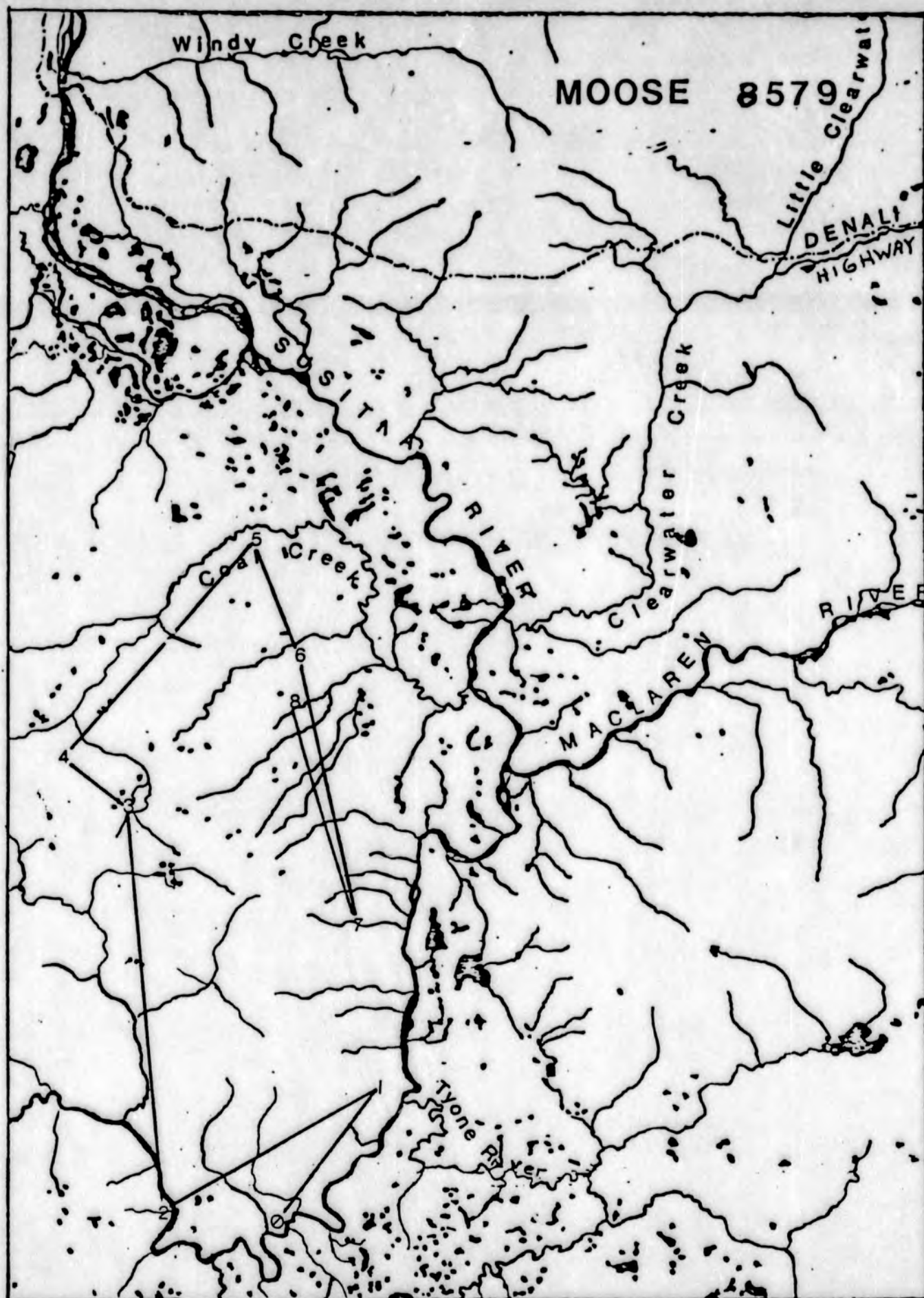
1 (11:50 AM)	22 November 1976	With 1 cow and 1 large bull
2	3 December 1976	With 1 yearling and 2 cows
3	27 December 1976	With 2 cows, 1 small bull and 2 large bulls
4 (9:30 AM)	17 January 1977	Alone
5 (10:30 AM)	3 March 1977	Alone
6 (6:16 PM)	6 April 1977	Alone
7 (9:20 AM)	22 April 1977	With 1 cow, riparian willow, condition 4
8	26 May 1977	Alone, sparse short spruce
Ø	31 May 1977	Not visually observed
Ø	1 June 1977	Alone
9	3 June 1977	Alone, willow
10	8 June 1977	With 2 new calves, alder
11	16 June 1977	Alone, alder
12	28 June 1977	Not observed, alder
13	5 July 1977	Not observed, tall alder
14 (11:00 AM)	5 August 1977	Not observed
15	5 October 1977	With 1 cow and 1 small bull, alder
16	30 November 1977	With 1 yearling, riparian willow



<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8578	Orange	10	20 March 1977	Not pregnant, with 1 bull

Observations

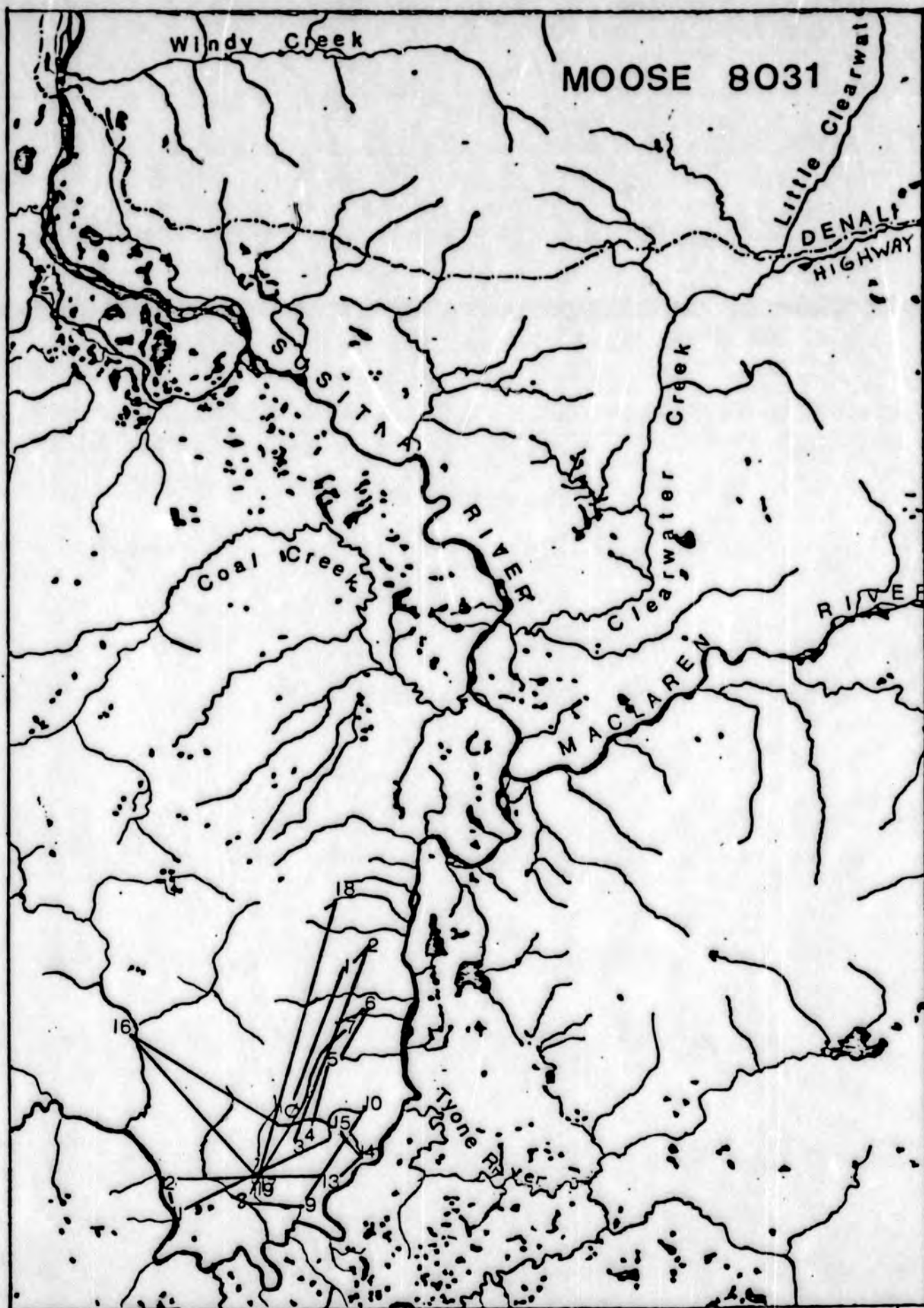
1		30 March 1977	Not visually observed (TB-AL)
2 (10:30 AM)		22 April 1977	Alone, upland small spruce bog
3		13 May 1977	No visual observation due to two other cows in area, steep river banks and heavy spruce (TB-AL)
(11:00 AM)		30 May 1977	No calf, with 1 bull and 2 cows (TS-KB)
4 (2:00 PM)		3 June 1977	With 10 cows and 1 bull, open spruce, no calf (TB-KB)
5 (2:30 PM)		6 June 1977	Up high in scrub sparse spruce, with 1 cow and yearling
		10 June 1977	No calf, with a cow with calf and 1 lone cow, yearling male grizzly present (SE-KB)
		17 June 1977	With 1 adult, no calf
(10:30 AM)		27 June 1977	Alone (TB-AL)
		30 June 1977	With 1 cow and bull, cow with calf 1/8 mile away (KB-TB)
(10:00 AM)		6 July 1977	Alone, upland tundra, no calf, feeding (WB-KB)
6 (10:15 AM)		23 July 1977	Bedded down with 3 adults and 1 small bull, mixed brush upland tundra with short scattered spruce (WB-KB)
7		22 August 1977	Alone within 1/4 mile is cow with yearling, in sparse medium spruce with lots of dwarf birch almost alpine (WB-KB)
(8:55 AM)		30 August 1977	With cow and calf in sparse short spruce, feeding (WB-KB)
8 (5:00 PM)		5 October 1977	Alone, standing in scrub spruce, willow (WB-KB)
9 (1:40 PM)		22 November 1977	Alone, standing in upland short sparse spruce (WB-KB)



<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8579	Orange	14	20 March 1977	Pregnant, 15 minutes artificial respiration (broke couple of ribs), with 1 calf

Observations

1		22 March 1977	With cow, upland willow surrounding medium spruce, condition 4 (WB-KB)
2		13 May 1977	Definite location didn't see due to steep riverbanks and heavy spruce (TB-AL)
3 (11:30 AM)		3 July 1977	Alone, feeding in upland tundra (WB-KB)
4 (10:15 AM)		25 July 1977	Alone, no calf, riparian willow habitat in upland tundra, bedded down
5 (5:30 PM)		18 August 1977	With a cow with calf in tall spruce sparse and dwarf birch (WB-KB)
6 (2:00 PM)		5 October 1977	With 10 cows, 1 small bull in upland short spruce (WB-KB)
7		3 November 1977	With #61 which has calf (SE)
8 (2:00 PM)		22 November 1977	Alone, running, in tall riparian spruce (WB-KB)



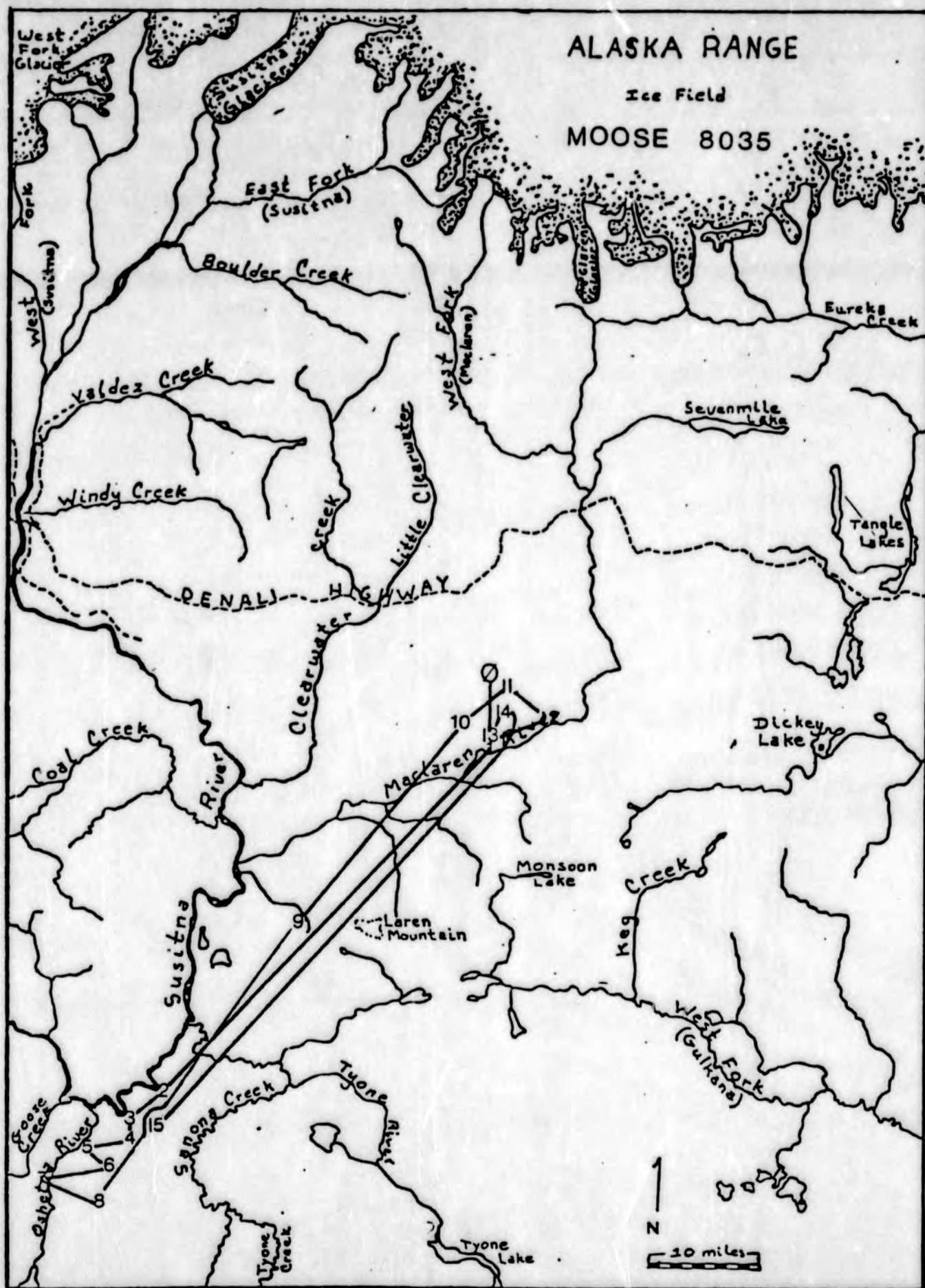
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8031	Green	NA		
Visual	Blue	3	22 October 1976	none

Observations

1		2 November 1976	With several bulls and cows within 1/4 mile, also #2 with calf (TB)
2 (11:15 AM)		19 November 1976	Unobserved due to vegetations and poor snow (WB)
3 (10:15 AM)		16 December 1976	With a yearling cow
4 (Noon)		24 December 1976	With a calf
5 (3:30 PM)		19 January 1977	With a calf, within 1/4 mile 2-3 year old bull with 1 antler and cow with calf
6 (1:00 PM)		3 February 1977	Did not attempt to observe (TS)
7 (Noon)		4 February 1977	Visually observed accompanied by calf
8 (3:00 PM)		22 February 1977	With calf, with cow with twins (TS)
9 (Noon)		5 March 1977	With calf
10 (3:30 PM)		30 March 1977	Didn't visually observe (TB-AL)
11 (8:15 AM)		25 April 1977	With calf and another cow, tall spruce-willow
12 (3:15 PM)		13 May 1977	Didn't see due to steep river banks but definately there, singnal not heard until almost overhead (TB-AL)
(2:00 PM)		20 May 1977	With calf, also 2 cows with calves, 1 cow, medium spruce upland, 2500'
13 (11:00 AM)		30 May 1977	With yearling and 1 cow, no calf, feeding, less than 40' spruce and muskeg (TS-KB)
14		3 June 1977	With yearling and 1 cow
(1:30 PM)		6 June 1977	With a yearling in scrub spruce 200' above river (WB-KB)
		10 June 1977	With yearling, sparse medium spruce (SE-KB)

8031 continued

	17 June 1977	With yearling (SE-KB)
15	24 June 1977	Couldn't see due to wind (TB-AL)
16 (11:45 AM)	3 July 1977	Bedded down with yearling (bull) at least 17 other moose there (WB-KB)
17 (10:35 AM)	23 July 1977	With bull yearling in dense medium spruce, 2700', standing together
(5:30 PM)	18 August 1977	Bedded down with her yearling bull with 1 large bull in dense medium spruce (WB-KB)
(9:15 AM)	30 August 1977	Unable to observe, probably bedded down in thick medium spruce
18 (1:15 PM)	5 October 1977	With 4 cows, 1 cow with calf, 1 yearling in dense medium spruce upland (WB-KB)
19 (1:30 PM)	22 November 1977	With 4 cows, 1 calf, 2 large bulls, 1 yearling bull, standing, feeding, dense medium tall spruce, essentially same location as 17



<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8035	Blue	NA	27 October 1977	3-4 minutes artificial respiration, with one #11. probably 3 other cows. 1 large bull, 1 small bull

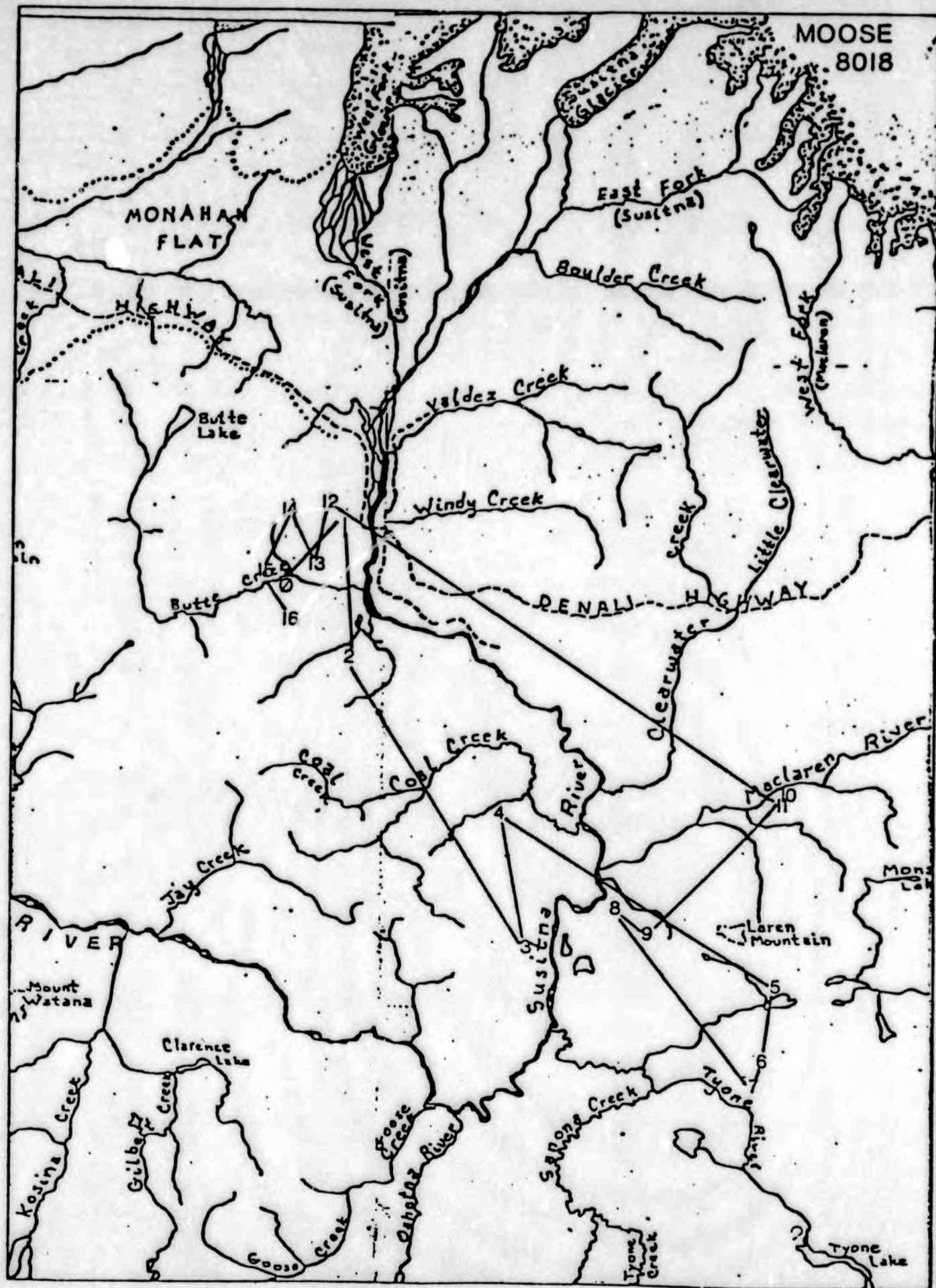
Observations

1		2 November 1976	With 1 cow
Ø		19 November 1976	Not visually observed, with radio 8030 and cow
2 (10:15 AM)		16 December 1976	Did not visually observe due to fog
3 (Noon)		24 December 1976	With 1 cow, within 1/4 mile 1 cow with calf and 5 cows
4 (3:45 PM)		19 January 1977	With 2 yearlings (1 is bull), over 1/4 mile a total of 11 moose which included 2 medium bulls with 1 antler and 2 calves
5 (1:00 PM)		3 February 1977	No attempt to observe
6 (1:00 PM)		4 February 1977	With 2 yearlings (1 bull), other moose in area but no count
7 (3:30 PM)		22 February 1977	With 2 moose
8		5 March 1977	With 1 yearling
Ø		30 March 1977	No visual observation
9		22 April 1977	Condition 5-6, riparian willow
10 (2:30 PM)		25 May 1977	Alone, medium medium spruce, feeding
	(2:00 PM)	1 June 1977	Alone, bedded down, sparse medium spruce
	(Noon)	6 June 1977	Alone, dense riparian tall spruce
	(8:30 AM)	10 June 1977	With cow, standing in riparian spruce
		17 June 1977	With 1 cow
11		25 June 1977	Alone
		6 July 1977	With 1 cow in upland tundra, resting

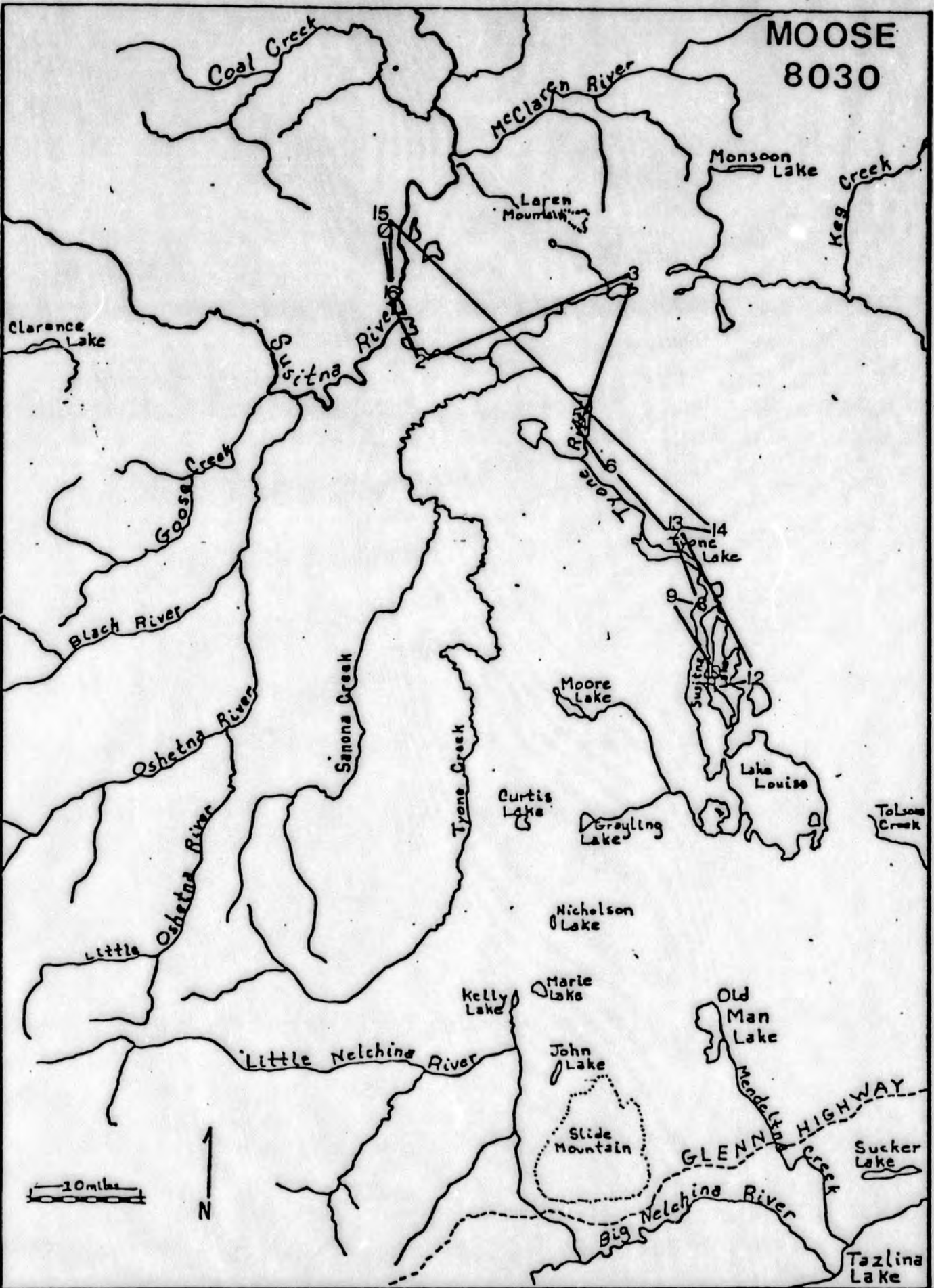
8035 continued

(Noon)	12 July 1977	With 1 cow, upland riparian
12 (1:15 PM)	23 July 1977	Bedded down, sparse medium spruce
13 (4:45 PM)	18 August 1977	Bedded with a cow and yearling bull, sparse short spruce
14 (4:30 PM)	5 October 1977	With 1 large bull, 13 cows, small moose 1 calf, scrub willow with medium medium spruce
15 (2:00 PM)	22 November 1977	Feeding, alone, medium short spruce

MOOSE
8018



<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8018	Green	NA	27 October 1976	Probably with a calf, with one cow
<u>Observations</u>				
1 (12:10 PM)			22 November 1976	With calf, 3 cows and 3 calves (1 set twins)
2 (1:50 PM)			3 December 1976	With medium bull, within 1/4 mile 5 cows, and 3 cows with 2 calves
3 (11:15 PM)			24 December 1976	With 1 cow
4 (1:20 PM)			19 January 1977	Alone
5 (1:00 PM)			7 February 1977	Alone
6 (1:00 PM)			5 March 1977	With calf
7 (11:02 AM)			30 March 1977	With calf
8			25 April 1977	With calf, medium medium small spruce
9 (7:45 PM)			10 May 1977	With 3 cows, sparse medium spruce
Ø			27 May 1977	
10 (Noon)			30 May 1977	With 1 new calf, feeding, near a cow with twins
Ø (4:30 PM)			6 June 1977	With calf, resting, river floodplain with medium medium spruce
11 (8:00 AM)			10 June 1977	With calf, lying down in sparse tall spruce
12 (10:30 AM)			12 July 1977	Unable to observe, in thick upland tundra, within 1/2 mile cow with calf
13 (12:30 PM)			23 July 1977	No visual, dense willow and alder must be bedded down
14 (9:00 AM)			22 August 1977	Unable to observe due to dense alder-willow within 1/4 mile cow with calf
15 (2:15 PM)			5 October 1977	Alone, standing, riparian willow
16 (10:30 AM)			22 November 1977	With 2 cows, 3 calves, bedded riparian willow



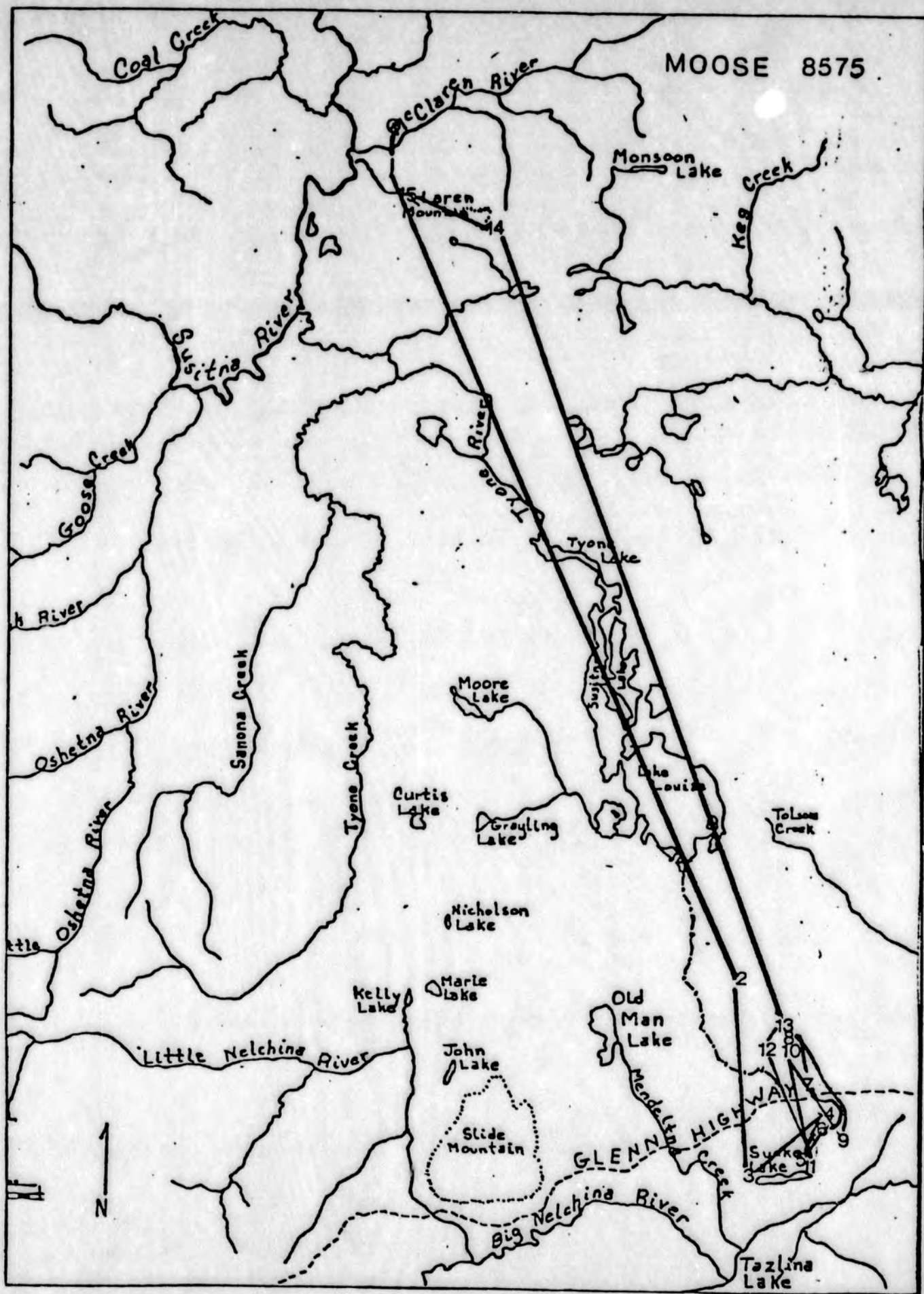
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8030	Black	NA	22 October 1976	With 5-6 cows

Observations

1		2 November 1976	
2		19 November 1976	With 1 cow, and close to radio 8035
3 (9:07 AM)		16 December 1976	With cow and calf
4		19 January 1977	Alone, however, large concentration moose in area
5		3 February 1977	No attempt to observe
6 (Noon)		5 March 1977	Alone
7 (10:22 AM)		30 March 1977	
8 (12:30 PM)		22 April 1977	With 2 cows, medium medium spruce
9 (5:00 PM)		10 May 1977	No attempt to observe
Ø (9:52 AM)		13 May 1977	Walking, dense tall spruce
10 (10:00 AM)		30 May 1977	With one new calf on island, feeding, sparse medium spruce
Ø (11:45 AM)		6 June 1977	With calf, feeding, sparse tall spruce
Ø (Noon)		10 June 1977	With calf on island, resting, sparse tall spruce
11 (1:15 PM)		15 June 1977	Alone, moved to next island, feeding on shore in water
Ø		17 June 1977	Alone
Ø		25 June 1977	Unable to observe due to dense vegetation
Ø		30 June 1977	With calf on island, medium medium spruce
Ø (10:15 AM)		7 July 1977	With calf
Ø (10:00 AM)		12 July 1977	With calf, bedded, medium medium spruce
12 (10:00 AM)		23 July 1977	With calf, running dense medium spruce

8030 continued

13	25 August 1977	With calf and 1 cow, sparse medium spruce
14	30 August 1977	With calf, bedded, dense medium spruce
15 (1:00 PM)	5 October 1977	With calf, 1 cow with calf, and 1 small bull, medium short spruce
16 (1:15 PM)	22 November 1977	With calf, standing in dense short spruce



<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8575	Orange	3	21 March 1977	Pregnant, with group of 3 moose

Observations

1 (2:40 PM)	30 March 1977	Alone
2 (7:45 AM)	22 April 1977	Alone, bedded
Ø	10 May 1977	Did not attempt to observe
3 (9:10 AM)	11 May 1977	Within 1/2 mile of 3 cows, dense tall spruce
4 (8:30 AM)	25 May 1977	Alone, appeared pregnant, medium medium spruce
5 (2:45 PM)	26 May 1977	With cow that has new calf, resting, medium medium spruce
6	30 May 1977	Alone, feeding, sparse tall spruce
7	10 June 1977	Alone, traveling, willow
Ø	17 June 1977	Alone
8 (8:00 PM)	22 June 1977	Alone, feeding, sparse tall spruce
9 (1:00 PM)	28 June 1977	Alone, bedded, dense medium spruce
10 (9:00 PM)	6 July 1977	Alone, bedded, dense medium spruce
11 (1:00 PM)	12 July 1977	Alone, bedded, riparian willow
12 (7:30 AM)	2 August 1977	Alone, bedded, medium medium spruce
13 (9:45 AM)	17 August 1977	Alone, bedded, sparse medium spruce
Ø (2:00 PM)	18 August 1977	With 2 cows, bedded, medium medium spruce
Ø (9:45 AM)	13 September 1977	Alone, bedded, dense medium spruce
Ø	30 September 1977	No visual, cow was traveling
14 (5:00 PM)	5 October 1977	Alone, in dense medium spruce, within 1 mile 1 cow with twins and 1 cow with calf
15 (1:00 PM)	22 November 1977	With 1 cow, bedded, dense tall spruce

APPENDIX II

Wildlife Studies

Introduction

The proposed Susitna Hydropower Project will have impacts on several wildlife species which either reside in the project area, use the area for migration or other seasonal purposes or use habitat downstream which will be altered by the stabilization of water flow. The following individual proposals comprise an integrated program to provide information needed to predict the impacts of the Project on wildlife and to provide a basis for making decisions which might minimize those impacts.

This program will not answer all questions. It is designed to provide an acceptable basis of knowledge in a limited time period using presently available techniques. Emphasis has been placed on species which are likely to be most adversely affected by the project and are of greatest interest to man.

The design, timing, manpower requirements and funding levels of the individual projects have been coordinated for efficiency. No single project can be conducted by itself without considerable change in design and increase in cost. For example the moose study is the core of the entire package. The wolf, wolverine, bear and caribou studies are dependent on the moose study for manpower equipment and logistic support. The moose, habitat mapping and vegetation studies are also dependent on each other as each will influence the design of the others and their results must be compatible for final data analysis. If one project does not produce results at the proper time other projects will be delayed, reducing the quality of information and increasing the overall cost of the program.

Title: Habitat mapping and vegetation studies required for analysis of the effects of the Susitna Hydropower Project on wildlife.

Objectives: To prepare a vegetative type map of areas within and adjacent to proposed impoundments, along transmission corridors and along the downstream floodplain.

To identify key moose browse species and determine the condition and trends of selected moose habitats.

To determine the effects of altered water flow on key plant species and map areas where substantial vegetation changes will occur.

Background: Most impacts of the Susitna Hydropower Project on wildlife will occur through loss or alteration of habitat. Where habitat is totally lost to a population through inundation or blocking of migrations it is necessary to know the importance of that particular habitat to the population and the availability of alternative habitats. Where habitat will be merely altered, it is also necessary to know what elements within that habitat are important to the population and what changes will occur in those elements. Direct studies of wildlife species can

delineate a population and tell us where various components of the population are at different times and to a certain extent why they are there. However, wildlife studies must be accompanied by habitat studies if we are to determine the full significance of habitat alteration to the population.

This project is not an actual proposal. Several of the studies outlined here could be expanded to meet the needs of other disciplines. Therefore, this is a statement of information needed to evaluate the effects of the Susitna Project on wildlife. Actual study proposals should be developed to provide this information on the schedule outlined.

Procedures: A habitat type map of the proposed impoundment areas, all drainages flowing into the impoundments, access and transmission corridors and the downstream floodplain should be prepared during the first two years of the study. This map should be of sufficient detail to permit delineation of specific habitats favored by moose and must be accompanied by sufficient ground truth data to identify the distribution and abundance of moose browse species. In order to accomplish this it is essential that the principal investigators of moose studies work directly with the habitat mappers.

Studies of the effects of water table and influence of water level fluctuations on vegetation, particularly moose browse species, along the floodplain of the Susitna River should be initiated immediately. A map of areas where changes in flow caused by the dams will alter the vegetation, either through changes in soil moisture or by allowing plant succession to occur, should be prepared. Emphasis should be placed on areas of high moose use such as the lower Susitna River.

Detailed studies of vegetation in important moose wintering areas should be conducted to identify plant species used by moose and quantify their presence, use and trends. Study areas would be identified from data collected under the moose studies.

Schedule:

FY 78	Habitat mapping, effects of water level studies
FY 79	Habitat mapping, effects of water level studies
FY 80	Map areas of expected plant composition changes. vegetation studies on moose winter range
FY 81	Moose winter range studies
FY 82	Moose winter range studies

Title: Impact of the Susitna Hydropower Project on Moose Populations

Objectives: To identify moose subpopulations using habitat subject to direct and indirect impact of the Susitna Hydropower Project.

To determine the seasonal distribution, movement patterns, size and trends of those subpopulations.

To determine the timing and degree of dependency of those subpopulations on habitat to be impacted by the Susitna Hydropower Project.

Background: Several subpopulations of moose occupy habitats that may be inundated or substantially altered by the proposed Susitna Hydropower Project. Limited studies conducted in 1977 identified one subpopulation which occupied the upper ends of tributaries north of the proposed impoundment areas during spring, summer and fall, then migrated to the Susitna River bottomlands during winter. Similar populations almost certainly occupy drainages to the south of the impoundments. There is also strong evidence that riparian habitat along the mainstem, which may be significantly altered by the stabilization of water flow, also serves as winter range for several subpopulations of moose. These habitats may be critical to these populations in severe winters. Other subpopulations may be nonmigratory and use areas to be affected all year. Some migratory populations may not rely on the river bottoms for seasonal range but may migrate through them on their way between seasonal ranges.

The degree of impact will vary depending on the subpopulations size, status and degree of dependence on altered habitat and the nature of the habitat alteration. Many factors must be considered including: the sex and age composition of members of the subpopulation using the habitat (often pregnant cows or cows with calves are more dependent on lowland areas than bulls), the overall range of the subpopulation (some members of a nearby subpopulation migrate up to 60 miles indicating that reductions in moose densities could occur over a vast area), the availability of alternative ranges particularly during severe winters (habitat alterations which may be relatively insignificant in normal or mild winters may be devastating when heavy snowfall makes alternative ranges unavailable), etc.

An adequate assessment of the potential impacts of the Susitna Project on moose requires a thorough understanding of moose populations using the area. This information must then be related to a knowledge of the habitat and the elements within that habitat that are necessary for moose. This study is designed to provide the necessary information on moose. It is essential that certain habitat studies be conducted concurrently. A habitat map of sufficient detail to delineate types selected by moose, covering the impoundment area, surrounding drainages, transmission corridors and the floodplain of the Susitna River to its mouth, should be prepared at an early stage of the studies. Detailed browse studies should be conducted at sites selected on the basis of use by moose to identify important browse species, measure the degree of use and identify other elements of the habitats that are important to moose. The role of

the water table and spring flooding in maintaining moose habitat below Devils Canyon should be determined and maps delineating areas where the alteration of the flow will result in vegetation changes should be prepared.

This moose study and the habitat studies outlined above should be closely coordinated as each will influence the final design of the other and all are necessary to relate habitat changes to moose.

Procedures: During 1977, 12 moose were radio collared and 14 others were collared with visually identifiable collars. These moose were tracked from March to December 1977. Under this study, tracking of those moose will be continued, to further delineate the ranges of that subpopulation.

Additional moose will be radio collared in drainages along the south side of the proposed impoundment area and in riparian habitats along the mainstem below Devils Canyon.

Each radio collared moose will be relocated regularly. For each relocation the exact location, habitat type, activity of the moose and association with other animals will be recorded.

A random stratified census and seasonal sex and age composition counts will be conducted on subpopulations most likely to be affected by the Susitna Hydropower Project. Concentrations of moose will be mapped throughout the area whenever the opportunity arises.

These data will be used to identify subpopulations using areas to be impacted, to determine the seasonal ranges and migration routes of each subpopulation and to estimate the size and composition of those subpopulations most likely to be impacted. Locations of moose will be overlaid on habitat maps to determine the degree of use of certain habitat types as well as specific habitats. This information will be analyzed by subpopulation, season, sex and age class and reproductive status. Areas likely to be altered by the project that are critical to a subpopulation will be identified and recommended for more detailed vegetation studies.

Schedule:

FY 78	Radio collar moose, tracking flights, composition counts
FY 79	Tracking flights, composition counts, random stratified count. Review habitat map and map of downstream areas to be impacted and identify data gaps. Identify areas for detailed vegetation studies.
FY 80	Replace radios and radio collar new moose to fill identified data gaps, tracking flights, composition counts.
FY 81	Tracking flights, composition counts, random stratified counts.
FY 82	Tracking flights, composition count, start final analysis of data.
FY 83	Tracking flights, complete analysis of impact of Susitna Hydropower Project on moose, write final report.

Cost:

FY 78	\$220,000
FY 79	\$210,000
FY 80	\$180,000
FY 81	\$210,000
FY 82	\$175,000
FY 83	\$ 85,000

Title: Mitigation measures for lost moose habitat.

Objectives: To identify and evaluate measures for enhancing moose habitat.

To locate areas where moose habitat enhancement would effectively mitigate loss or deterioration of moose habitat resulting from the Susitna Hydropower Project.

Background: Important and perhaps critical moose habitat will be totally lost or reduced in quality by the Susitna Hydropower Project. The proposed moose and habitat studies should quantify this loss and its resulting impact on moose populations.

Moose tend to favor subclimax ranges. In recent years several agencies have recognized a potential for enhancing habitat for moose by setting back plant succession through artificial means. The Alaska Department of Fish and Game, U.S. Fish and Wildlife Service and U.S. Forest Service have all experimented with such techniques as mechanical crushing, prescribed burning and fertilizing. At present these techniques have not been fully evaluated.

Such techniques are probably effective only in certain types of habitats. In some cases it might be possible to fully mitigate the impact on a particular subpopulation of moose. For example, if an effective technique can be found to maintain willow habitats on river bars without periodic flooding, impacts on subpopulations dependent on downstream habitat might be kept to a minimum.

In other cases where critical habitat will be completely destroyed it might be possible to make alternative habitat available to the affected subpopulation of moose. However, there will likely be some subpopulations for which mitigation measures will not be possible. In these cases the loss to human users could be offset by enhancing the range of populations of moose away from the Project area.

In order to assess these possibilities it is necessary to evaluate the various techniques and to delineate habitat where these techniques would have a positive effect on moose.

This project is designed to provide information to assess the feasibility of mitigation and to initiate long term studies which would direct actual mitigation efforts. Evaluation of these long term studies will take many years. The need to complete the long term studies will depend on the results of the feasibility study.

Procedures: A complete review of potential moose habitat manipulation techniques will be made. Areas which have been experimentally manipulated in the past will be visited and the quantity and quality of potential moose browse produced will be assessed. Information gaps will be identified and if necessary further experimental manipulation will be recommended.

Data from the habitat mapping, vegetation and moose studies will be used to identify areas where habitat manipulation might offset adverse impacts on each of the subpopulations of moose that are identified.

Schedule:

FY 79	Preliminary review of techniques and identification of areas of past experimentation.
FY 80	Evaluation of success of previous manipulation efforts. Identification of data gaps. Recommendations on future experimentation.
FY 81	Continue evaluation of manipulated areas. Initiate manipulation experiments to fill data gaps.
FY 82	Evaluate techniques. Identify potential areas for mitigation.
FY 83	Evaluate techniques. Identify potential areas for mitigation.

Cost:

FY 79	\$ 5,000
FY 80	\$ 20,000
FY 81	\$275,000 (actual cost will depend on results of FY 79 and 80 studies)
FY 82	\$ 20,000
FY 83	\$ 20,000

Title: Impact of the Susitna Hydropower Project on caribou populations.

Objectives: To identify subpopulations of caribou in the Nelchina Basin.

To determine the seasonal ranges and migration routes of these subpopulations with emphasis on traditional migration routes across proposed impoundment areas and potential alternative routes.

To determine the availability of suitable alternative seasonal ranges to caribou subpopulations that might be isolated from traditional ranges by the proposed impoundments.

Background: The Nelchina basin has been the most important sport hunting area for caribou in Alaska. Although caribou numbers were reduced from a recorded high of 72,000 to a low of 10,000 the population is presently increasing and is now estimated to exceed 14,000 caribou. Proposed management plans state that the population will be allowed to increase until it numbers 20,000 caribou.

Caribou traditionally have used a variety of ranges on both sides of the Susitna River and varying numbers have crossed the Susitna at least twice a year. Major crossing locations have been recorded in areas which would be affected by the proposed hydropower project. Because caribou frequently migrate long distances and may periodically overgraze one range and shift to another, it is necessary to examine the status of caribou and identify alternative ranges over a large area.

Range studies conducted by the Alaska Department of Fish and Game have shown that the most desirable winter ranges remaining in the Nelchina basin are located in the Clearwater Mountains, Chumilna Hills, Susitna Uplands and Monahan Flats. Most of these ranges are north of the Susitna River while historical and recent calving and summer ranges exist south of the river. The preferred lichens south of the river have generally declined and have not shown substantial recovery even with lowered caribou populations. Meanwhile, the Nelchina population has used this area to a greater extent than the other portions of its range. A portion of the winter range exists east of the Richardson Highway in the Wrangell Mountains but movement into this range may be affected by the recent construction of the oil pipeline from Prudhoe Bay to Valdez. All of these factors make it likely that the ability to cross the Susitna will remain critical to the well being of the Nelchina caribou herd.

To determine the extent that the impoundments will affect this movement is difficult. Other migration routes may be used in addition to those already shown in the literature or sufficient range may be available to the east to support the proposed population level. It is also possible that a separate but smaller population exists north of the Susitna which may increase to fill the available range in that area even if the existing Nelchina population were confined to the area south of the proposed impoundments.

Procedures: Caribou on both sides of the Susitna River will be radiocollared during the breeding season. Monitoring flights will be made at a relatively low intensity (approximately monthly) throughout most of the year to determine if more than one population exists in the area and to determine seasonal ranges of each population identified. More intensive monitoring flights will be made during the periods of precalving and postcalving movements and winter shift to determine present migration routes and the timing of migration. It will be necessary to repeat this procedure for several years to determine variation among years.

Traditional migration routes will be determined by mapping trails and will be compared with present routes.

Potential alternative ranges will be identified and evaluated using the modified Hult Surlander method of range analysis. These ranges will be compared with Nelchina ranges that have been studied for a number of years.

Schedule:

FY 79	Radio collar caribou, monitor movements. Conduct range analysis.
FY 80	Replace inoperative radios, monitor movements.
FY 81	Replace inoperative radios, monitor movements.
FY 82	Replace inoperative radios, monitor movements.
FY 83	Monitor movements. Repeat range analysis to determine trends.

Cost:

FY 79	\$120,000
FY 80	\$ 95,000
FY 81	\$ 95,000
FY 82	\$ 95,000
FY 83	\$102,000

Title: Effects of the Susitna Hydropower Project on wolves.

Objectives: To determine the number of wolf packs and the number of wolves in each pack that inhabit areas to be directly affected by the Susitna Hydropower Project.

To determine the proportions of each pack's territory that lies within areas of impact.

To determine the location of dens, rendezvous sites, hunting areas and the other essential activity areas of each pack in relation to proposed impoundments and construction activities.

To determine the dependence of each pack on prey populations that may be adversely affected by the Project.

Background: Wolves are of considerable national concern as evidenced by recent newspaper and magazine articles. They are known to inhabit the entire project area and information on population size and movements is needed to determine project impacts.

Studies in other areas of southcentral Alaska have demonstrated that some wolves have home ranges as large as 2,000 square miles while many packs have territories ranging from 200 to 600 square miles. It is known that the immediate project area may contain five or more wolf packs. It appears that some of these packs use the Susitna River as a territory boundary, and inundation and associated development could have a dramatic influence on them. These packs depend heavily on moose populations that use the impoundment areas. In addition other studies have shown that any human disturbance relatively close to a wolf den may cause abandonment of the traditional site and perhaps reproductive failure.

Procedures: Two to four wolves will be radio collared in each pack whose territory is believed to include potential impoundment areas and construction sites. The numbers of wolves in each pack will be determined, each pack's territory will be delineated and the degree and nature of use of potential impact areas will be determined through repeated relocations and observation of activities. Specifically, all den sites, rendezvous sites and favored hunting areas will be mapped. These data will be used to determine the degree of dependence of wolves on various areas that will be impacted by the Project.

Dependency on various prey species will be determined by scat analysis and observation of hunting behavior and kills. This information will be used in conjunction with data from the accompanying studies of prey species, particularly the moose study, to estimate indirect impacts on wolves caused by a reduction in prey availability.

Field activities and manpower for this study will be integrated with the moose study. Wolves frequently will be tagged and relocated at the same time as moose. Full funding of the moose study is required for the successful implementation of this study.

Schedule:

FY 78	Radiocollar wolves, monitoring flights.
FY 79	Replace lost radios, monitoring flights.
FY 80	Replace lost radios, monitoring flights.
FY 81	Radiocollar new wolves to fill data gaps. Monitoring flights.
FY 82	Monitoring flights.
FY 83	Monitoring flights.

Cost:

FY 78	\$55,000
FY 79	\$36,000
FY 80	\$29,000
FY 81	\$40,000
FY 82	\$25,000
FY 83	\$13,000

Title: Effects of the Susitna Hydropower Project on black and brown/grizzly bears.

Objectives: To estimate the numbers of black and brown/grizzly bears using the area to be impacted by the Susitna Hydropower Project.

To determine the dependency of these bears on areas to be impacted, with emphasis on identification of denning areas and seasonal feeding areas.

Background: Very little is known of either brown or black bear populations in the Susitna Basin except that brown bear densities appear to have been very high for several years. We do not know how many bears inhabit the area or how dependent they are on the impoundment areas. Studies should be conducted to estimate bear numbers in and surrounding project area, determine whether the same bears are resident or whether a larger number have a seasonal dependency on the area, and determine the location and extent of denning activities.

A major problem with any large construction project is the attraction of bears to camps and construction sites. This usually results in threats to human safety, delays in construction and destruction of bears. If areas of bear concentration can be identified and avoided during construction, these problems can be substantially reduced.

Procedures: Bears will be radiocollared in the project area. Movements in and around the area will be monitored. Den sites and concentration areas will be mapped.

Bear numbers will be estimated through marked/unmarked ratios observed during spring and fall composition counts and by recording all bears seen during tracking flights.

Field activities for this study will be closely integrated with those for the moose and wolf studies. Full funding of the moose study is required for the successful implementation of this study.

Schedule:

FY 79	Radiocollar bears, monitoring flights composition counts.
FY 80	Monitoring flights, composition counts.
FY 81	Monitoring flights, composition counts.
FY 82	Monitoring flights.

Cost:

FY 79	\$95,000
FY 80	\$57,000
FY 81	\$50,000
FY 82	\$35,000

Title: Effects of the Susitna Hydropower Project on wolverine.

Objectives: To determine the population status of wolverines using areas to be impacted by the Susitna Hydropower Project.

To determine movement patterns and identify habitats of seasonal importance to wolverines.

Background: Less is known about the wolverine than any other big game species in Alaska. Threatened with extinction throughout most of its range in the Scandinavian countries, parts of Russia, the continental United States and Eastern Canada, it is still considered relatively abundant in Alaska. Studies in Idaho and Sweden indicate that wolverines have exceptionally large home ranges. Records of males moving 15 miles in a 24 hour period are not uncommon.

The Talkeetna mountains on either side of the Susitna River between Gold Creek and the MacLaren River presently support a healthy population of wolverines. Although their density is not known at this time, it is probably as high or higher there than in any other portion of their range in Southcentral Alaska. Because the welfare of this species in Alaska is of both national and international concern, some intensive efforts to determine the status, distribution, and movement patterns of wolverine in the project area are warranted.

Procedures: A limited number of wolverines will be radiocollared and tracked in conjunction with other telemetry studies in the area. Home ranges, movement patterns, and seasonal habitat use will be determined by systematic relocation of radiocollared animals.

A systematic aerial survey of wolverines and their tracks will be made in conjunction with wolf studies to determine the distribution and numbers of wolverines using the area.

These data will be used to estimate the number of wolverines using the impoundment areas, determine the degree of dependency of certain wolverines on those areas and identify specific areas of importance to wolverines.

Schedule:

FY 79	Radiocollar, monitoring flights, census.
FY 80	Radiocollar, monitoring flights, census.
FY 81	Monitoring flights.

Cost:

FY 79	\$30,000
FY 80	\$25,000
FY 81	\$10,000

Title: Distribution and status of Dall sheep adjacent to the Susitna Hydropower Project area.

Objectives: To determine the numbers of Dall sheep inhabiting mountains adjacent to proposed dam sites.

To delineate the seasonal ranges of the sheep population.

Background: A relatively isolated sheep population inhabits mountains adjacent to the proposed dam sites. While there will probably be little direct impact on this population by the proposed project, there is a possibility of adverse impacts from human disturbance as a result of dam construction activities and increased access.

Procedures: Aerial surveys will be conducted to determine the size of the sheep population and to delineate seasonal ranges.

Schedule:

FY 79	Aerial surveys.
FY 80	Aerial surveys.
FY 81	Aerial surveys.

Cost:

FY 79	\$3,000
FY 80	\$3,000
FY 81	\$1,000

Title: Distribution and abundance of furbearers and small game in the proposed Susitna Hydropower Project impoundment areas.

Objectives: To determine the distribution and relative abundance of furbearers and small game in the proposed impoundment areas and determine the degree of use of those species by humans.

To determine the dependence of furbearers and waterfowl on downstream habitats which will be altered by changes in water flow.

Background: Little is known about the distribution and abundance of either furbearers or small game. In order to assess the potential impact of the project on small game it will be necessary to conduct a basic biological reconnaissance. It is known from data collected incidentally to other projects that the Susitna River Basin provides habitat for large numbers of fox, wolverine, and river otter. All three of these species are highly sought by trappers.

Stabilization of water flow could substantially alter aquatic furbearers and waterfowl habitat downstream.

Procedures: Limited aerial surveys will be conducted to determine the presence, distribution and relative abundance of fox, otters, beavers, ptarmigan, waterfowl and raptors. On the ground observations will be made in conjunction with the nongame project.

Trappers and residents of the area will be interviewed.

Surveys of aquatic furbearers and waterfowl will be conducted in downstream areas of probable habitat alteration that will be identified by studies on the effects of water flow on habitat.

Schedule:

FY 79	Surveys in impoundment areas, interviews.
FY 80	Surveys in impoundment areas, interviews.
FY 82	Surveys downstream.
FY 83	Surveys downstream.

Cost:

FY 79	\$35,000
FY 80	\$35,000
FY 82	\$25,000
FY 83	\$25,000

Title: Distribution and abundance of nongame species of wildlife in the area to be impacted by the Susitna Hydropower Project.

Objectives: To determine the occurrence, distribution and relative abundance of small mammals and passerine birds in the proposed impoundment areas.

Background: Little is known about the occurrence, distribution or abundance of small mammals and both resident and migratory passerine birds in the Project impact area. A limited reconnaissance should be conducted.

Procedures: A literature search will be conducted. Surveys from the ground will be made and limited trapping will be done. Portions of this study will be coordinated with small game and furbearer studies.

Schedule:

FY 79	Literature search, initiate surveys.
FY 80	Complete surveys.

Cost:

FY 79	\$7,000
FY 80	\$8,000

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**THE DISTRIBUTION AND MOVEMENT
PATTERNS OF CARIBOU IN ALASKA**

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**State of Alaska
William A. Egan
Governor**

**Department of Fish and Game
Wallace H. Noerenberg
Commissioner**

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Frank Jones
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**Alaska Department of Fish and Game
Game Technical Bulletin No. 1
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an evaluation
of the
ISER electricity demand forecast

July 30, 1980

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In December 1979, Energy Probe was awarded a contract by The House Power Alternatives Study Committee of The Alaska State Legislature to examine and evaluate an electricity demand forecasting model being developed by The University of Alaska's Institute of Social and Economic Research (ISER).

Energy Probe's work, along with research carried out by several other consultants retained by The Power Alternatives Study Committee was intended to provide a framework within which the proposed Susitna Hydroelectric Power Development could be evaluated. A working paper published in January 1980 presented an initial evaluation of the ISER model, primarily on the basis of ISER's "Detailed Work Plan".

The following is the final report prepared under Energy Probe's contract. It presents an evaluation of the ISER demand forecasting model in its present form; tests the sensitivity of Railbelt electricity demand to changes in various policy and technological factors; and outlines what the authors believe to be the appropriate interpretation and application of the forecast within the broader context of State energy policy development.

The views and conclusions presented herein are those of the authors alone, and do not necessarily reflect the position of The House Power Alternatives Study Committee.

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APPENDIX A-1

1. INTRODUCTION

The electricity demand forecasting model developed by the Institute for Social and Economic Research (ISER) is a major step forward for Alaskan energy planning. The ISER model is of a quality which is orders of magnitude ahead of previous forecasting models employed in the State.

This report seeks to accomplish three tasks. The first of these is an introduction to the structure and logic of the ISER model aimed at a non-technical audience. The second is a technical review of the ISER model with a focus on the methods employed and areas for further development. The third is a demonstration of the use of the model in documenting the effects of alternative energy policy assumptions on the model's output.

By far the most important of these is the third. Since Alaska's electricity future is not fixed but rather subject to both fate and policy intervention it is important to appreciate that any forecast depends on assumptions concerning factors which can and cannot be controlled.

On the fate side of the ledger are all those factors which are beyond the control of Alaskans. These include national economic policy to the extent that it sets the tone for state economic and social development and, more importantly, the future of resource discovery and exploitation in Alaska.

Manageable factors include the ways in which Alaskans actually use the energy which is available to them - whether they use it efficiently or inefficiently. A very clear example of the "manageability" of these factors is the recent energy conservation legislation which will undoubtedly influence energy use in the State.

Planning is a process by which those factors which are controllable are identified and managed to bring about a desirable future. In addition, planning seeks to identify items subject to fate to adequately prepare for the realization of a range of possible outcomes. A forecasting model is nothing other than an aid to clear thinking in this complex situation. A good forecasting model should be able to accommodate both controllable and non-controllable factors and progress logically to actual numeric forecasts. On this count the ISER model is exemplary.

In any forecasting environment assumptions are crucial; to the extent that they are hidden there is no clear link between policy and actual outcomes. To the extent that they are open and accessible they are the basis for analysis and action. On this count as well, the ISER model is excellent. Assumptions are clearly stated and readily changed. When the model is ultimately computerized the latter will become even easier and the model even more useful.

But what is most important to realize is that the ISER model is only a tool. Alaskans do to a large extent have control over many aspects of their energy future. In an appropriate planning environment, the ISER model can be utilized to suggest means of making that future more desirable.

2. A USER'S GUIDE TO THE ISER FORECASTING MODEL

2.1 Introduction

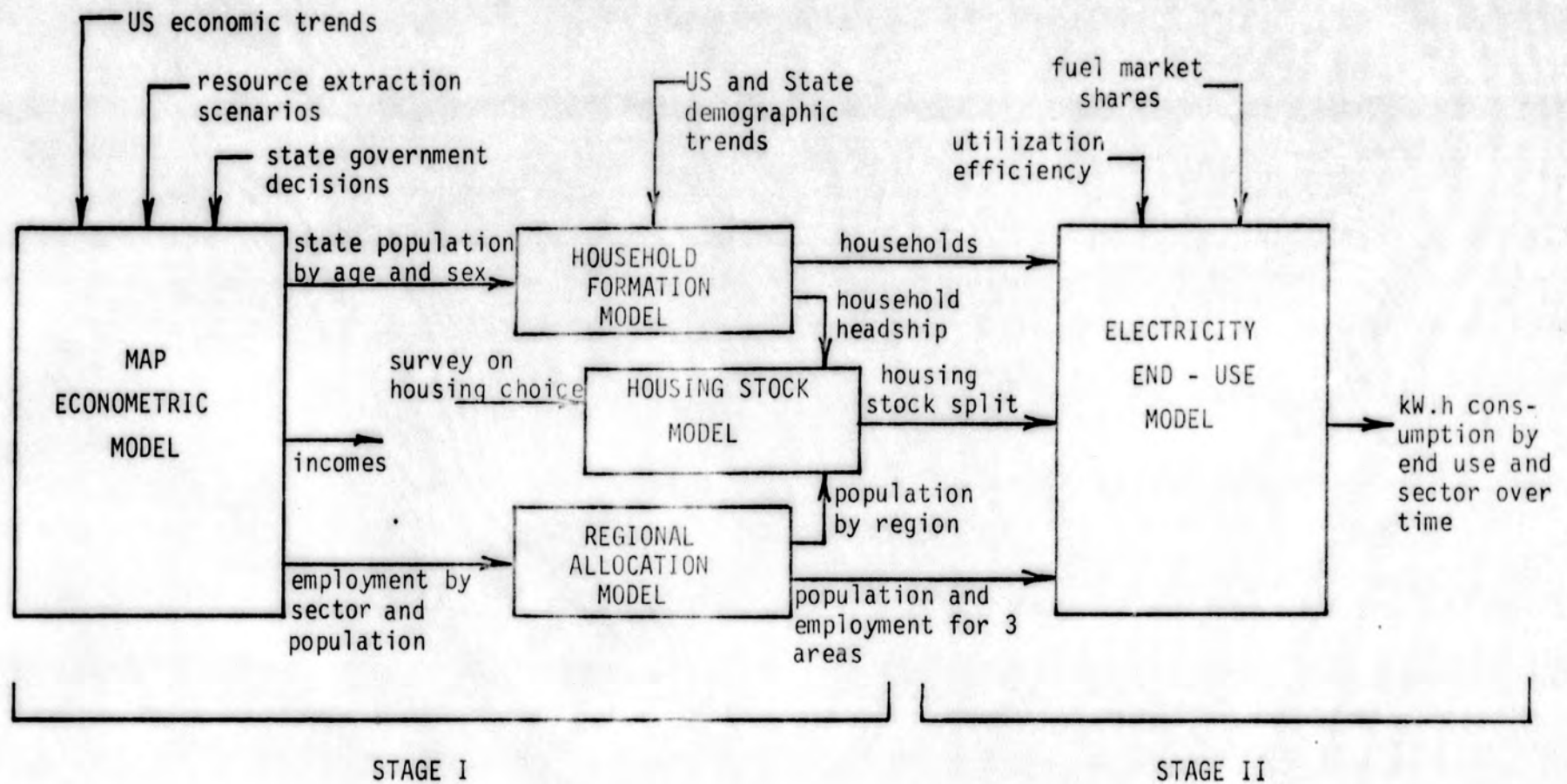
The ISER electricity demand forecasting model, while seemingly complex, has a very straightforward and logical structure and flow of information between components. The output of the model is projected values of electricity consumption for each of the three geographical areas of the Railbelt classified by final use (i.e. heating, lighting, etc.) and consuming sector (commercial, residential, etc.). In its current form the ISER model produces values for the years 1985, 1990, 1995, 2000, 2005 and 2010.

To accomplish this task the model relies on five specialized sub-models linked by key variables and driven by policy and technical assumptions and state and national trends. A flow diagram showing the sub-models and their linking and driving variables is given in Figure 2.1 below. Of the five sub-models, only the MAP econometric model was in existence prior to the Railbelt study; the remaining four were developed by ISER during the course of the study.

2.2 Stage I Components

In our earlier working paper (contained as the appendix to this report) we argued that the electricity demand forecasting process was essentially two-stage. In Stage I, basic

Figure 2.1: A Schematic of the ISER Electricity Demand Forecast



economic and demographic information is developed as input to an electricity demand model which we called Stage II. The final ISER model has this basic structure with the MAP, household formation, housing stock, and regional allocation models performing the Stage I function and the electricity end use models in the Stage II role.

2.2.1 The MAP Econometric Model

The basis of the Stage I function in the ISER model is MAP, a medium size econometric model which translates forecasted or assumed levels of national economic trends, state government activity, and developments in the Alaska resource sector into forecasted levels of statewide population by age and sex, employment by industrial sector, and income. While the MAP model is internally complex, its basic logic is that the State of Alaska will tend to follow national trends in economic development yet will deviate somewhat with resource sector and state government activity. These will cause the state to perform somewhat better or worse than the Outside. In periods of plenty, Alaska will attract immigrants seeking employment opportunities; in periods of relatively poor economic performance, people will tend to leave the State to seek opportunities in the lower-48.

As a result of this basic logic, MAP's output is quite sensitive to the national trends, resource activity, and state government actions assumed as input. Since MAP inputs directly

into the electricity end use model, the final results of the forecasting process are equally sensitive to these crucial assumptions.

MAP's output, while technically quite reasonable, is not appropriate for direct input into the electricity model for two reasons. The first of these is that MAP produces forecasts for the entire state of which the Railbelt and its component areas are only a part, albeit an important one. Secondly, electricity consumption is more closely related to households and the number of housing units than to the number of individuals in the market area; MAP produces only the latter. The household formation, housing stock, and regional allocation models translate MAP output into final Stage I form.

2.2.2 The Household Formation Model

The household formation model groups individuals into household units on the basis of national and state demographic trends. The basic logic of this model is that an individual has a finite chance of being a household head; the probability of headship depends on the individual's age and sex. Applying these probabilities to MAP's output yields the number of households, a critical input into the electricity end use model, and the number of household heads by age and sex, an input into the housing stock model.

2.2.3 The Regional Allocation Model

The purpose of the regional allocation model is to allocate MAP's statewide forecasts of population to the regions of the Railbelt. The inherent logic of this model is that regional population shares are sensitive to employment opportunities in the various regions. These opportunities in turn depend on which industrial sector is predominant in the MAP forecast, and its likely location. The regional allocation model ultimately disaggregates MAP's statewide forecasts of employment and population into regional shares. This information serves as input into both the housing stock model and the electricity end use model.

2.2.4 The Housing Stock Model

Because heating of residences is an important use of electricity in the Railbelt; and because there are a number of different types of housing available (single family, duplex, apartments and mobile homes) it is necessary to forecast the numbers of each type of dwelling unit in each of the Railbelt regions. This task is accomplished in the housing stock model which combines the household headship information from the household formation model, the regional population information from the regional allocation model, and the results of an independent survey on housing choice, to produce the number of housing units by type and region for each of the forecast years.

The logic of the housing stock model is quite similar to that of the household formation model. After combining the household and population information to produce the number of households per region over the forecast period, the information on housing choice is applied to assign each household to a dwelling. The assignment is based on the probability that a household head of a particular age and sex will choose to live in either a single family, duplex, apartment or mobile housing unit. The housing stock model thus produces the last crucial item of Stage I information, namely, the number of housing units by type and region over the forecast period.

2.2.5 Stage I Summary

In summary, the Stage I portion of the electricity demand forecasting process is handled in the ISER model by MAP, the household formation model, the regional allocation model, and the housing stock model. MAP produces forecasts of statewide employment, population and income on the basis of national economic trends, activity in the Alaska resource sector, and state government policy. The household formation model groups individuals into household units on the basis of state and national demographic trends. The regional allocation model assigns a portion of statewide population and employment to the regions of the Railbelt on the basis of the location of projected economic activity. The housing stock model produces forecasted counts of dwelling units by type on the basis of the output of the household formation model, the regional allocation

model, and a survey of housing choices.

The regionally disaggregated employment, population and housing information is then passed forward to the electricity end use model for translation into projected requirements for electricity in the Railbelt.

Assumptions play a central role in determining the overall output of the Stage I part of ISER's model. While the most important of these are national economic trends, resource sector activities, and state government decisions which drive MAP, there are in addition national and state demographic trends and housing choice information which ultimately influence electricity consumption forecasts for space and water heating, and for other residential uses. Critical among these are the assumptions which lead to projections of household size: should these prove incorrect, or for that matter, should any assumption in the model prove incorrect, then the forecast as a whole becomes somewhat suspect.

2.3 Stage II: The Electricity End Use Model

The ISER electricity end use model translates the Stage I output into estimates of the final demand for electricity for each region and consuming sector in the Railbelt. The basic logic of virtually all components of ISER's Stage II model is that electricity is used in identifiable activities such as cooking, heating a building, etc. Each activity has an observed

electricity "intensity", that is, a quantity of electrical energy required to fuel a single unit of the activity in question. Further, these intensities are subject to change over time. Combining this information with the output of Stage I, which projects the magnitude of specific activities over the forecast period, yields projections of electricity requirements for each activity in each region. These may be summed to give final forecast estimates.

Consider, for example, the activity of refrigeration. In 1980, a "typical" refrigerator in the Railbelt used about 1250 kWh per year. Over time this average intensity changes as older, smaller, manual-defrost models are replaced by newer, larger, frost-free units. Suppose, hypothetically, that a typical refrigerator in service in the year 1995 uses 1800 kWh annually as a result of fifteen years of replacement of worn out units with new large units and purchases of new units by newly formed households. If there are, say, 15,000 households forecasted to be located in the Fairbanks region in 1995 then the total energy requirement for refrigeration in Fairbanks in 1995 is $1800 \text{ kWh} \times 15,000 \text{ households}$, or 27,000,000 kWh, assuming that each household has a refrigerator.

In actual fact, the ISER method does not work this way mechanically; however, logically and mathematically ISER's model follows this basic procedure for nearly all activities.

2.3.1 The Residential Sector

In the residential sector, ISER has identified seventeen separate activities for analysis. These are:

1. heating a single family home
2. heating a duplex
3. heating a multi-family unit
4. heating a mobile home
5. powering a water heater for general hot water needs
6. powering a water heater for hot water input into a dishwasher
7. powering a water heater for hot water input into a washing machine
8. powering an electric range
9. powering a clothes dryer
10. powering a refrigerator
11. powering a freezer
12. powering a television set
13. powering an air conditioner
14. powering a dishwasher exclusive of hot water needs
15. powering a washing machine exclusive of hot water needs
16. powering lights
17. powering small, unspecified appliances

In the model, activities 5 through 15 are treated similarly as they relate to energy for large appliances. Activities 1 through 4 are also similar as they deal with space heating. Activities 16 and 17 are dealt with as special cases.

In space heating, the basic unit of analysis is the individual heating plant of the dwelling unit. For an electrically heated dwelling unit this means either an electric furnace, a collection of baseboard or ceiling resistance units, or an electric heat pump. ISER has assumed the latter to be insignificant over the forecast period. Heating plants are classified according to their "vintage", that is, their period of installation. There are seven vintages of heating units,

pre-1980, 1981 - 85, 1986 - 90, and so on.

Each vintage of heating plant has its own average electricity requirement which is based on the size, construction, and "retrofit" potential of the dwelling unit into which it was originally installed. For units built in 1980 and before, average consumption is simply the observed consumption of existing units with no conservation or retrofit over time. For new units, average consumption is the product of four terms: a base consumption level, a housing unit size coefficient, a conservation coefficient, and a retrofit coefficient. The base level gives the consumption of a typical electric unit currently being produced. The size coefficient factors this up over time to account for increasing dwelling unit sizes. The conservation coefficient factors the product down to account for improved heating techniques; and the retrofit factor further reduces this product to account for improvements to the dwelling unit's efficiency over the life of the heating plant. The average consumption of an electric heating plant can, therefore, increase or decrease with newer vintages depending on the assumptions made concerning base level consumption and the relative strengths of conservation and retrofit as opposed to increasing unit size.

Heating plants in the ISER model wear out over time, according to an expected lifetime schedule. A heating plant has an explicit probability of "surviving" from one forecast year to the next, which depends on the age of the heating unit.

For example, the probability that a heating plant installed in 1980 will still be in service in 1985 is much higher than the probability that a heating plant installed in 1980 will be in service in the year 2000.

When a heating plant "dies", the model assumes that, in effect, the housing unit dies with it. The heating unit is replaced with either an electric or non-electric heating plant according to specified probabilities of "capture" which run on the order of 9:1 in favour of non-electric units. If an electric heating plant is chosen, it is of the average consumption appropriate to the vintage of the replacement period. This assumes for all intents and purposes that either the dwelling unit itself is replaced with a new unit or that the dwelling undergoes major alterations to increase its size to approximate that of currently produced units.

There is a logic problem in this case which will be discussed in our technical review. Basically, the problem is that the replacement of electric units by non-electric units is likely overstated as is the alleged "growth" of units which switch from one electric heating plant to another in a particular period. In terms of electricity requirements, these tend to offset one another, to an unknown extent. We will assume that they offset one another exactly for the purposes of our subsequent analysis; however, we strongly recommend that the space heating section of the ISER model be reformulated in terms of dwellings rather than heating plants to more accurately

reflect reality.

In operation the ISER electricity end use model accepts as input the number of dwelling units by type from the housing stock model of Stage I and works recursively through the forecast period by vintage. For a given forecast year, the difference between housing units required and those "surviving" from previous periods constitute new housing starts. The number of these which are electric is multiplied by the average consumption of electric units of the new vintage; together with the total consumption of previously built electric units this gives electric space heating requirements for the forecast year.

Assumptions again are critical at this stage in the model. The most important are the relative effects of increasing size as compared to conservation and retrofit potential; additionally, the relative "capture" of electric as opposed to oil or gas heating is quite important.

For major appliances, the ISER electricity end use model follows a structure similar to that of the space heating segment. Each appliance is classified according to its vintage; for each vintage the average consumption is computed as the product of base level consumption, a size factor and a conservation factor. The appliances follow a survival schedule similar to that of heating plants; the number of appliances of a particular type in service at a point in time is the number

of households times the probability that a household will own the appliance. In some cases, this probability is close to 1 already; for others it is more modest but is assumed to grow over the forecast period.

General water heating, for purposes other than clothes or dishwashing is adjusted downward to account for diminishing household size. Where alternative fuels exist, an explicit assumption is introduced to determine the electrical share.

Operationally, the model determines required additions to the appliance stock by subtracting required stock in a forecast year from "surviving" units from previous periods. As in the space heating model, the total energy consumption is the sum of the numbers of units of each vintage multiplied by the appropriate energy intensity per unit.

The remaining activities in the residential sector are lighting and powering small appliances. The ISER model assumes a constant electricity requirement of 1000 kWh per unit annually for lighting. This level is assumed constant over the forecast period with increasing lighting requirements arising from increased dwelling size offset by conservation and technical improvements in the efficiency of lighting devices. Small appliances begin with a base requirement (in Anchorage, this is 1010 kWh per year per housing unit), and grow by a constant amount in each five year forecast period to accommodate expanded use of existing small devices as well as the use of

new small appliances which may come into service over the forecast period.

In summary, the residential portion of ISER's electricity end use model operates on seventeen identifiable activities. With the exception of lighting and small appliances, the model works with discrete vintages of consuming devices. It introduces explicit assumptions about the energy intensity and survival characteristics of each device and vintage and calculates the numbers of each vintage in service on the basis of output of the Stage I process, and, where appropriate, explicit assumptions about electricity's share and the proportion of households owning a particular energy using device.

2.3.2 The Commercial-Industrial-Government Sector

Because of data shortages the ISER electricity end use model is rather thin in the CIG sector. While there are certainly as many specific activities using electricity in this sector as in the residential sector, they are unknown at the present time. Consequently, the ISER model takes a "second best" approach to modelling electricity requirements for the CIG sector.

In the CIG portion of the end use model there is effectively only one activity, providing all the electricity required for a CIG employee to carry out his or her job. Included, or

rather subsumed by this classification are lighting, heating, equipment operation, and all of the other activities specific to employment.

The CIG portion of the model employs a structure similar to that of heating and major appliances in the residential sector. Jobs are of one of seven vintages, depending on their creation date which is in turn related to the estimates of employment originating in the MAP model and allocated to regions by the regional allocation model. The basic logic is that the energy intensity of a particular job depends on the technology in place at the time of its creation; the job maintains essentially the same energy intensity over the forecast period although conservation may be factored in over time.

Explicit assumptions about per job energy intensities are a central feature of the CIG portion of the model; in ISER's forecast these are projected to grow nearly three-fold over the forecast period. Jobs created in the 2005 - 2010 period require about 30,000 kWh per year in the Anchorage region as compared to about 10,000 kWh per year for jobs created before 1980.

Operationally, the CIG model is virtually identical to the residential model except that it is driven by employment rather than the number of households. For a given forecast year, employment growth is calculated by subtracting

existing employment from total employment. Energy intensities specific to the respective "vintages" of jobs are applied and the results summed to give overall CIG electricity requirements.

Because of the aggregate nature of CIG activity in the model, it is virtually impossible to identify all the assumptions upon which it is based. The actual parameters used in the forecast indicate that ISER was quite conservative in working with this portion of the model; a large amount of electricity growth per employee is foreseen. However, it is not clear in which of the specific activities of employment the growth is to occur.

2.3.3 Stage II Summary

The Stage II function of the ISER forecast method accepts input from Stage I and translates this information into detailed projections of electricity requirements for each region of the Railbelt. The electricity end use model developed by ISER identified 18 electricity using activities, of which 17 are in the residential sector and 1 in the commercial-industrial-government sector. The model forecasts on the basis of the vintages of consuming devices. Explicit assumptions regarding numbers of devices in operation, energy intensity, and electricity's share of the fuel market are introduced where appropriate.

3. A TECHNICAL REVIEW OF THE ISER FORECASTING METHOD

3.1 Introduction

Prior to the development of ISER's electricity forecasting model, both ISER and Energy Probe agreed that the goal of ISER's research should be the development of an "econometric end-use" (EEU) forecasting model. The name is derived from econometric methods, which employ statistical techniques to estimate the effects of price, income, and other pertinent factors on demand, employment, or population change, and end-use methods, which seek to explain energy use according to its final use.

The EEU approach is rapidly gaining wide acceptance in the electric utility industry as the most sensible approach to the increasingly difficult task of demand forecasting. As mentioned in our working paper, EEU is a means to combine engineering information on final electricity usage with economic information which governs consumer choice.

In an ideal EEU model, not only would basic economic and demographic variables be modelled and forecasted econometrically, so too would information on devices which transform electricity into useful work. The number of appliances, for example, would depend on not only the number of households in a given period,

but also on the current levels of energy and other prices, incomes, and even state fiscal policies.

The disadvantage of pure EEU is that it is extremely data-intensive. This proved most telling for ISER's research; a basic scarcity of data rendered EEU impracticable for Alaska at this time. Consequently, ISER opted for a "next best" strategy which combined an econometric model, MAP, with four new non-econometric models to produce the required forecast.

3.2 MAP

The basis of the ISER electricity forecasting model is MAP, a medium-size econometric model of the State of Alaska. MAP is appropriate for a large role in electricity forecasting because it was designed to deal with different possible events in the resource sector and different possible policies for state finance.

Technically, MAP is quite good, as we argued in our earlier Working Paper. It produces statewide forecasts of employment and population by age and sex on the basis of state and national trends and resource and state government activities. Unfortunately, MAP's output is not directly applicable to electricity forecasting for the Railbelt and we made a number of recommendations on improving this situation, the majority of which have been imple-

mented by ISER in their subsequent work.

3.3 The Household Formation Model

We recommended that the demographic data output of MAP be expanded to include the number of households by age of head to complement MAP's population by age and sex. This was carried out by the addition of the household formation model.

The household formation model is an adequately developed method of accounting for households but relies only on demographic analysis for its aggregation of individuals; no economic activities modelled in MAP affect household formation.

3.4 The Regional Allocation Model

Since MAP produces statewide estimates of economic and demographic variables another required change was to distribute to Greater Anchorage, Fairbanks, and Glenallen-Valdez appropriate shares of statewide activity. The regional allocation model was developed to meet this requirement. This is extremely important because resource development projects used in projections of statewide activity could shift population and economic growth regionally within the state and even within the Railbelt.

The forecasting model must be capable of accommodating the possibility of a remote oil discovery leading to the expansion of communities outside the Railbelt grid, for example. Other scenarios might include projects which have a differential impact on the three Railbelt regions.

The ISER approach to this problem is acceptable. It appears to be a precise statistical allocation of regional activity based on resource sector employment and other factors. However, there has been so little variation in the regional proportions of activity in the years for which data is available that the regional allocation model has not been thoroughly tested.

While likely not as precise as it appears, the regional allocation model is adequate in the context of the present study; much more development would be required to adequately handle unusually-located resource projects or to expand the study area to other regions of Alaska.

3.5 The Housing Stock Model

The housing stock model is the final bridge between MAP and the electricity end use model. The most important aspect of this model is the projection of the relative proportions of single family, duplex, apartment, and mobile units.

Like the household formation model, the housing stock model is based only on demographic factors and not on the economic output of MAP. Because of the lack of year-by-year housing data it is not possible to relate housing stock to construction activity, interest rates, and other influential variables which would clearly be desirable.

While the necessary data is missing it is possible to recreate it in the future on the basis of aerial photography, utility hookups, housing sales, and building permit activity. We strongly recommend this be done in future improvements to the ISER model.

3.6 The Electricity End Use Model - Residential Sector

The residential part of the end use model applies information on heating plant, appliance ownership, housing heating efficiency, and their changes over time to forecasts of households and housing units. The numerous ways in which this allows the analyst to examine the impact of alternative policy options is admirable; the detailed calculation process allows for changes in virtually any aspect of residential electricity consumption patterns.

A major problem in the model is the apparent confusion between housing stock attrition, which is not in the model but should be, and heating plant attrition, which is in the model but overly emphasized. Essentially, the rate of heating plant attrition is

quite high, given that the heating units of concern are electric and consequently last indefinitely given repairs to small components.

The model should allow for a very slow loss of actual dwellings, especially mobile homes, and for a somewhat faster loss of heating plants to newer and more efficient designs. Consequently, the particular numerical values used by ISER which simultaneously understate attrition of buildings and overstate retrofit are open to question.

3.7 The Electricity End Use Model - CIG Sector

The commercial sector end use model is quite undeveloped and sparse in comparison to the residential model. Originally, ISER had intended to build the model on the basis of floor space in commercial, industrial, and government buildings with a very modest breakdown by type of activity. In the final analysis, employment was used as the benchmark for electricity use projections.

This is adequate for the present study but is difficult to interpret as end use analysis as no physical efficiency changes can be directly related per employee energy use. Clearly, a model based on physical attributes of structures, such as floor area, would be easier to relate directly to energy use.

Furthermore, the final results reflect no breakdown of commercial-industrial, government into sectors; and breakdowns published by ISER were generated by across-the-board allocations of final consumption.

The most important problem in the CIG forecast is that the per-employee energy consumption figures are based on 1973-78 changes in consumption per CIG customer, i.e. store, factory, etc. While these two years avoid the highest point in the pipeline boom which might exaggerate energy use, the 1978 figure may have been pushed up by the practices of the boom years (uninsulated buildings, lights on constantly, etc.) This may be an important biasing figure when translated forward into per employee values for future periods.

Alaska's recent energy conservation legislation offers the strong possibility that a significant number of energy audits of residential and CIG customers will be carried out. The audits offer a prime opportunity to build a better data base which includes information on the physical characteristics of buildings. In the mean time, a close scrutiny of actual CIG electricity sales should offer a check on ISER's assumptions and should reveal whether the potential biases suggested above are in operation.

Eventually, more detail of the CIG sector must be built into the model. At the very least, information on principal activity, size of establishment, and region must be included. As we will note in the following section, the actual CIG forecast produced by ISER appears to be based on overly-rapid increases in energy use per employee in an era of growing energy awareness.

3.8 Summary

In summary, the ISER method is a major improvement over any other forecast methods which, to our knowledge, have been used in Alaska. It is a two part process with the Stage I model (MAP plus household formation, regional allocation, and housing stock extensions) feeding information on future households, employment, and housing stock into an electricity end-use model. The latter features an adequately comprehensive residential component but an underdeveloped commercial portion.

4. AN ANALYSIS OF THE ISER MODEL OUTPUT

4.1 Introduction

As indicated above, the ISER model forecasts Railbelt electricity consumption in terms of energy (or MWh) by end use and consuming sector, for each of the Railbelt's three divisions, for the years 1985, 1990, 1995, ..., 2010, and for each of three economic scenarios (which attempt to capture a reasonable range of economic development possibilities). Of the three economic scenarios - low, moderate and high economic growth - ISER considers the moderate case to be the "most probable". A summary of aggregate Railbelt electricity growth for each of these three scenarios is presented in Figure 4.1 following:

Figure 4.1: Summary of ISER Electricity Projections			
	<u>Low</u>	<u>Moderate</u>	<u>High</u>
1985	2921 (GWh)	3171	3561
1990	3236	3599	4282
1995	3976	4601	5789
2000	5101	5730	7192
2005	5617	6742	9177
2010	6179	7952	11736
<u>Annual Growth (%)</u>			
1980-1990	3.08	4.18	6.00
1990-2000	4.66	4.76	5.32
2000-2010	1.94	3.33	5.02
<u>Average Annual Growth 1980-2010 (%)</u>			
	3.22	4.09	5.45

While ISER has considered and calculated the impacts on electricity demand of various economic scenarios, it has held constant through all its electricity demand projections its electricity end use assumptions, with the exception of the "moderate economic growth/shift to electricity" case. Because forecasts of electricity demand are highly sensitive to these end use assumptions, it is worth noting both the assumptions utilized in the ISER model, and the manner in which they were incorporated into the forecasts.

In summary, the following general assumptions have been utilized in ISER's end use calculations:

1. The electricity market is presently in relative equilibrium, except for space heating in Fairbanks, where a shift away from electric space heating is underway.
2. This equilibrium is expected to remain in effect throughout the forecast period because of relatively constant fuel price ratios.
3. The price of energy relative to other goods and services will continue to rise.
4. Rising real incomes will act to increase the demand for electricity.
5. Federal policies will be effective in the area of appliance energy conservation, but will have a much

smaller impact on building stock efficiencies.

6. No state conservation policies directed exclusively toward electricity will be implemented.
7. No significant state policies designed to alter the price or availability of alternative fuels are implemented.
8. No new electricity technologies will be introduced.
9. In terms of residential appliances:
 - (a) saturation rates will track national trends;
 - (b) for some appliances, reduced household size will act to reduce average electricity requirements;
 - (c) consumption is sensitive to the appliance scrapping rate;
 - (d) unspecified appliance consumption grows in order to accommodate the possibility of new domestic electricity applications.
10. In terms of residential space heating:
 - (a) a slight trend toward single family homes is projected;
 - (b) average housing unit size continues to grow;
 - (c) natural gas availability will not significantly increase;
 - (d) space heating alternatives such as oil, wood or coal will not greatly affect aggregate space heating demand;

(e) no significant increase in heat pumps occurs.

11. In terms of commercial-industrial-government use:

- (a) employment will grow more rapidly than the population;
- (b) no major conservation measures are anticipated;
- (c) the distribution of electricity end uses will not shift significantly.

12. Miscellaneous utility sales (street lighting and second home use) will grow at rates consistent with overall utility sales.

These assumptions enter the end use model through a series of calculations, as documented in the "User's Guide" section of this report.

Although ISER contends that these end use assumptions are "probable", we argue that in some cases they are unlikely, i.e. they indicate a growth rate in electricity demand which we believe to be too high.

In order to demonstrate the effects of utilizing different end use assumptions within the model, we have taken ISER's moderate economic growth case, and have developed two alternative end use scenarios for the Anchorage sub-region of the Railbelt. The first of these - Case "A" - indicates what we believe will be the result of the recent state conservation bill, combined with national trends in conservation policies and technologies.

Case "B" outlines what we believe would be the product of a conservation program more stringent than that presently contemplated by the State Legislature, but which nonetheless lies well within the realm of the possible.

4.2 Case "A" End Use Scenario

4.2.1 Residential Space Heating Requirements

ISER's calculations for future residential space heating requirements employ a number of specific assumptions. The following figure indicates ISER's assumptions, and where applicable, our modifications for the Case "A" end use scenario.

These modifications seem appropriate given the scope and intent of the recent energy conservation bill. Lower growth in dwelling unit size (assumption 2) is a reflection of a recent stabilization of dwelling unit size in the lower-48, and of smaller expected households.

The impact of the conservation, retrofit and unit size modification assumptions documented in Figure 4.2 is a reduction in Anchorage space heating requirements growth from ISER's expected 3.77% per annum to 1.98% per annum, a 47% reduction.

Figure 4.2: A Comparison of ISER and Case "A" Assumptions

I.S.E.R.

1. Additions to the housing stock will require about 10% more electricity for space heating than the average pre-1980 unit, reflecting larger unit size at the margin
2. Average dwelling unit size for all unit types (single family, duplex, multi-family and mobile homes) will increase 5% per 5-yr. period throughout the forecast period
3. Pre-1980 stock will remain at present levels of efficiency throughout the forecast period (i.e. no retrofits assumed)
4. Post-1980 units will be 5% more efficient per square foot than pre-1980 units for all housing types throughout the forecast period
5. Once built, new units will remain at constructed levels of efficiency throughout the forecast period, except for single family units, which will improve 2%

Case "A"

1. no change
2. Lower growth in unit size is assumed. Single family and mobile units grow 15% larger by 1985 and then stabilize; multi-family and duplex units grow 20% larger by 1990 and then stabilize
3. Retrofit schedules for Pre-1980 stock:
 - (a) single family and duplex: 3% per 5-yr. period efficiency improvement, stabilizing at 15% in 2005
 - (b) multi-family: 2% per 5-yr. period efficiency improvement, stabilizing at 10% in 2005
 - (c) mobile homes: no retrofits assumed
4. All post-1980 units will be 5% more efficient per square foot per 5-yr. period
5. Once built, units conform to retrofit schedule as in (3) above, effective beginning 5 years after the completion date of the unit

4.2.2 Major Residential Appliance Energy Requirements

ISER's method of dealing with major appliances is similar to their space heating technique, with the exception of the retrofit parameter, which does not exist for appliances. In summary, ISER's appliance assumptions are as follows:

Figure 4.3: ISER's Major Appliance Assumptions

Appliance	kWh Requirements per Unit per Year	Unit Growth per 5-yr. Period	Efficiency Improve- ment over 1980
water heater	3650	2.5%	14%
stove	1250	0	3%
clothes dryer	1000	0	6%
refrigerator	1560	5.0%	29%
freezer	1550	5.0%	21%
television	400	0	32%
air conditioner	400	0	21%
dishwasher	230	0	0%
dishwasher (water)	740	2.5%	24%
clothes washer	70	0	0%
clothes washer (water)	1050	0	31%

Source: ISER Worksheets

In terms of a moderate conservation effort, these values, and especially the estimated reduction in demand attributable to conservation, seem quite reasonable. While not a function of state policy, appliance efficiencies have been the focus of much federal study; indications are that federal appliance efficiency standards will be realized. Therefore, for our Case

"A" scenario, we accept ISER's major appliance consumption. These assumptions yield a growth rate in major appliance energy demand in the Anchorage district of 3.17% per annum.

4.2.3 Unspecified Residential Appliance Requirements

ISER has disaggregated unspecified appliance energy demand into lighting (1000 kWh/household/year) and assorted appliances (1010 kWh/household/year and growing at 50 kWh/household/year). Because this classification net of lighting contains a very large number of appliances with extremely low utilization rates and energy requirements (i.e. an electric radio at 10 kWh/year), it is necessary to treat it as an aggregate. ISER's allowance of 50 kWh/household annual growth in assorted appliance energy demand, while holding lighting demand constant, seems reasonable given the uncertainty surrounding the actual appliance stock, its potential for efficiency improvements, and the possibility that new small appliances will enter the market in the future.

Thus, for our Case "A" scenario, we have accepted ISER's unspecified appliance assumptions, which yield a growth rate in Anchorage district of 4.9% per annum throughout the forecast period.

4.2.4 Residential Summary

In general, we find ISER's end use assumptions acceptable,

except for space heating electricity demand, which we believe are unrealistically high. Utilizing our assumptions for space heating while accepting ISER's appliance assumptions, results in a growth forecast for the Anchorage region of 3.36% per annum, compared to USER's 3.75%.

4.2.5 The Commercial-Industrial-Government Sector

ISER's Commercial-Industrial-Government sector (CIG) end use model is, because of serious data limitations, much less detailed than the residential end use model. In general, CIG employment for each of the snapshot years is multiplied by an electricity use per employee parameter, yielding total electricity consumption for that "vintage" of employee. Summing this figure with the electricity consumption of all previous "vintages" of employees yields total consumption for that year. The following values were used in the ISER CIG end use model.

Figure 4.4: ISER CIG Assumptions

<u>Date</u>	<u>Base MWh/Employee</u>	<u>(1 - Cs)</u>	<u>(1 - ret)</u>	<u>Actual MWh/Employee</u>
1980	10.675	1.0	1.0	10.675
1985	15.156	1.0	1.0	15.156
1990	18.180	.95	1.0	17.270
1995	21.200	.90	1.0	19.080
2000	24.220	.90	1.0	21.800
2005	27.240	.90	1.0	24.520
2010	30.26	.90	1.0	27.230

We have serious reservation about accepting the values used in the CIG end use model. It is difficult to imagine that electricity use per employee can nearly triple within the confines of existing CIG electricity applications. Such rapid growth in per employee electricity use seems to suggest that major new applications for electricity will be found. However, ISER's assumption that fuel price ratios will remain nearly constant throughout the forecast period seems to limit the potential for the development of new applications (notwithstanding actual unavailability of alternative fuels).

Secondly, ISER's assumes only a 10% reduction by 1990 in the efficiency with which each CIG employee utilizes electricity (the $(1 - C_s)$ term above). Such a figure seems to underestimate commercial sector savings of 15 - 30% that are already being attained. (Ontario Hydro, for example, inhabits one of the world's most energy efficient commercial structures. Since the building's completion in 1976, Hydro has cut lighting loads by a further 15%).

While the lack of CIG data certainly suggests the need to be conservative, we believe the 10% conservation estimate is far too low.

And thirdly, ISER assumes that no retrofits will be conducted on the buildings inhabited by CIG employees (the $(1 - \text{ret})$ term remains constant at 1.0). Rising electricity prices seem to

imply the incentive for major retrofitting on commercial structures.

For our Case "A" scenario, we will assume data values as follows:

- (a) Per employee electricity utilization is allowed to grow, as ISER has forecast, to 1995, but remains stable at the 1995 level throughout the remainder of the forecast period;
- (b) All stock is assumed to retrofit, resulting in a 2% savings per employee per 5-year period, effective from five years after the completion of the structure within which the CIG employee is assumed to work;
- (c) While we have reservations about the 10% reduction in per employee energy consumption resulting from conservation, we will accept it for Case "A" (but will increase the role of conservation in our Case "B" analysis).

These amendments result in a reduction of the Anchorage district CIG electrical growth rate from ISER's 4.2% per annum to 3.6% per annum over the entire forecast period.

4.2.6 Summary of Case "A" Scenario

The following figure summarizes electrical demand growth in

the Anchorage region according to our suggestions above. The effect of our revisions is to reduce overall growth in the Anchorage area by approximately .5% per year, from ISER's 3.98% to what we believe to be a more realistic 3.49%.

Figure 4.5: Case "A" Summary

<u>Date</u>	<u>Space Heat</u>	<u>Major Appl.</u>	<u>Minor Appl.</u>	<u>C-I-G</u>	<u>Total</u>	<u>ISER Forecast Total</u>
1985	492	464	203	1219	2378	2438
1990	556	523	255	1353	2687	2782
1995	660	628	334	1777	3399	3564
2000	784	753	427	2151	4115	4451
2005	848	858	509	2450	4665	5226
2010	903	975	604	2797	5279	6141
<u>Average Annual Growth 1980 - 2010:</u>						
ISER:		3.98%				
Energy Probe		3.49%				

4.3 Case "B" End Use Scenario

4.3.1 Residential Space Heating Requirements

Figure 4.6 below indicates the residential space heating assumptions utilized in our Case "B" end use scenario (reference should be made to Figure 4.2 for comparison with Case "A" and ISER assumptions).