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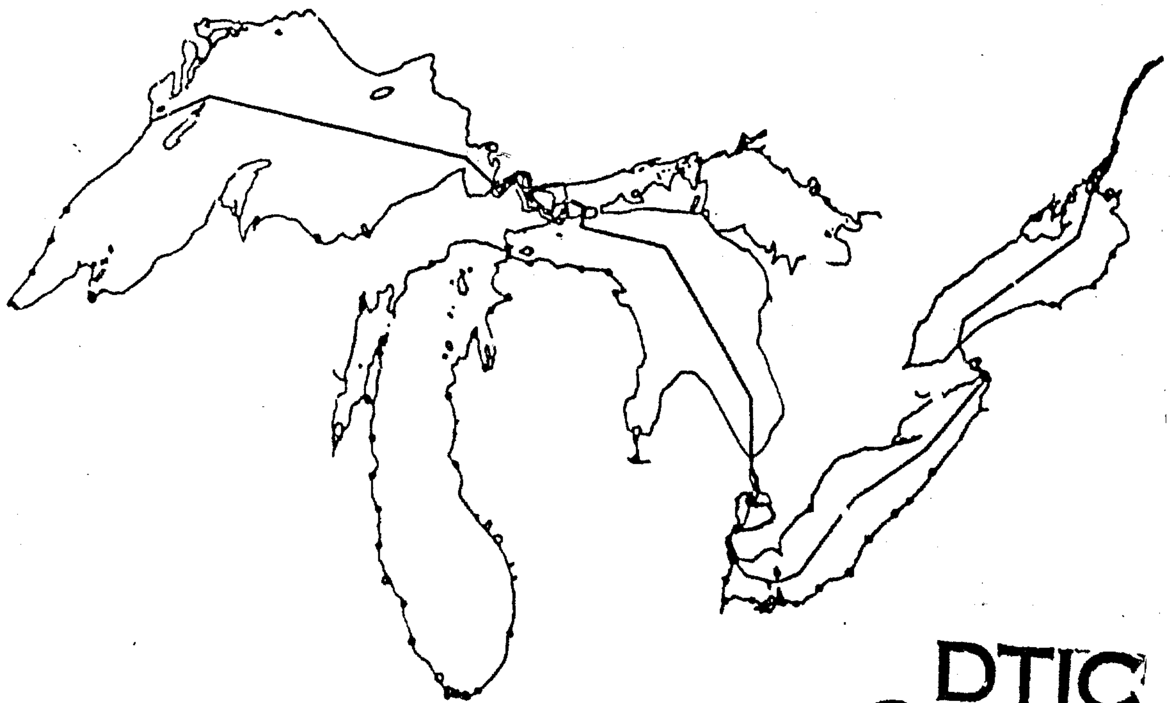

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This report of studies conducted a third consecutive winter describes results of observations of movements of mammals across the St. Marys River; in particular deer in the Neebish Island area, where more than 90% of mammal crossings of the St. Marys River take place. It also supplements information on crossing rates and locations of mammals on the river.

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FINAL SUPPLEMENTAL REPORT

POTENTIAL EFFECTS OF WINTER NAVIGATION ON MOVEMENTS OF LARGE LAND MAMMALS IN THE EASTERN LAKE SUPERIOR AND ST. MARY'S RIVER AREA 1981-82

by

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Modification of
Contract No. 14-16-0009-79-053

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Under Agreement No.
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PREFACE

This is a Draft Supplemental Report on the Modification of Contract Number 14-16-0009-79-053 between Northern Michigan University and the Department of Interior, U.S. Fish and Wildlife Service, covering the winters of 1981-82. Funding was provided by the Detroit District, U.S. Army Corps of Engineers. The purpose of the original study, conducted during the winters of 1979-80 and 1980-81, was (1) to determine the species and relative numbers of mammals that use the ice of the St. Mary's River and Whitefish Bay for travel, (2) to describe the locations most commonly used for travel, (3) to determine the purpose of using the ice such as migration, traveling directly across the ice, traveling along the ice, or foraging on the river or bay, (4) to observe whether animals would swim across open water in winter, and (5) to assess potential effects of winter shipping on the movements of mammals on the ice. The results of the two previous winters of study were presented in previous reports (Robinson and Fuller 1980; Robinson, Jensen and Amacher, 1982).

After a single winter's study it was recognized that further information was needed, specifically on movements and behavior of deer in and about their winter deeryard on Neebish Island where frequent channel crossings occurred and on densities of wolves in Ontario in the vicinity of Whitefish Bay and St. Mary's River. Also, because of a possibly lingering effect of winter demonstration shipping between 1972 and 1979, it was recommended in the 1980 report that winter shipping be discontinued for at least three consecutive winters to permit the system to readjust and so that data gathered on mammal movements on the ice might be more representative of baseline non-shipping conditions.

The purpose of the 1980-81 modification of the contract was to provide a second field season to determine variability in movements of mammals studied during the winter of 1979-80 and to obtain more specific information, particularly on the movements of two species, the wolf (Canis lupus) and the white-tailed deer (Odocoileus virginianus).

The 1980-81 studies provided an estimate of wolf numbers and locations of wolf packs on the Canadian side of the study area. It also substantiated common locations of crossings by mammals of the St. Mary's River, and verified the preliminary conclusions that coyotes and foxes are little affected by ship traffic. The study also concluded that efforts of deer to cross the river are seriously impeded by hip passage.

This report of studies conducted a third consecutive winter describes results of observations of deer in the Neebish Island area, where more than 90 percent of mammal crossings of the St. Mary's River take place, and supplements information on crossing rates and locations of other mammals on the river.

EXECUTIVE SUMMARY

This report describes a third consecutive winter of observations of movements of mammals across the St. Mary's River. The main objective of the studies was to describe travels of mammals on the ice in the absence of winter shipping in order to evaluate potential effects of shipping on such movements. Emphasis during the winter of 1981-82 was on deer movements in the Neebish Island area, where previous studies had shown that more than 90 percent of winter mammal activity on the ice occurs. Methods included ground and aerial surveys, description of movements of individual deer by radio-telemetry, pellet survey to estimate deer numbers, and systematic ground search to locate dead deer for determining extent and causes of deer mortality.

From 3 January - 27 March 626 sets of mammal tracks were observed crossing channels of the St. Mary's River. Of these 70.4 percent were deer, 12.5 percent were coyotes, 6.4 percent were unidentified canids (coyotes, fox, or dog), 3.8 percent were foxes, 3.5 percent were domestic dogs, and 3.4 percent were snowshoe hare. No wolf tracks were found in 1982.

The total estimated number of mammals crossing shipping channels in 1981-82 was 1384, compared with 1144 in 1979-80 and 508 in 1980-81. Movement of mammals on ice was apparently increased with the severity of winter. Canids found easier traveling conditions on ice than on land. Deer crossed the river more frequently to St. Joesph Island apparently to find food which was scarce on Neebish Island when snow was deep.

A population of at least 700 deer was estimated from pellet surveys on Neebish Island in 1982, an increase from previous years. Increases in crossing rates of deer between Neebish Island and St. Joseph Island in 1982 could be attributed to one or more of the following: severe weather causing deer to seek available food on St. Joseph Island, good travel conditions on the ice with absence of ice ridges caused by early winter shipping, resumption of traditional winter movements after three consecutive winters without shipping, and increased numbers of deer present.

Occasional passage of vessels in 1982, as in previous winters, again prevented deer from crossing the river for periods of up to 48 hours after passage. All winter shipping would impede or prevent migration of deer to Neebish Island and mortality of such animals likely would be high. The elimination of daily crossings by deer to St. Joesph Island to obtain food would eliminate that source of food and increase demand for food on Neebish Island. Resultant mortality of deer caused by malnutrition also could be high.

Tracks of foxes and coyotes following ship passage suggest that movements of these species would be relatively unaffected by winter shipping.

A small wolf pack occupying Cockburn Island remains a potential source of immigrating wolves to the U.S., provided they can cross shipping channels. Direct evidence of the effects of shipping on wolf movements across the ice remains unavailable.

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ACKNOWLEDGEMENTS

This study was funded by the U.S. Fish and Wildlife Service (Modification of Contract No. 14-16-0009-79-053) and the U.S. Army Corps of Engineers, and supported by the Department of Biology, Northern Michigan University. We gratefully acknowledge the assistance of student intern Douglas Wyble, field volunteer Jody Traves, Northern Michigan University grants accountant Sally Bentley, Biology secretary Pat Wagner, Ronald and Nancy Adams of Barbeau, the 14 student volunteers who participated in the dead deer search, Les Weigum of the U.S. Army Corps of Engineers, and project officer Keith Kraai of the U.S. Fish and Wildlife Service, whose efforts towards continuing this study extended above and beyond his normal work load and whose kind, but firm hand steered the project to completion.

PART I: INTRODUCTION

Before the impact of winter shipping on mammal movements across ice can be evaluated, it is necessary that data be obtained in the absence of shipping. Since the winter of 1979-80 we have studied movements of mammals on the St. Mary's River and Whitefish Bay (Robinson and Fuller 1980; Robinson, Jensen, and Amacher 1981). In 1980 we recommended that studies be conducted over at least three consecutive winters without commercial shipping, so that a resumption of conditions be approached resembling those prior to the year-round shipping feasibility studies which began in 1974 and continued through 1979. This report presents results obtained during a third winter of study.

On the St. Mary's River during the winters of 1979-80 and 1980-81, there were an estimated 1743 and 508 crossings, respectively. Of these, over 60 percent were of white-tailed deer (Odocoileus virginianus), about ten percent were of coyotes (Canis latrans), three percent were of foxes (Vulpes fulva), five percent were of domestic dogs (C. familiaris) and the remainder were unidentified mammals. Only one bobcat (Lynx rufus) track was seen crossing a channel. No wolf (Canis lupus) tracks crossed the ship channel but wolf tracks were seen on the ice during both winters. Tracks of moose (Alces alces) were seen on the ice of Whitefish Bay, but only a short distance from shore. No tracks of lynx (Lynx canadensis) were found on the ice.

Our studies showed that movements of coyotes and foxes were relatively unimpeded by occasional ship passage; they do not hesitate to cross a newly refrozen ship track. No opportunity arose to observe the behavior of wolves encountering a ship track and severe budgetary restrictions have prevented extensive searching necessary to obtain further observations of this endangered species. Deer were prevented from crossing ship channels for periods ranging from 24 to 48 hours after ship passage.

Over 90 percent of all mammal crossings took place on channels adjacent to Neebish Island. Because of the importance of white-tailed deer, both in numbers of animals crossing the channel and as an economic resource, we began in 1980-81 to gather detailed information on numbers, movements, and mortality of deer wintering on Neebish Island. The winter of 1980-81 was exceptionally mild and deer behavior may have been atypical. The 1980-81 study was designed to obtain further information on movements, numbers, and effects of winter shipping on deer in the Neebish Island area. Specifically the objectives were as follows:

1. To determine whether a relative stability of crossings by various species of mammals of the St. Mary's River in a third winter without shipping occurs as a reestablishment of "baseline" conditions.

2. To obtain an improved estimate of the number and times of deer migrating to Neebish Island.

3. To estimate the total winter deer population on Neebish Island for a second winter.

4. To describe the proportion of deer on Neebish Island that die during the winter and compare it with potential mortality caused by shipping.

PART II: THE STUDY AREA

Physical Geography

The study area (Figure 1) includes Whitefish Bay, which is the easternmost part of Lake Superior, and the St. Mary's River, which flows from Lake Superior to Lake Huron. Whitefish Bay covers about 1,650 km^2 and is 50 km long from Whitefish Point to its outlet into the St. Mary's River. The river is 101 km long and its channels vary in width from 0.2 to 7.0 km. Four large islands, Sugar, Neebish, St. Joseph, and Drummond range from 50 to 380 km^2 in area.

The Canadian side of Whitefish Bay is largely wooded with summer resorts and cabins along the immediate shoreline. The U.S. side is also wooded but has more permanent residents on the shoreline. Both shores of the St. Mary's River have been variously developed for agriculture and recreational housing, but they also include several tracts of undeveloped forested land extending up to 8 km long.

The cities of Sault Ste. Marie, Ontario, (population 85,000) and Sault St Marie, Michigan (population 15,000) are the largest urban centers in the area. They are located directly across from each other on the northwestern portion of the river and occupy aobut 10 km of shoreline on both sides.

Ice Conditions

The major portion of the St. Mary's River was frozen and snow covered by 2 January when field study began. The river was safe to cross on foot and on snowmobiles by 7 January. As in the previous two winters, there was open water at the Sugar Island and Drummond Island ferry crossings and the Rock Cut of West Neebish Channel. There were essentially no broken ice ridges formed along the ship track in 1981-82 in contrast to the high ridges created in 1980-81 because of thick ice formation and ship traffic in December 1980. On 27 March ice on the shipping channels was broken for the start of commercial shipping but solid ice remained on West Neebish Channel, a non-shipping channel, until 15 April. By 1 May the St. Mary's River was clear of ice from Sault Ste. Marie to a point south of Neebish Island. Ice conditions on shipping channels were favorable for mammal movements from late December until the start of commercial shipping on 27 March, with the exception of periods following passages of ice breakers.

Winter Shipping

In the winter of 1981-82, commercial winter shipping on the St. Mary's River ended on 31 December and resumed on 27 March. During that time ice on the St. Mary's River from Sault Ste. Marie to De Tour Village was broken by U.S. Coast Guard icebreakers on 3, 5, 12, 21, 27 January and 5, 16 February. Ar oil barge with icebreaker escort traveled upstream to Sault Ste. Marie, Michigan on 3 January, and returned downstream on 5 January.

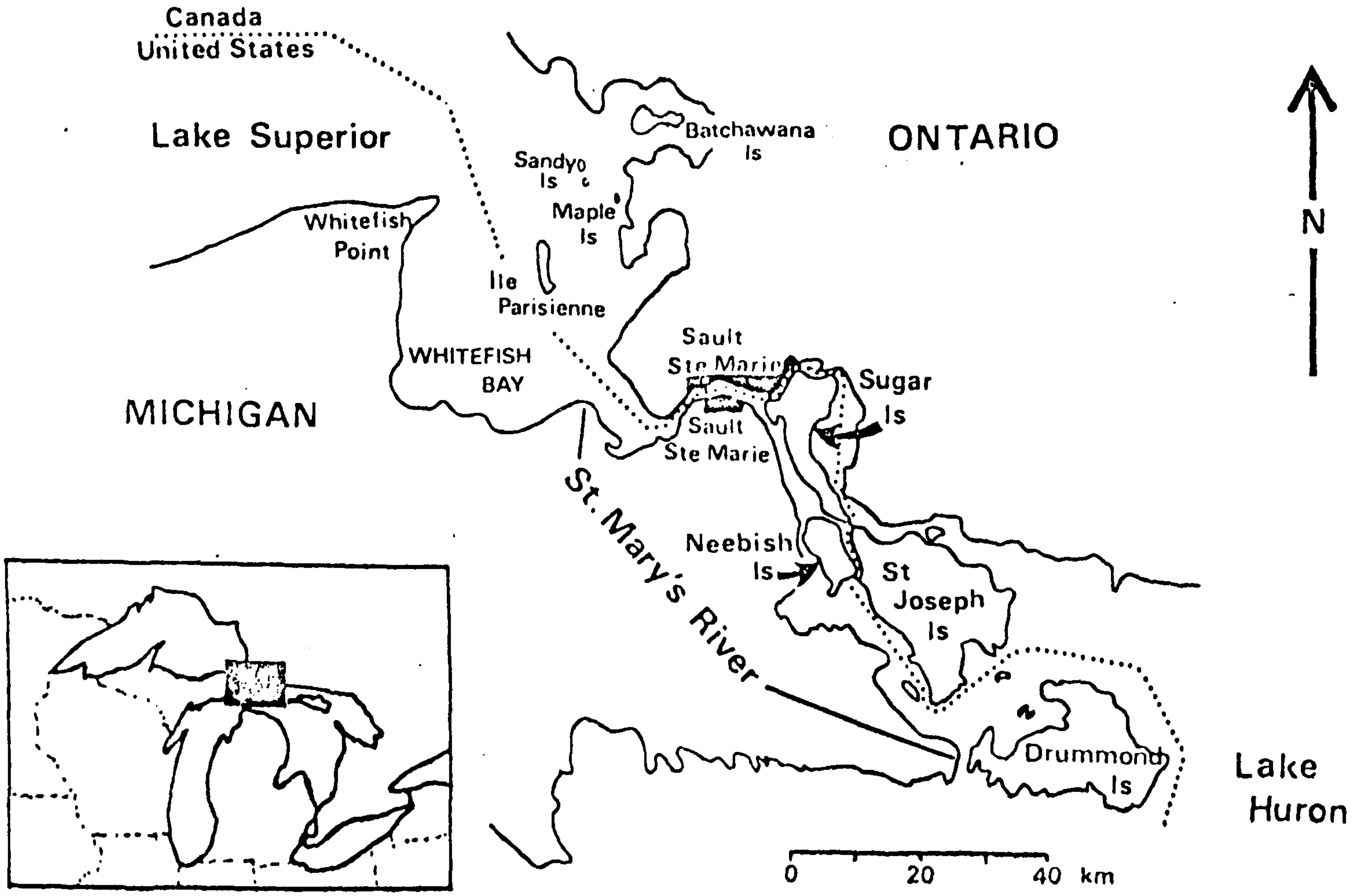

Figure 1. Map of the St. Mary's River Study Area.

Weather

Based on statistics compiled at Sault Ste. Marie, weather conditions during the winter of 1981-82 were more severe than average (Table 1). Weather conditions in December 1981 were about normal with an average temperature of -5.8^{o} C and snowfall of 65.8 cm. Mean temperatures in the January-March period were 3.3^{o} C colder than average and the total snowfall of 250.4 cm in the January-March period was 94.1 cm above average. Average snow depths on the ground during this period were also well above normal. The total freezing degree days recorded for the winter of 1981-82 was 2094 compared with the 80-year average of 1815.

Table 1. Summary of Weather Data Recorded by The National Weather Service, Municipal Airport, at Sault Ste. Marie Michigan

Weather Parameter	January 1-14	January 15-31	February 1-14	February 15-28	March 1-15	March 16-31	Mean or Total
Mean Daily Temp. (C) 1982	-14.3	-16.2	-15.3	-7.6	-9.9	-1.7	-10.8
1941-70	-9.9		-9.3		-4.4		-7.9
Cumulative Freezing Degree Days (F)	338-690	690-1183	1183-1562	1562-1752	1752-2019	2019-2094	2094
Mean Daily Snow Depth (cm) 1982	67.3	76.7	66.3	53.1	67.3	51.8	63.8
1942-78	29.9	38.7	47.7	47.7	41.4	23.7	37.9
Total Snow Fall (cm) 1982	107.7	72.6	14.0	12.7	22.6	20.8	250.84
1942-78	68.6		49.3		38.4		156.3
% of Days Snowfall > 2 cm - 1982	67	37	21	14	20	19	30
Mean Daily Wind Speed (km-hr) 1982	14.6	13.4	10.7	10.4	15.1	14.6	13.1
1941-70	12.2		15.8		16.6		16.2
% of Days Wind Speed ≥ 12 km-hr 1982	67	56	36	36	67	75	56
Average Sky Cover (%) 1982	80	72	73	70	63	86	74
1941-70	80		74		69		74
% of Days Cloud Cover ≥ 50% 1982	87	75	79	64	80	94	.80

PART III: METHODS

Track Survey Techniques and Locations

Between 3 January and 9 April movements of large mammals on the ice of the St. Mary's River were determined principally by ground surveys. Only five aerial surveys were conducted during this period. These few aerial surveys were conducted because unsafe ice on the river prevented the use of the ski-equipped airplane until 15 January and there were mechanical problems with that airplane the rest of the month. Alternative flying services with ski-equipped planes were not available so another air service was contacted and three surveys were conducted in February in an aircraft with wheeled landing gear. Poor tracking conditions from 1 to 14 March prevented aerial surveys. Table 2 summarizes ground and aerial track survey efforts during the winter of 1981-82.

In the winter of 1981-82,more extensive ground surveys were conducted than in the two preceding winters in areas of the St. Mary's River where mammal tracks had been found to be most numerous in previous winters. Three areas in particular were surveyed regularly: Middle Neebish Channel, the northern portion of West Neebish Channel and the Munuscong Channel (Figure 2). The southern portion of the Munuscong Channel, south of Johnson Point was surveyed on an almost daily basis throughout the winter. The number of days each segment was surveyed from the ground is given in Table 3.

Aerial surveys were conducted in a wheeled Cessna Skyland II aircraft. Two observers, in addition to the pilot, were present on all five flights. Surveys were conducted by flying at an altitude of approximately 60 m above the ice and at a speed of 130-150 km/hr. Surveys were made only when there was at least 48 hours of tracking possible (no snowfall > 3 cm or winds > 12 km/hr within two days before the survey). The five flights were made on sunny days which provided good contrast for seeing tracks. During each aerial survey, 64 km of shipping channels and 50 km of non-shipping channels between Sault Ste. Marie and De Tour Village were surveyed (Figure 3).

For the sake of comparative data the same criteria used by Robinson and Fuller (1980) during the winters of 1979-80 were used during the winter 1981-82. These data involved recording all tracks observed greater than 10 m from shore including when possible: species, aerial or ground observation, date, time of day, location of starting and ending points of tracks, number of animals in a group, whether the animal was seen or not, estimated age of track, direction of travel, whether the tracks crossed the channel or not, type of movement (i.e., meandering or traveling perpendicular or parrellel to shore), channel width, distance animals traveled on the ice, onshore depth of tracks in snow, minimum depth of track in snow on the ice, time since last snowfall or strong wind, ice conditions, snow condition, habitat type on land and time since ship passage.

As Robinson and Fuller (1980) pointed out, the actual number of tracks counted represents a minimum number of tracks, due to the fact that tracks of animals which walked on snowless ice or shortly before or during a snowfall

Table 2 . Summary of Aerial and Ground Survey Efforts During Studies of Mammal Movements Across the St. Mary's River, 3 January to 30 March 1982.

	January	February	March	Total
No. of aerial surveys	0	3	2	5
Total no. of hours	0	4.5	3.0	7.5
No. of km surveyed from the ground	121.8	108.1	62.8	292.7

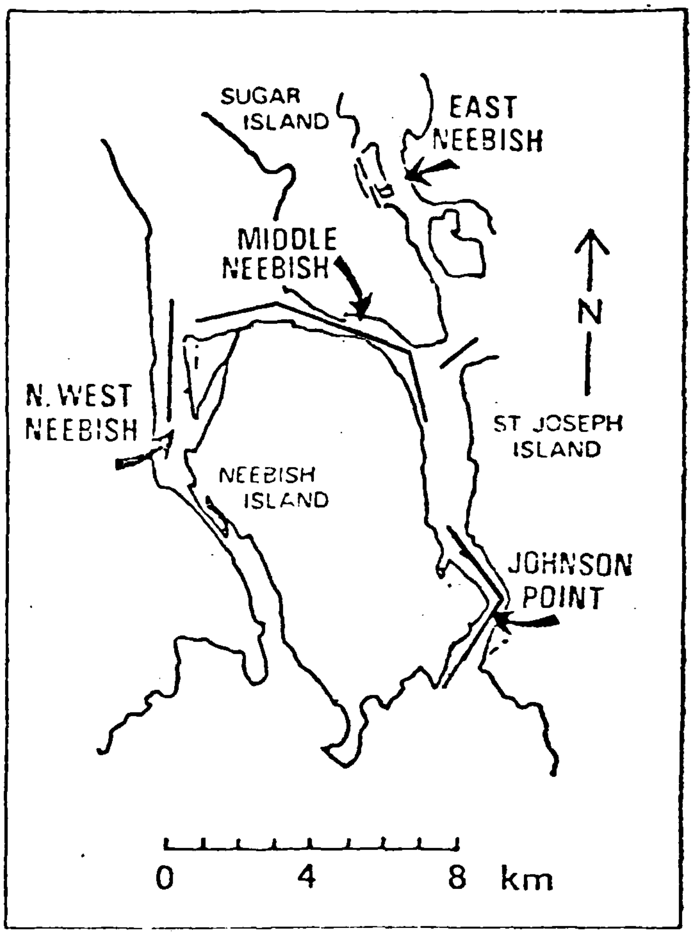

Figure 2. Map of the Neebish Island area showing the locations of ground transects on river channels surveyed for mammal tracks.

Table 3. Number of Days Each Channel Segment on the St. Mary's River was Surveyed from the Ground, 3 January to 30 March 1982.

Channel Segment	Segment length (km)	No. of ground surveys
Middle Neebish Channel	5.0	11
N. West Neebish Channel	2.3	7
Munuscong Channel (north of Mirre Point)	4.2	12
Munuscong Channel (Mirre Point to Johnson Point)	2.0	24
Munuscong Channel (south of Johnson Point)	1.7	64

Figure 3. Map of the St. Mary's River showing shipping channels (dashed lines) and non-shipping channels (dotted lines) surveyed for mammal tracks.

were not observed . The method described by Robinson and Fuller (1980) considers the number of tracks per day after a snowfall as a measure of the rate of activity. The time between the last track-obliterating wind or snowfall and the survey time was noted, and the number of tracks observed could thus be calculated tracks/24 hours, or tracks/day. To make samples of different lenghts comparable, the length of each sample was also used as a demoninator, resulting in the number of tracks/km-day as a standard unit to compare activity rated between months of the winter and portions of the study area.

Trapping and Radio-collaring Deer

In order to trap and radio-collar deer, two Stevenson-type box traps (Bartlett 1932) were set up in the winter deeryard on southern Neebish Island (Figure 4). The first trap became operational on 13 January and the second on 30 January. Traps were baited with cedar boughs and were checked daily. Traps #1 and #2 operated 74 days and 56 days, respectively. Trapping ceased on 9 April.

Physical data collected on trapped deer included: age, sex, hind foot length, neck and check girths and estimated weight. Each doe trapped was fitted with a radio-transmitting collar (Advanced Telemetry Systems, Inc.) and all trapped deer were marked by a Michigan DNR metal ear tag. Males were not radio-collared because of the high possibility of the collar causing injury as males matured.

Monitoring Radio-collared Deer

Winter home range sizes and the location of summer ranges were determined by monitoring radio-collared deer. Movements of radio-collared deer were recorded by triangulation from known ground locations (Marshall and Kupa 1963) and from an airplane (Mech 1974) during the winter and spring 1982. Movements of two deer that had been radio-collared in 1981 were monitored along with three deer radio-collared in 1982.

Radio-tracking from the air was necessary when the radio-collared deer moved out of the winter yard and out of the range of receivers on the ground. Two antennas were mounted on the Piper PA-12 aircraft, one on each wing strut, with the researcher inside operating the receiver. Pin-pointing an animal involved locating the signal and circling the area within which the signal originated. The location error for aerial tracking was calculated at .02 to 1.87 hectares (Hoskinson 1976). With practice, locating radio-collared deer became routine.

Estimates of Deer Numbers

In order to estimate the number of deer wintering on the southern portion of Neebish Island, a stratified random sampling of pellet groups was made on on 10 and 11 May 1982 (Bennett, English, and McCain 1940). Fifteen transects were selected in the wintering yard (Figure 5) and along each transect, ten randomly selected plots were surveyed for deer pellet groups. Each sample plot measured 1.2 m x 6.1 m (7.3 m^2) and each plot was classified as either a heavy deer use or a light use area based on previous observations of deer activity.

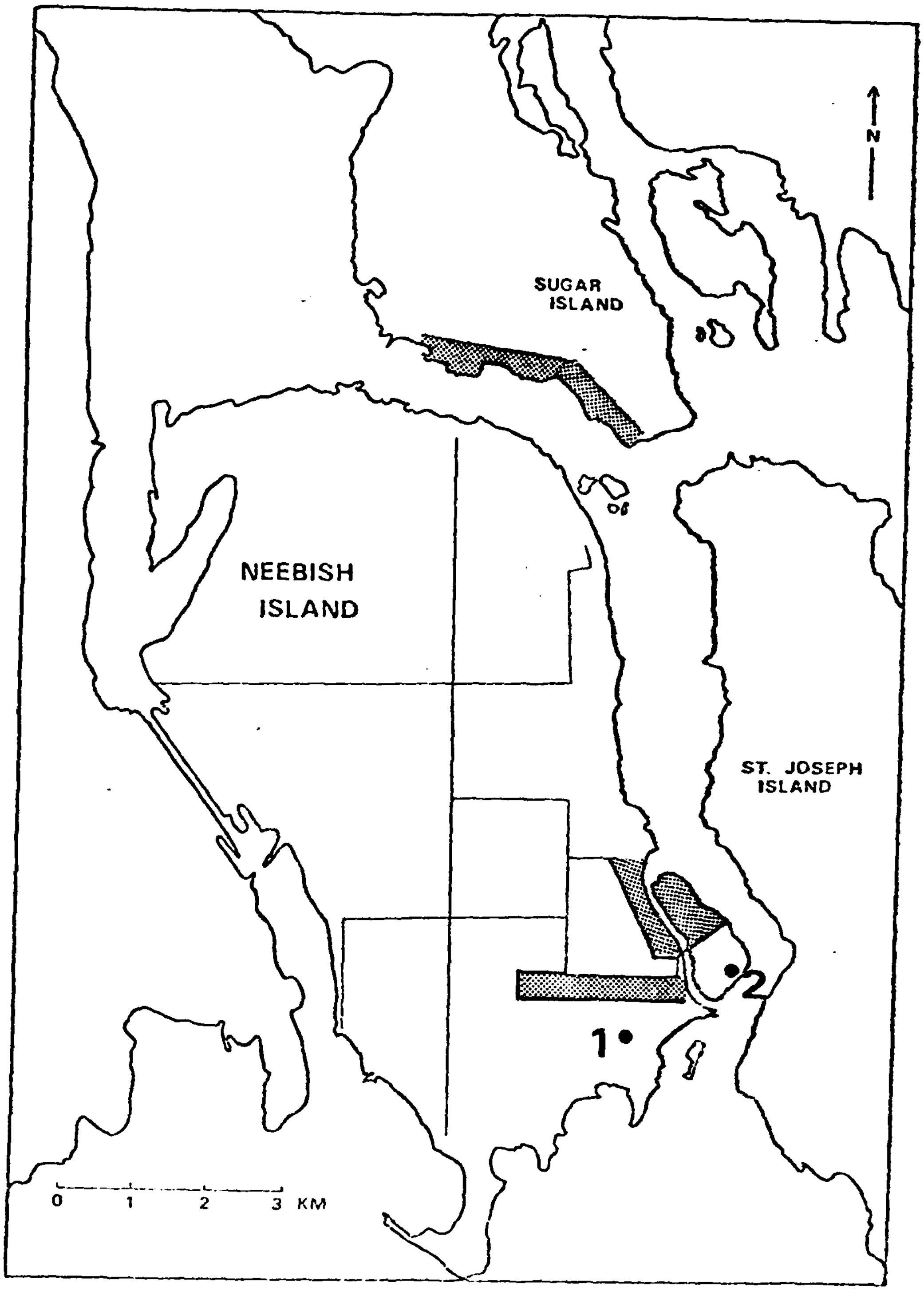

Figure 4. Locations of deer traps (numbers 1 and 2) and transects surveyed during systematic dead deer search on 17 April 1982.

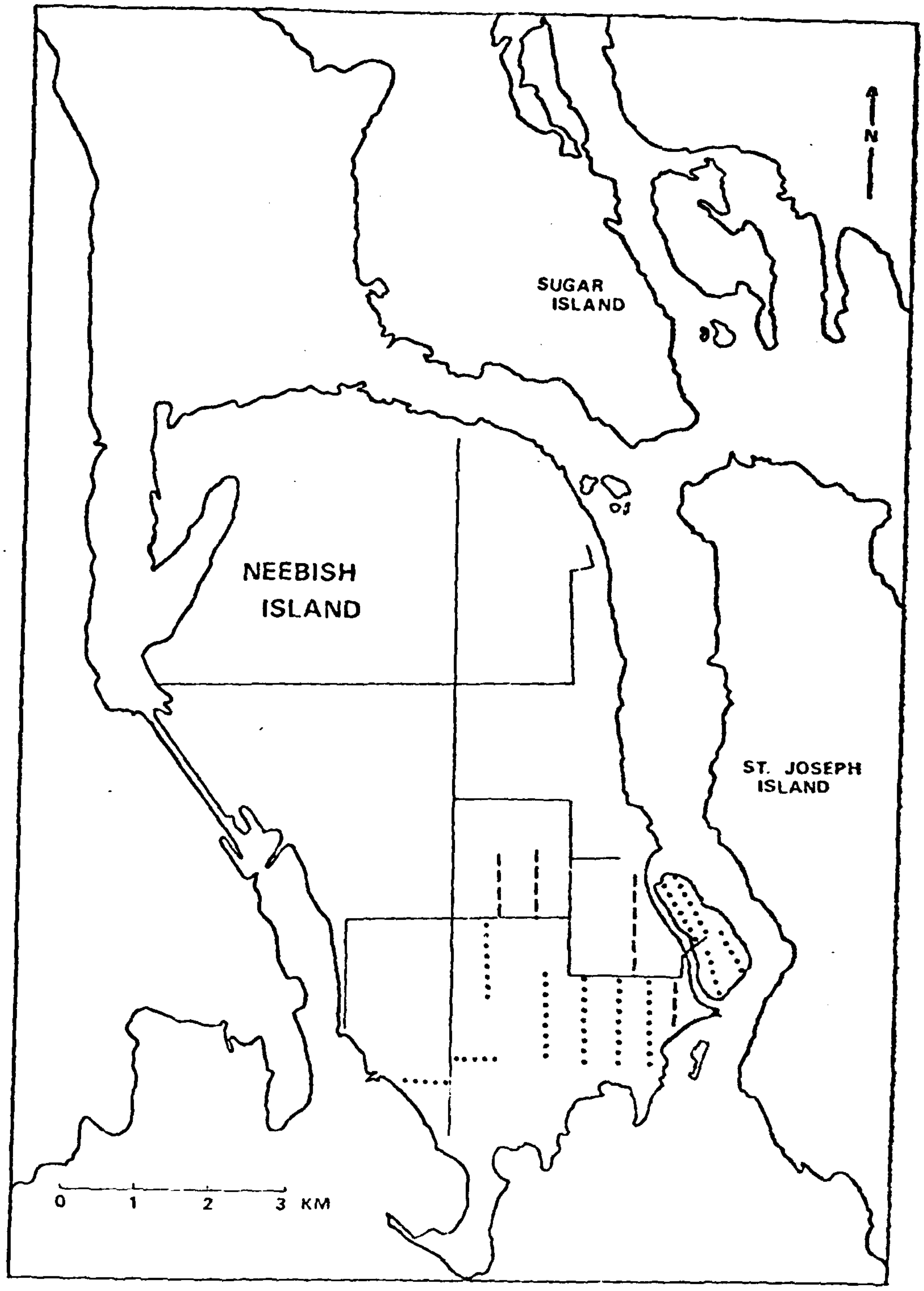

Figure 5. Locations of 15 transects surveyed for deer pellet groups. Dotted lines are transects in heavy deer use areas and dashed lines are transects through light use areas.

The average number of pellet groups per sample plot was calcutated for the light and heavy use areas.

The estimation of deer numbers was calculated by using the following formula:

$$\text{deer population} = \frac{\text{mean pellet groups per plot} \times \frac{1}{\text{plot size}} \times \text{size of area}}{\text{deposition period} \times \text{defecation rate per day}}$$

The deposition period was considered to be the time between leaf fall, October 19, 1981 (Michigan DNR), and the day of pellet surveys, 203 days in our case. The defecation rate of deer per day in the Upper Peninsula has been estimated at 13.5 pellet groups (Burgoyne and Moss 1981). The average number of deer per square km within 95% confidence limits for both light and heavy use areas was calculated. The confidence limits were calculated by multiplying the standard error of the mean number of pellet groups per plot by 1.96. This figure was then added to and subtracted from the average number of pellet groups per plot. The results were inserted into the formula, giving minimum and maximum deer densities at the 95 percent confidence level.

Estimates of Deer Mortality

Assessment of winter mortality was accomplished by a systematic dead deer search through three transects on southern Neebish Island and one transect on the southern edge of Sugar Island (Figure 4). The search involved 16 volunteers, divided into four groups, with searchers walking parallel and spaced about one chain (20 m) apart. The Sugar Island transect was surveyed in order to give an indication of overall deer activity as well as to locate possible carcasses. When a deer carcass was encountered the following data were collected: location of carcass, estimated time of death (year and season), and where possible a determination of sex and age was made and probable cause of death noted. When large bones were present (i.e., humerus, femur, tibia-fibula) the bone was collected. As available marrow permitted, three marrow samples were taken from each bone and analyzed using the dry reagent method described by Kie (1978). The percent of bone marrow fat (BMF) was used as an index of a deer's physical condition at the time of death. An animal was considered in poor condition when fat content was below 30 percent.

Browse Survey

The methods used by Beals et al. (1960) on the Apostle Islands were used as a guideline for browse analysis. The methods used are summarized as follows:

Browse condition and availability was estimated at two locations in the winter deeryard on southern Neebish Island, one location on Rains Island and at one location on St. Joseph Island (Figure 6). The site sampled on St. Joesph Island was a 64 hectare cedar-fir stand that most deer crossing the Munuscong Channel entered into and exited from during the study period. The stands were selected to give a representative sample of the forests in the deeryards.

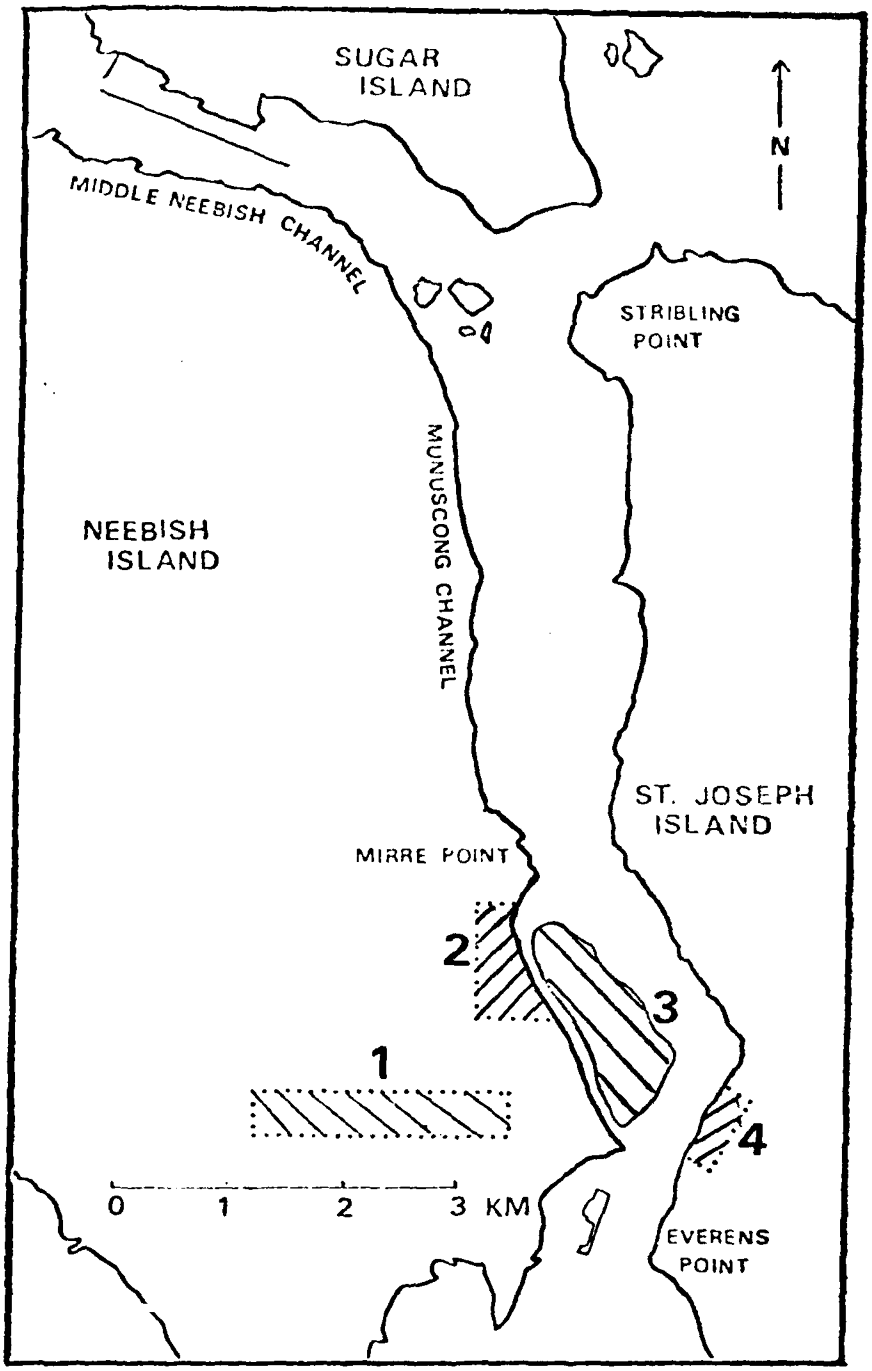

Figure 6. Browse survey transects. Transect no.1, Tally-Ho swamp; no. 2, southeast Neebish Island; no.3, Rains Island; and no. 4, St. Joseph Island.

Sampling of trees and browse was done by the point-quarter method (Cottam and Curtis 1956), and data were taken at 20 random points along compass lines. Browse was considered to be any woody stem with leaves and/or buds above the average snow depth (64 cm) and the established browse line (approximately 2 m). Each sampled browse stem was classified subjectively into one of five categories of browse damage: no browsing, light browsing, moderate browsing, heavy browsing, and completely browsed. Browse data from each of the four locations were described in several ways: the relative density (Number of stems of a species divided by the total number of stems of all species x 100), the relative number of stems in each browse category, and the minimum density of browse stems per hectare were obtained. The minimum density was calculated by averaging the distances obtained by the point-quarter method, squaring the average and dividing into the number of square meters in a hectare, as described by Cottam and Curtis (1956).

Three numerical indices - browse condition index, preference rating, and pressure index were presented by Beals et al. (1960) to describe deer-vegetation relationships. The browse condition index, describing the degree of browse damage for each stand, was calculated by multiplying the relative density of browse (in percent) in each browse damage category ; i.e., percentage browse undamaged by 0, slightly browsed by 1, moderately browsed by 2, heavily browsed by 3, and totally browsed by 4. These products then were added and divided by 100 giving a number between 0 and 4. A value of 4 indicated all stems sampled were totally browsed while a value of 0 indicated no stems were browsed. Since the browse condition index does not take into consideration the quality of browse available (deer are more likely to browse stands of choice food than stands of poor food), a preference rating was calculated. The plant species present were divided into four categories (Table 4) as described by Dahlberg and Guettinger (1956). The preference rating was calculated by multiplying the relative density of the first choice food by 1, the second by 2, third by 3 and fourth by 4. These products were summed and divided by 100 giving a number between 1 and 4 for each stand. A value of 1 would indicate a stand of all first choice food and 4 a stand of fourth choice, or starvation food.

The browse condition index and the preference ratings are derived independently and in order to describe each stand on the basis of browse damage and quality, the condition index and preference rating are multiplied giving the pressure index. Possible results range from 0 to 16, 0 for any stand that has not been browsed regardless of the prefererrnce rating. The maximum 16 would describe a stand containing all fourth choice food, totally browsed. A value near 16 could not be reached under natural conditions; deer would die of starvation before all fourth choice food is totally browsed. The maximum value obtained in the Apostle Islands study of Beals et al. (1960) was 6.4. This was regarded as a very heavily browsed yard. Pressure indices of 6.01 and above indicated very heavily browsed stands, 4.01-6.00 heavily browsed, 2.01-4.00 moderately, .01-2.00 lightly and 0 indicated no browse pressure (Beals et al. 1960).

Table 4. Preference Ratings of Browse Species Found in the St. Mary's River Study Area. Choices are According to Dahlberg and Guettinger (1956).

1st Choice

White Cedar (*Thuja occidentalis*)
Red Maple (*Acer rubrum*)

2nd Choice

Mountain Maple (*Acer spicatum*)
Fly honeysuckle (*Lonicera canadensis*)
Serviceberry (*Amelanchier spp.*)
Red-osier Dogwood (*Cornus stolonifera*)
Chokecherry (*Prunus virginiana*)

3rd Choice

Balsam Fir (*Abies blasamea*)
Sugar Maple (*Acer saccharum*)
White Spruce (*Picea glauca*)
Quaking Aspen (*Populus tremuloides*)
Michigan Holly (*Ilex verticillata*)
Balsam Poplar (*Populus balsamifera*)
Black Ash (*Fraxinus nigra*)
Beaked Hazel (*Corylus rostrata*)
White Birch (*Betula papyrifera*)

4th Choice

Alder (*Alnus rugosa*)

PART IV: RESULTS

Mammal Movements on the Ice of the St. Mary's River

Number of Crossings

During the study period, 626 individual sets of mammal tracks were recorded crossing various channels of the St. Mary's River. Figures 7 through 12 are maps showing all crossings by various species from 3 January to 9 April 1982. Of the 626 total crossings, 441 (70.4%) were of white-tailed deer, 78 (12.5%) were of coyotes, 40 (6.4%) were of unidentified canids (coyote, fox, or possibly dog), 24 (3.8%) were of foxes, 22 (3.5%) were of dogs and 21 (3.4%) were of snowshoe hare. In addition to these crossings, 31 sets of tracks were recorded (24 deer, 3 coyote, 2 fox and 2 hare) in which animals did not cross the ship track but returned to shore.

Temporal and Geographic Distribution of Mammal Crossings

Table 5 summarizes the crossing rates of mammals by species, on the St. Mary's River for various time periods during the winter of 1981-82.

Deer (441 counted crossings): Crossing rates for deer were highest in February and late March, lower in early January and in early March and were lowest in late January. The high rates during February and late March were due to the frequent crossings of the lower Munuscong Channel (Figure 7). High numbers of deer crossings occurred in two areas of the St. Mary's River (Figure 7); Middle Neebish Channel and Munuscong Channel, south of Mirre Point. Crossings between Sugar and Neebish Islands occurred only in January and early February, whereas crossings of the lower Munuscong Channel occurred throughout the study period.

Coyotes (78 crossings): Crossing activity of coyotes was high in early January, early February and early March. Rates were lower in late January and late February and there were no crossings recorded in late March. Coyote tracks were found on all channels surrounding Neebish Island, with 37 tracks on the Munuscong Channel, 32 tracks on Middle Neebish Channel and five tracks on West Neebish Channel. Coyotes generally traveled in groups of two or three whereas foxes tended to be found traveling alone.

Unknown Canids (40 crossings): Activity by unknown animals on the ice closely resembled coyote activity (Table 5). Twenty-one of 40 unknown canid crossings occurred on the Munuscong Channel, nine were across Middle Neebish Channel and ten were divided among four other channels (Figure 9).

Foxes (24 crossings): Fox crossing rates were highest in early January and early March and low the remainder of the winter. Of the 24 recorded fox crossings, 13 were on the Munuscong Channel, six on West Neebish Channel and five across Middle Neebish Channel (Figure 10).

Dogs (22 crossings): Crossings of domestic dogs occured most often in February and late March. Twenty of the 22 recorded crossings were on the lower Munuscong Channel, south of Johnson Point. The other two crossings occurred on West Neebish Channel (Figure 11).

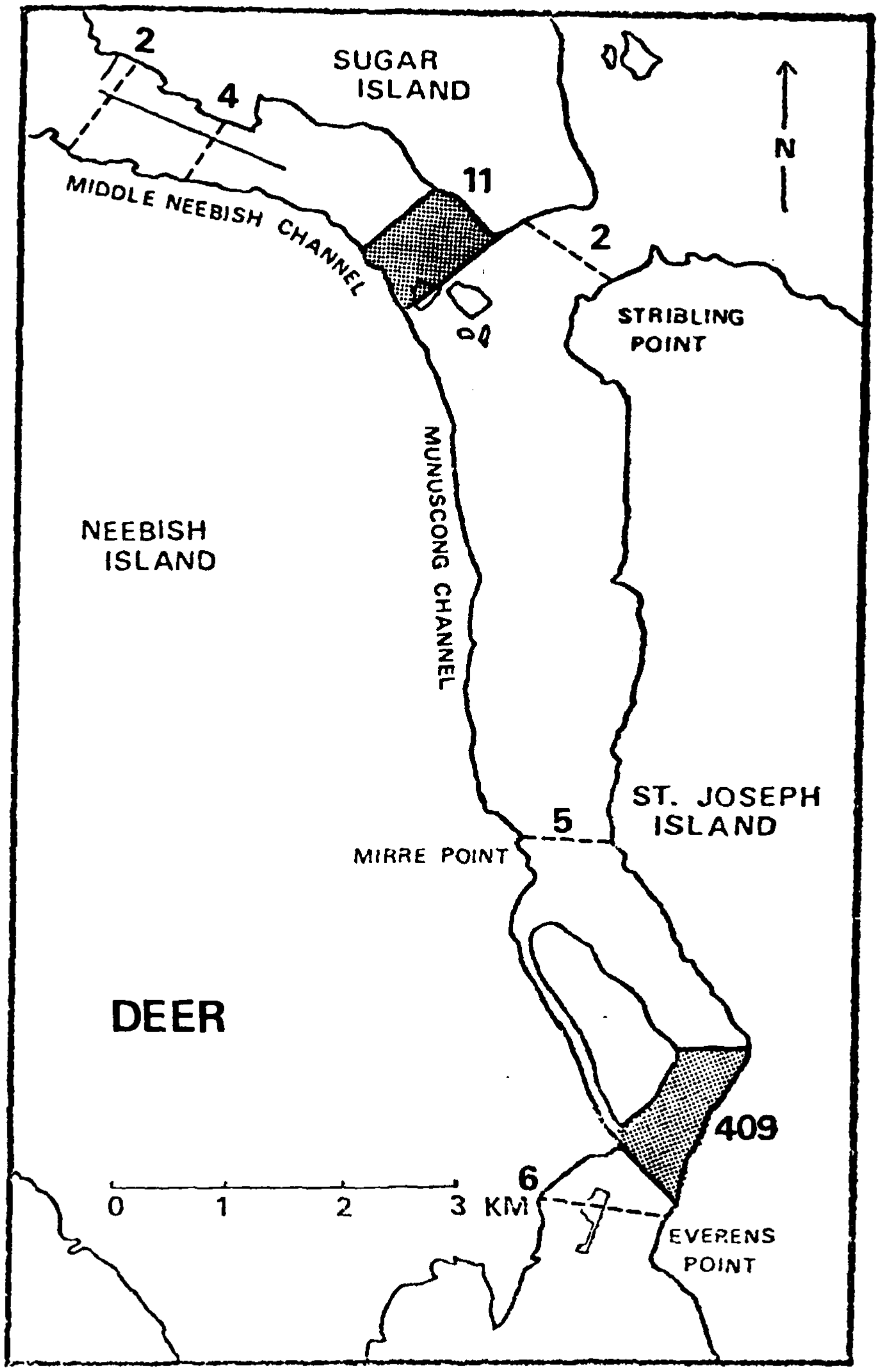

Figure 7. Locations of crossings by deer on the St. Mary's River in 1982.

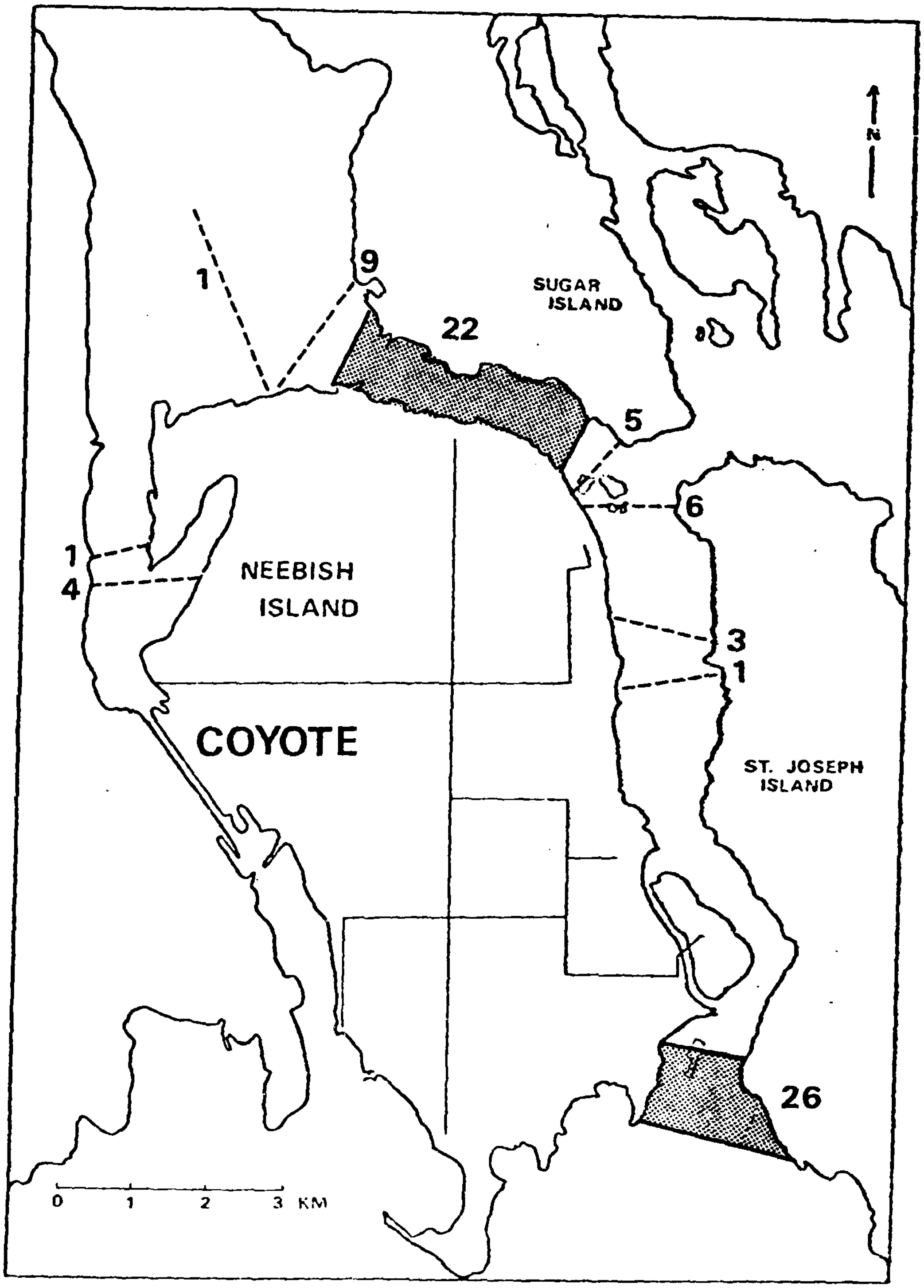

Figure 8. Locations of crossings by coyotes on the St. Mary's River in 1982.

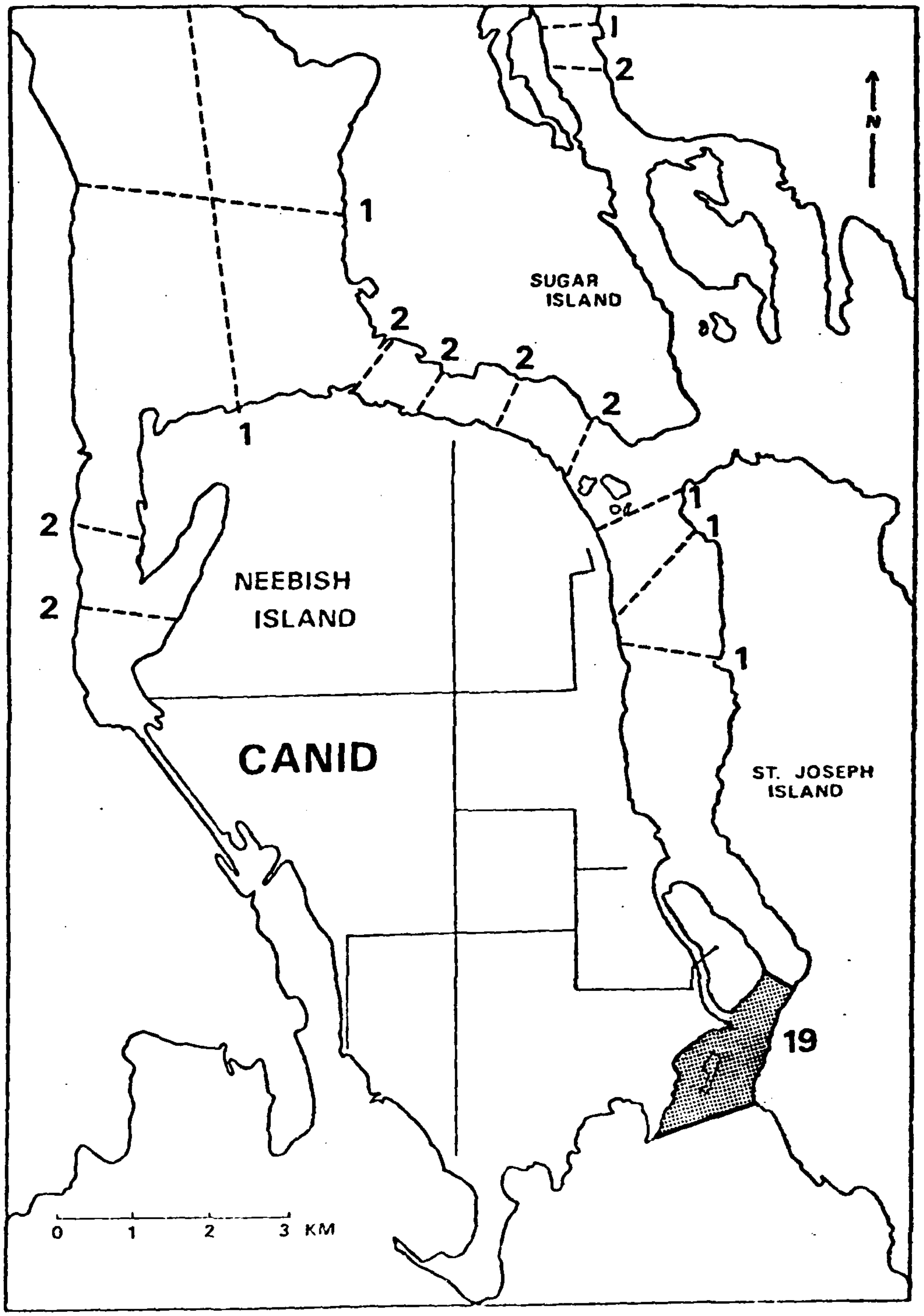

Figure 9. Locations of crossings by unidentified canids on the St. Mary's River in 1982.

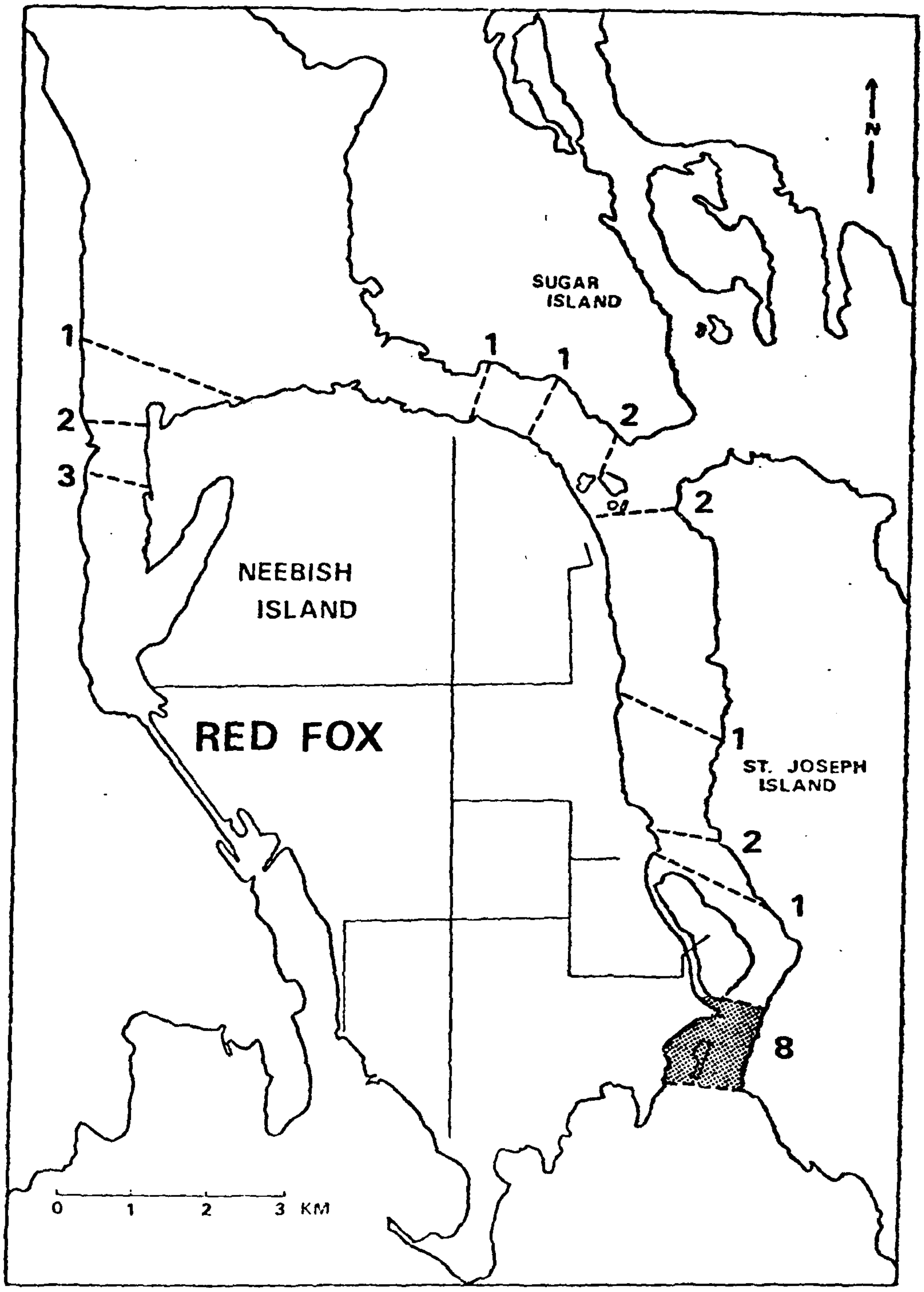

Figure 10. Locations of crossings by red foxes on the St. Mary's River in 1982.

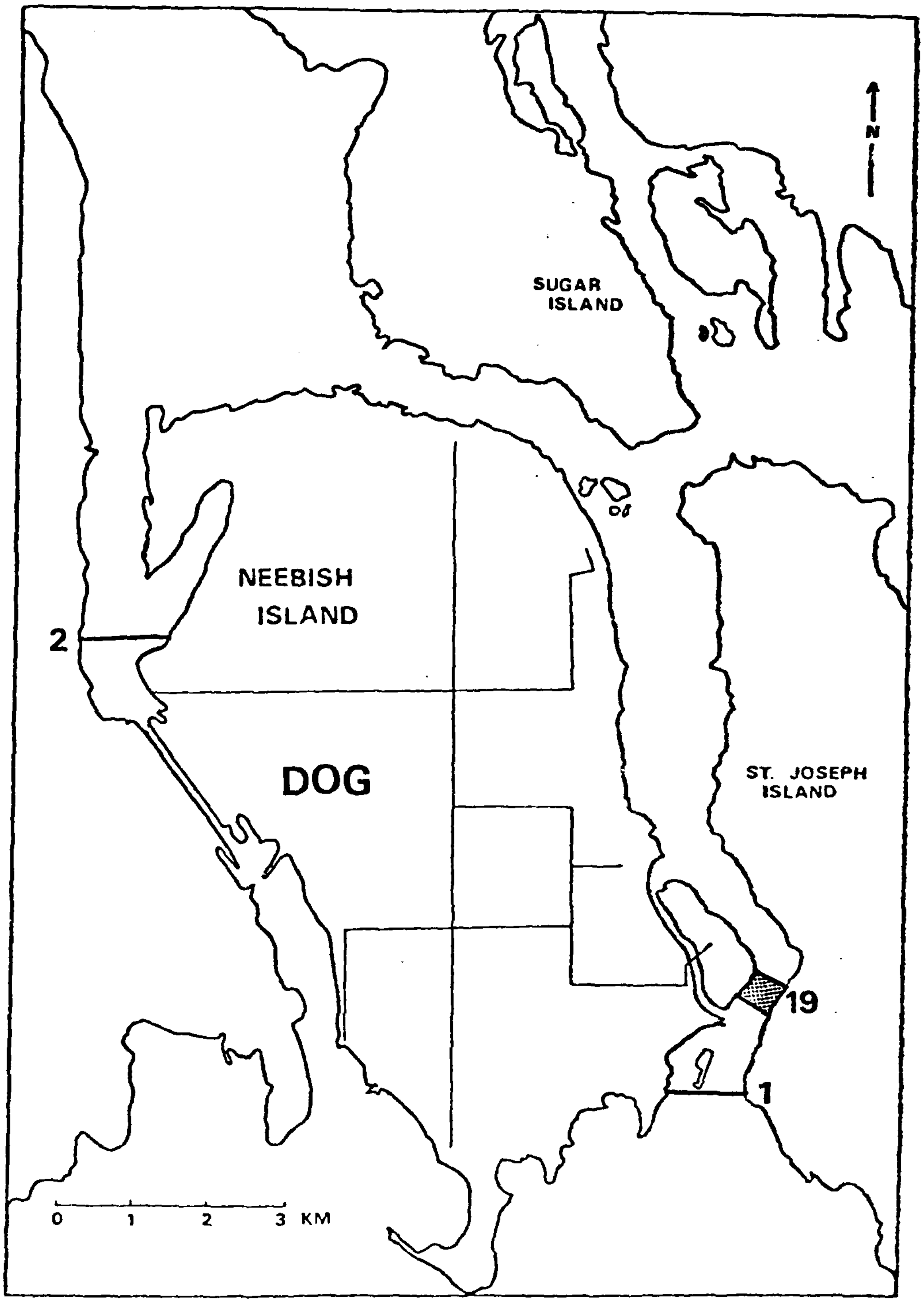

Figure 11. Locations of crossings by domestic dogs on the St. Mary's River 1982.

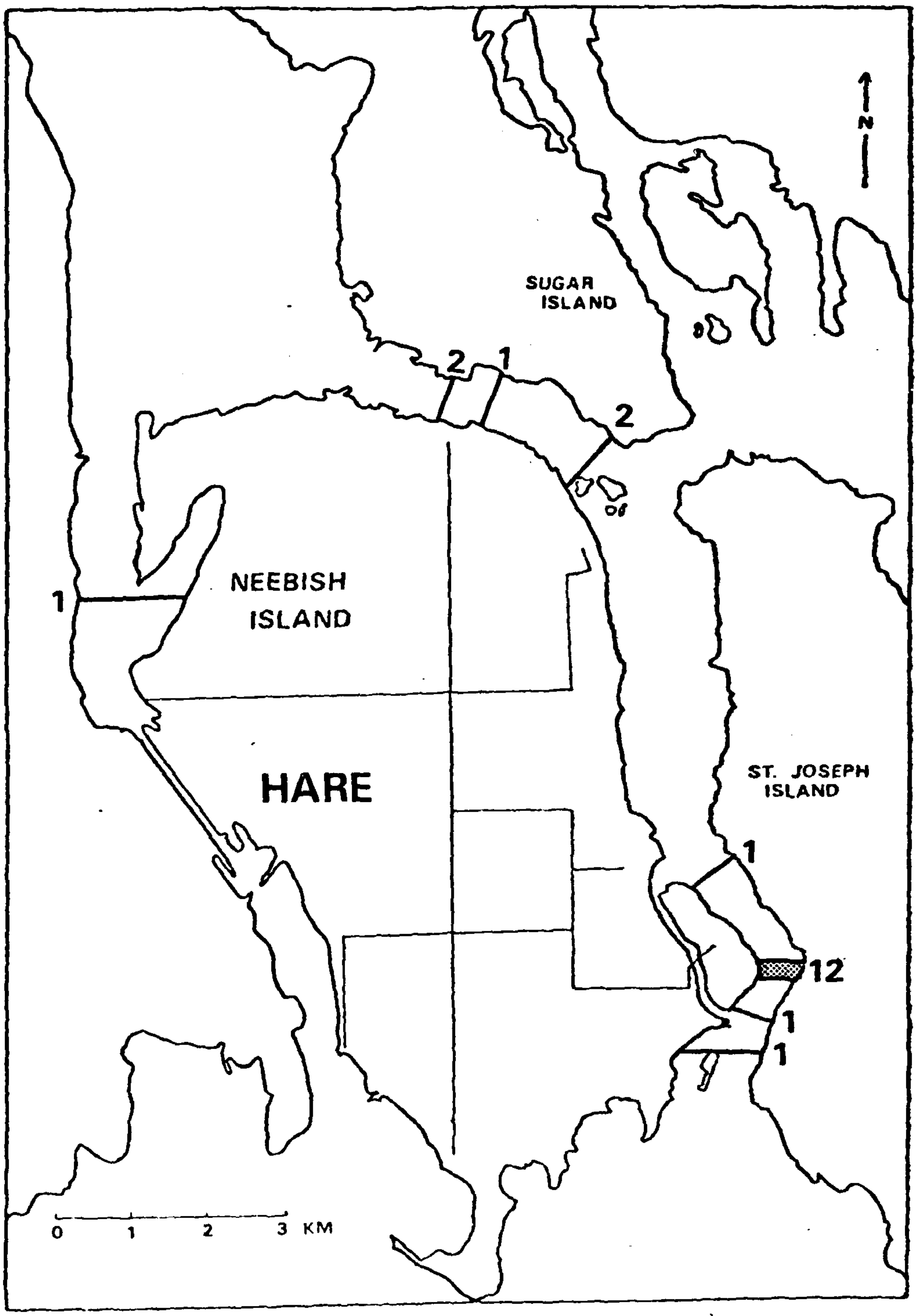

Figure 12. Locations of crossings by snowshoe hares on the St. Mary's River in 1982.

Table 5 . Mean Number of Crossings/km-day by Mammals on the St. Mary's River, 3 January to 9 April 1982. Number of Crossings is Shown in Parentheses.

		SPECIES					
Period	No. of km-days	Deer	Coyote	Unknown Canids[a]	Foxes	Dogs	Hare
January 1-14	34.4	.58 (20)	.44 (15)	.12 (4)	.17 (6)	0.0 (0)	.23 (8)
January 15-31	119.6	.13 (16)	.07 (8)	.05 (6)	.05 (6)	0.0 (0)	.03 (3)
February 1-13	67.5	2.58 (174)	.36 (24)	.30 (20)	.01 (1)	.15 (10)	.01 (1)
February 14-28	59.3	2.28 (135)	.17 (10)	.07 (4)	.07 (4)	.12 (7)	.15 (9)
March 1-15	62.5	.42 (26)	.34 (21)	.10 (6)	.11 (7)	0.0 (0)	0.0 (0)
March 16-31	20.9	3.35 (70)	0.0 (0)	0.0 (0)	0.0 (0)	.24 (5)	0.0 (0)
April 1-9	3.9	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Totals	368.1	1.20 (441)	.21 (78)	.11 (40)	.07 (24)	.06 (22)	.06 (21)

[a]Most likely coyote or red fox; possibly dog.

Snowshoe hare (21 crossings): Crossings rates for hares were highest in early January and late February. Fifteen of 21 crossings were on the Munuscong Channel, five were across Middle Neebish Channel and one was on West Neebish Channel.

Directions of Crossings of Deer

Of the 17 deer that crossed Middle Neebish Channel, 16 traveled from Sugar Island south to Neebish Island. Only one of the 17 crossed from Neebish north to Sugar Island. This southward movement of deer from Sugar to Neebish Island was also observed in the winters of 1979-80 and 1980-81. Of the 422 deer crossing the southern Munuscong Channel (south of Mirre Point) in 1982, 216 (51.2%) crossed from St. Joseph Island and traveled west to Neebish Island, and 206 (48.8%) deer traveled from Neebish Island to St. Joseph Island. As in the two previous winters crossings of the Munuscong Channel were quite evenly divided between both directions.

Local Movements of Deer

During the study period, and also in the previous winters, crossings of the lower Munuscong Channel, south of Johnson Point, were frequent. In 1982, 409 (92.7%) of the 441 total recorded deer crossings were found on this one km portion of the Munuscong Channel. In 1979-80 there were 171 crossings in this area and in 1980-81 there were 74 crossings in this area. In each year there was no tendency to cross in a single direction. During the month of February, 1982, 301 crossings (68.3% of total deer crossings) took place on this portion of the channel and on 2 February 1982, 65 sets of deer tracks were recorded. These 65 crossings, about half in each direction had taken place in a 24 hour period, and during that time we observed a group of eight deer crossing from Neebish Island to St. Joseph Island. Based on these frequent crossings, both monthly and daily, we estimated about 30-40 animals habitually crossed this portion of the Munuscong Channel.

Estimated Total Number of Crossings

The crossing rates listed in Tables 5 and 6 were used to estimate the total number of crossings by mammals on the St. Mary's River study area from 1 January to 27 March 1982. Because no portion of the study area was surveyed each day for tracks, the correction factor used by Robinson and Fuller (1980) and Robinson, Jensen and Amacher (1981) was again used in 1982 to estimate total crossings. This correction factor, used for days when track surveys were not conducted, assumed, crudely and probably conservatively, that crossing rates were one half of observed rates on days in which at least two of three weather factors considered a hindrance to tracking were present. These factors are also considered a deterrent to mammal movements. At least two to these three weather variables, daily snowfall $\geq$ 2 cm, wind speed $\geq$12 km/hr and cloud cover $\geq$ 50% (Table 1) occurred on 65% of the days when surveys were not conducted.

Using this correction factor we assumed that crossing rates were one half of observed rates on 55 days during the winter, and on 30 days crossing rates were the full rates, as presented in Tables 5 and 6. Only 17 km of the shipping channel were surveyed extensively during the 1982 study period (the channels around Neebish Island in which >90% of all crossings were recorded in the two previous years) so with the above information (number of days, crossing rates, and number of km) we estimate a total of 1384 mammals crossing the shipping channel on the St. Mary's River from 1 January to 27 March, 1982. Of the 1384 total we estimate 885 (63.9%) crossings by deer, 205 (14.8%) by coyotes, 107 (7.7%) by unknown canids, 69 (5.0%) by red foxes, 59 (4.3%) by dogs, and 59 (4.3%) by hares (Table 7).

Deer Population and Mortality Studies

Deer Trappings

During the study period, 12 deer including nine buck fawns and three doe fawns, were live-trapped on southern Neebish Island. The three does were fitted with radio-collars. All buck fawns were tagged with Michigan DNR ear tags and/or orange cattle ear tags. Table 8 summarizes the physical data of 13 trapped deer, including one deer killed by the falling door of the trap. Technical data for the radio-transmitters and Michigan DNR identification numbers are given in Appendix A. Two of the radio-collared deer became accustomed to feeding on the cedar boughs in and around the traps. Deer 772 and 122 were caught a total of ten and five times, respectively. There were also multiple captures of three tagged buck fawns.

There were a total of 43 captures (including recaptures) for 107 available trap nights, for a success rate of 40.2% or one capture per 2.5 trap nights in 1982. In the previous year, a relatively light winter, success was one capture per 9.7 trap nights with a total of five animals caught. The scarcity of natural browse in 1981-82 probably caused some deer to lose caution and subject themselves to being trapped in order to obtain food.

Status of Deer Radio-collared in 1981

Of the five deer radio-collared in the winter of 1981, two were shot during the hunting season in November, one was shot illegally on the southern part of Neebish Island in January 1982, one (the only female collared) was still transmitting in May 1982, and the signal of one deer was lost after 14 November 1981 on northwestern Neebish Island. It is likely that this buck was shot during the rifle deer season (November 15 to 30) and the collar was not returned. The next attempt at locating this deer was made on 3 January 1982.

Movements of Radio-collared Deer

Winter home ranges and movements of the four radio-collared deer in 1982 are shown in Figures 13 through 16. Sizes of home ranges and movements are summarized in Table 9. Winter home ranges of deer 135 (collared in February 1981) and 772 overlapped as did the winter ranges of deer 400 and 122. Deer 400, caught in trap #2 on 2 February, remained in an area close to the trap until 26 February. Between 9:15 a.m. on 26 February and 11:45 a.m. on 27 February this doe fawn crossed the Munuscong Channel, south of Johnson Point,

Table 6 . Comparison of Mean Number of Crossings/km-day (x 10) of Deer on Various Segments of the St. Mary's River, January - April 1980, 1981 and 1982. Number of km-days for Each Segment is Shown in Parentheses.

Channel Segment (shipping channels only)	1980	1981	1982
Middle Neebish Channel	3.66 (106.6)	4.49 (11.14)	2.71 (62.8)
North Munuscong Channel (North of Mirre Point)	.77 (90.8)	0.0	.88 (79.8)
Munuscong Channel (South of Mirre Point)	20.04 (104.8)	32.21 (28.56)	33.20 (125.0)

Table 7. Comparison of Estimated Total Number of Crossings by Mammals of the Shipping Channel on the St. Mary's River, January to April, 1980, 1981 and 1982. Percent of Column Total is Shown in Parentheses.

Species	1980		1981		1982	
Deer	598	(52.3)	441	(86.8)	885	(63.9)
Coyote	155	(13.5)	32	(6.3)	205	(14.8)
Dog	40	(3.5)	23	(4.7)	59	(4.3)
Canid	55	(4.8)	8	(1.6)	107	(7.7)
Red Fox	55	(4.8)	4	(0.8)	69	(5.0)
Hare	--		--		59	(5.0)
Unknown	241	(21.1)	--		--	
Total	1144		508		1384	

Table 8. Data on Deer Trapped on Neebish Island in the Winter of 1982.

Date Trapped	Sex	Age at Capture	Hind Foot length (cm)	Neck Girth (cm)	Chest Girth (cm)	Estimated Weight (kg)
14 Jan	Male	Fawn	43	36	99	40
17 Jan	Male	Yearling	48	47	122	60
24 Jan[a]	Female	Fawn	44	39	86	42
25 Jan[b]	Female	Fawn	41	39	91	40
27 Jan	Male	Fawn	42	41	95	40
4 Feb[c]	Female	Fawn	43	37	81	40
6 Feb[d]	Male	Fawn	46	33	63	20
12 Feb	Male	Fawn	43	36	74	40
17 Feb	Male	Fawn	42	40	86	45
23 Feb	Male	Fawn	43	39	76	36
28 Feb[f]	Female	Fawn	43	41	89	45
3 Mar	Male	Fawn	42	42	79	41
13 Mar	Male	Fawn	46	30	69	32

[a]Accidental trap mortality
[b]Deer 772 (radio-collared)
[c]Deer 400 (radio-collared)
[d]Died of starvation later in winter
[e]Shot by poacher later in winter
[f]Deer 122 (radio-collared)

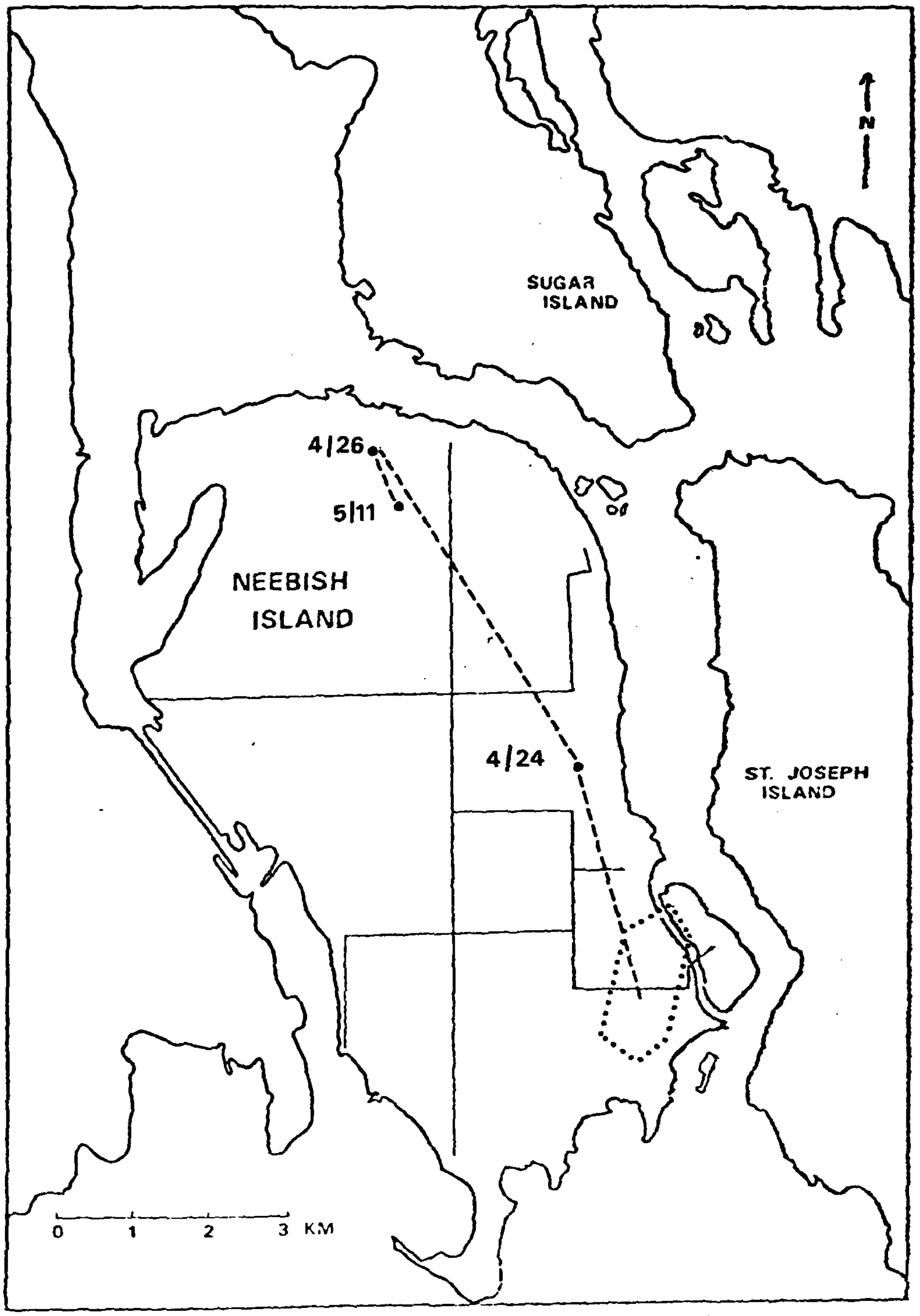

Figure 13. Winter home range (...) and movement into summer range (---) for deer 135. Dates and locations of some telemetry fixes are included.

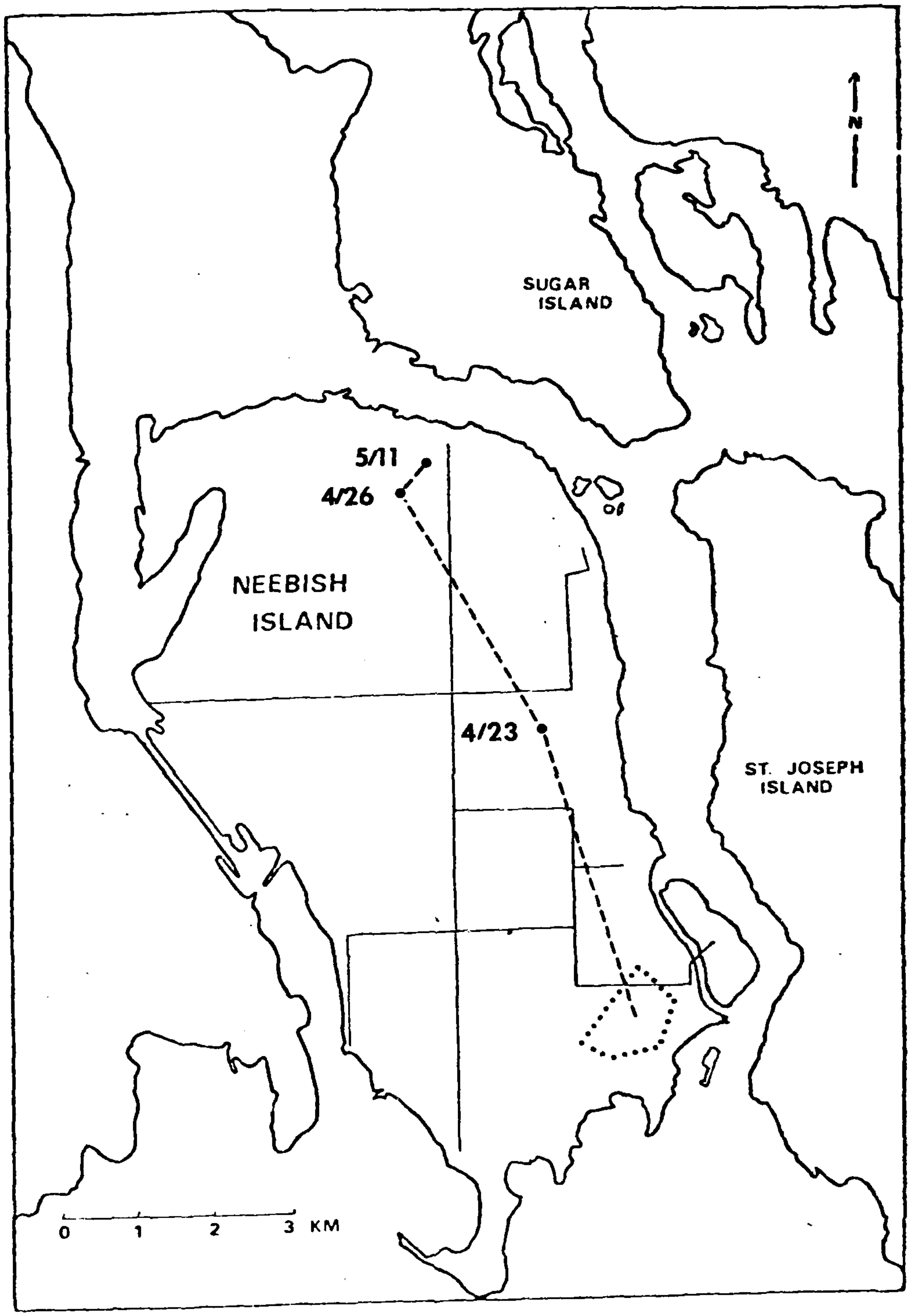

Figure 14. Winter home range (...) and movement into summer range (---) of deer 772. Dates and locations of some telemetry fixes are included.

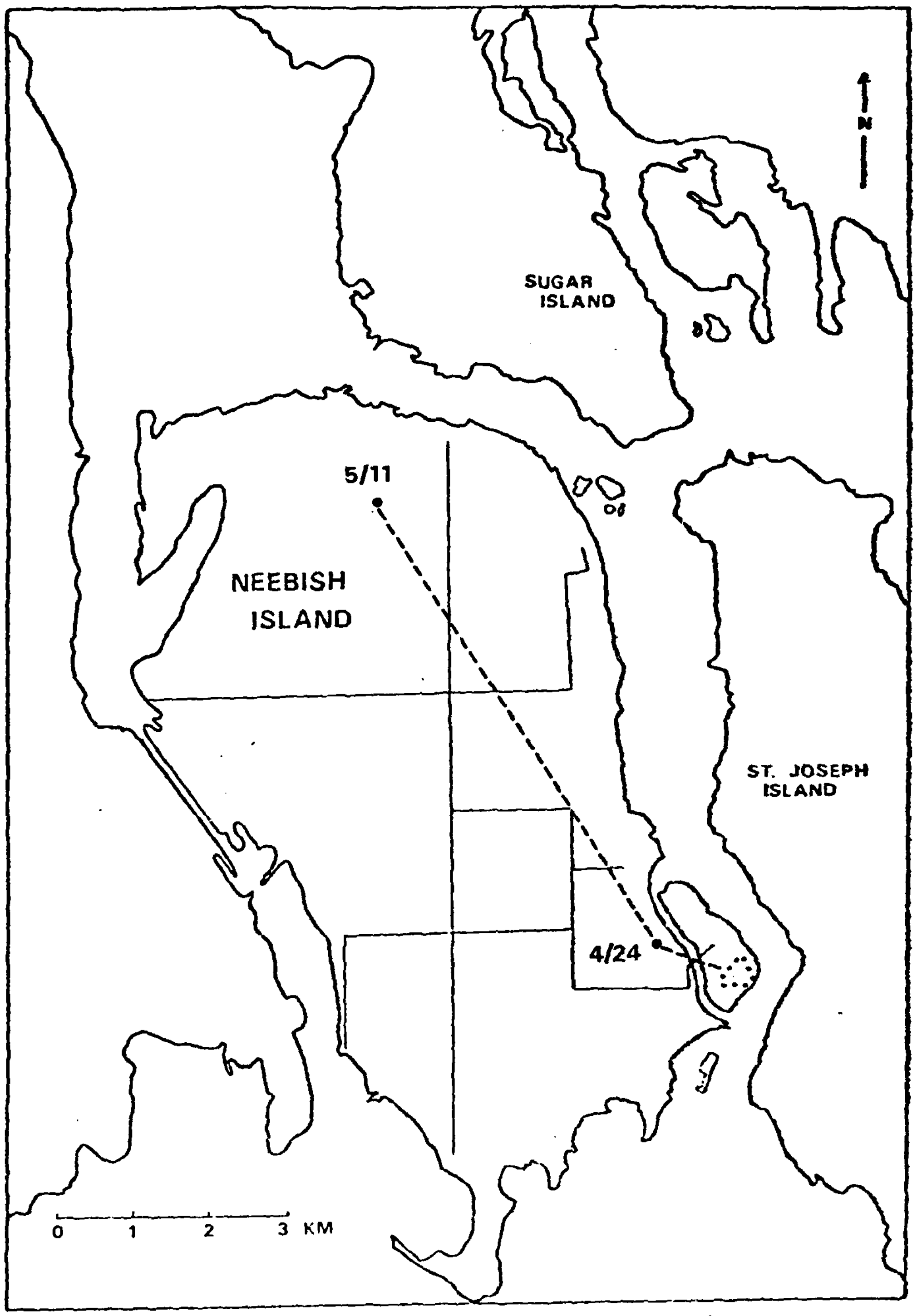

Figure 15. Winter home range (...) and movement into summer range (---) of deer 122. Dates and locations of some telemetry fixes are included.

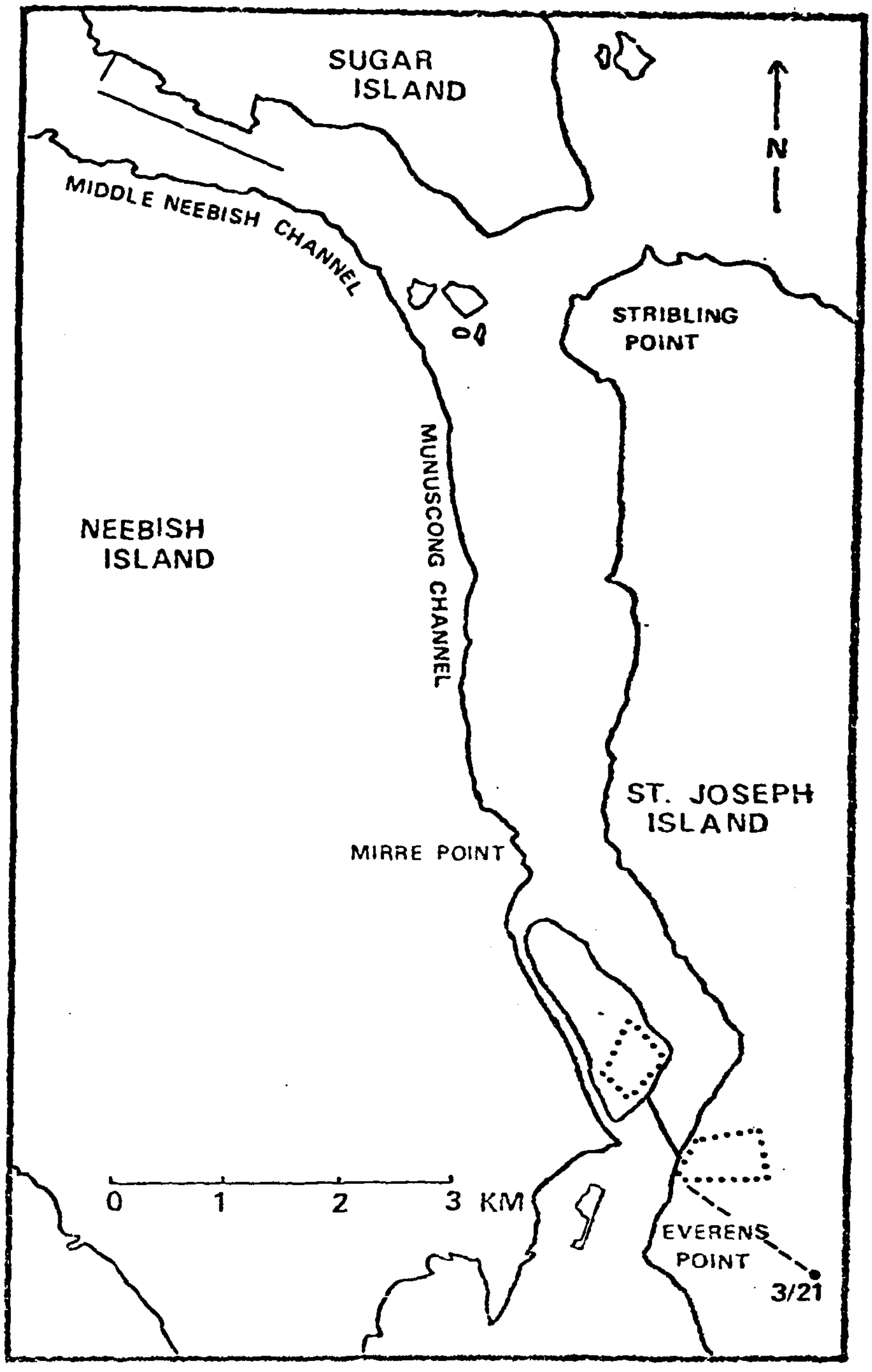

Figure 16. Winter home range (...) of deer 400 and location of last telemetry fix on 21 March. Winter home range is divided in two by the St. Mary's River (Munuscong Channel). Between 4 February and 21 March three crossings of the channel were made by deer 400.

Table 9 . Summary of Home Range and Movement Data for Four Radio-collared Deer on Neebish Island, 1982.

Deer No.	Date Trapped	Sex	Area of Winter Home Range (ha)	Average Daily Movement (km)	Approximate Distance Between Winter and Summer Ranges (km)	Number of Radio Locations
135	2/12/81	Female	155	.4	9	87
772	1/25/82	Female	70	.4	9	50
122	2/27/82	Female	9	.2	9	25
400	2/4/82	Female	49	.4	--	31

to St. Joseph Island (Figure 16). This animal crossed to Neebish Island on 19 March and returned to St. Joseph Island within 24 hours. It was located on St. Joseph Island on 21 March and has not been located since. Extensive ground surveys were conducted on Neebish Island and St. Joseph Island in April and an aerial survey was made on 12 May in order to find this deer, but it could not be located. It is possible that the radio-transmitting collar malfunctioned.

The other three radio-collared deer remained in the winter yard on southern Neebish Island throughout the winter (Figures 13 to 15). Movements out of the winter range started about 10 April for deer 135 and 722, though they did not travel together. On 25 April, deer 122 began moving north to its summer range. On 10 May, these three deer were located on the north central part of Neebish Island (Figures 13-15), approximately nine km from where they were trapped. Deer 135, radio-collared in February 1981, returned (in April 1982) to the same area it occupied in the summer, 1981. It moved out of its winter range each year in early April.

Effects of Ship Passage

During the 1982 study period, opportunities to observe tracks on the St. Mary's River occurred after the passage of ships on 3, 5, 12, 21, 27 January, 5 and 16 February. Track surveys were also conducted during commercial shipping in early April.

In 1981-82, 465 sets of deer tracks were observed on the ice. Twenty-four sets of tracks indicated that the animals returned to shore without crossing. Of these 24, broken ice due to passage may have influenced 15 turnbacks. In April during daily commercial shipping, eight deer attempted to cross and all turned back. Of the seven remaining turn-backs, one occurred within 24 hours of ship passage, three more occurred between 24 and 45 hours of ship passage, and three occurred between 45 and 60 hours after ship passage.

Table 10 is a summary of mammal crossings and turn-backs expressed as proportions at various time intervals after ship passage. Thus, nine of 11 deer returned to the shore when encountering the ship track within 24 hours of ship passage and three of 22 deer returned to the shore when encountering the ship track between 24 and 36 hours after ship passage. Of the other animals, only the snowshoe hare encountered the ship track and turned back and that could have been for other reasons since other crossings were completed during a shorter time after ship passage.

Turnbacks Before Reaching the River

During February 1982, there were 301 deer crossings, an average of 11 per day, on the Munuscong Channel, south of Johnson Point. This portion of the St. Mary's River was surveyed on 26 of 28 days in February. No surveys were possible on 11 and 20 February because of snowstorms. Excluding these two days there were only three days in February in which no deer crossings took place. No crossings or attempted crossings occurred on 6, 17, and 18 February. The

Table 10. Proportion of Animals That Turned Back From the Ship Track at Various Time Intervals During the Winter 1982 (Proportion = Number of Turnbacks/Number of Attempted Crossings).

	Approximate number of hours since ship passage			
Species	12	24	36	48
Deer		9/11	3/22	0/2
Coyote	0/3		0/13	0/6
Red Fox			0/5	
Unknown Canid	0/2	0/1	0/4	
Dog	0/1			
Hare			0/7	1/1

Katmai Bay (icebreaker) made a trip upstream on 5 February and downstream on 16 February. Table 11 lists the number of deer crossings shortly before and after the passage of the Katmai Bay on 5 and 16 February.

It appears that deer maybe able to detect the presence of open water or even thin ice without having to test it, possibly by odor. In February 1980 Robinson and Fuller (1980) observed an adult female deer with fawn apparently sniffing the ice on Munuscong Channel about 10-15 m from an open channel cut by the Katmai Bay an hour earlier. The doe and fawn turned back to Neebish Island without approaching closer to the open water. In addition, the fact that attempted crossings (either turnbacks or successful crossings) occured on days immediately following ship passage in February 1982, but did occur on all other days in the month in which tracking was possible, suggests that the number of deer venturing onto the ice and turning back from a ship track only partially reflects the number of deer that are actually impeded from crossing. It also suggests that drowning of deer by falling through thin ice, at least in this location, maybe an uncommon occurrence.

Population Estimate

Of the 150 plots sampled for deer pellet groups, 106 were determined to be in heavy deer use areas and 44 in light use areas. Average number of pellet groups in the heavy use plots was 3.65 and .57 in the light use areas. Using the formula given previously (page 15) we calculated an average of 202 deer per km^2 in heavy use areas of the yard and 31 deer per km^2 in the light use areas. The 95% confidence limits give ranges of 167 to 236 deer per km^2 and 26 to 46 deer per km^2 (Table 12).

We estimate the size of the deeryard on Neebish Island to be 12.9 km^2 and approximately 20% (2.6 km^2) are heavy deer use areas and 80% (10.3 km^2) are light use areas. Using the above estimates of deer per km^2 and the sizes of the areas of light and heavy deer usage, the number of deer wintering on Neebish Island ranges from 702 to 1088 animals.

Estimates of Winter Mortality

The systematic dead deer search conducted 17 April, covered approximately 170 ha (13%) of the estimated 1,300 ha making up the winter deeryard on southern Neebish Island (Figure 4). Remains of 13 deer were found during the search and all were determined to have died during the winter of 1981-82. In addition, nine other dead deer had been found earlier in the study. The density of deer carcasses in the search area was 7.7/km^2. Extrapolation to the entire yard of 13 km^2 yields an estimate of 100 deer dying during the winter. This estimate assumes that all dead animals in each transect surveyed were found. All three carcasses known to be present before the search were found during the search, so we feel confident that the search was effective in finding practically all carcasses in the survey area. With a population estimate of 702-1088, based on the pellet group survey, 100 winter mortalities in the deeryard represents 9.2-14.2% of the deer present.

Of the 22 dead deer found during the study period, four had been illegally shot, one doe fawn was killed accidentally by the door of the deer trap when

Table 11. Number of Deer Crossings on the Lower Munuscong Channel Before and After the Passages of the U.S. Coast Guard Icebreaker, Katmai Bay, on 5 and 16 February.

Date	Time of Track Survey	Number of Deer Crossings in the Previous 24 Hours
5 February	11:00 A.M.	9
[5 February	11:00 P.M.	Katmai Bay upstream]
6 February	11:00 A.M.	0
7 February	11:30 A.M.	1
8 February	10:00 A.M.	7
16 February	10:00 A.M.	31
[16 February	11:00 P.M.	Katmai Bay downstream]
17 February	3:00 P.M.	0
18 February	2:00 P.M.	0
20 February	11:00 A.M.	10

Table 12. Calculations for Population Estimate From Pellet Survey Neebish Island 1982.

$$\text{Formula 1} = \frac{\text{mean no. pellet groups per plot} \times \frac{1}{\text{plot size}} \times \text{size of area}}{\text{Deposition period} \times \text{defecation rate per day}}$$

plot size = $7.3m^2$
size of area =
$2.6\ km^2$ (heavy use area)
$10.3\ km^2$ (light use area)
deposition period = 203 days (between leaf-fall, 19 Oct. 81 and sampling 11 May 82)
defecation rate = 13.5 pellet groups/day

Heavy Use Areas

Mean no. of pellets per plot = 3.65

Standard error = .32

95% Confidence limits = 3.65 $\pm$ (.32) (1.96)
= 3.02, 4.28

Inserting above values into Formula 1 gives a range of deer density on heavy use areas (95% C.L.) = 167 to 236 deer/km^2

Light Use Areas

Mean no. of pellet groups per plot = 0.57

Standard error = .13

95% confidence limits = 0.57 $\pm$ (.13) (1.96)
= 0.32, 0.82

Inserting above values into Formula 1 gives a range of deer density on light use areas (95% C.L.) = 26 to 46 deer/km^2

Heavy use area = 2.6 km^2 x 167 to 236 deer/km^2 = 434 to 614 deer
Light use area = 10.3 km^2 x 26 to 46 deer/km^2 = 268 to 474 deer
95% C.L. range of deer population = 702 to 1088 deer

its twin tripped the release, two were killed by predators (probably coyotes) and 15 died of undetermined causes. A summary of the data collected on winter deer mortalities is given in Appendix B. Figure 17 shows the locations of the winter mortalities. Also listed in Appendix B is an estimation of the percent bone marrow fat for 20 deer based on chemical analysis and visual inspections at the time the carcasses were found. The percentages of bone marrow fat based upon chemical analysis appeared to be too high, based upon visual inspection. The lowest value was 50% for an animal which had watery, red gelatinous marrow indicating the animal was in very poor nutritional condition (Severinghaus and Cheatum 1956). It is possible that the samples had been slightly dehydrated before the analysis was done, with any loss of water increasing the apparent percentage of marrow fat. In view of this apparent discrepancy, we are inclined to accept the visual estimates of fat content as the more representative indicator. Of the 20 marrow samples, eight (40%) had less than 30% fat content, indicating malnutrition (Severinghaus and Cheatum 1956).

Browse Analysis

In order to determine food conditions for deer, relating to their winter survival, data on vegetation were collected from 320 available browse stems, 80 in each of the four sampled transects (Figure 6). Seven species, balsam poplar, mountain maple, balsam fir, beaked hazel, quaking aspen, white cedar and fly honeysuckle had total relative densities above 5% and made up 80.9% of the browse stems sampled. Relative density (no. of stems of each species/total number of stems x 100) of 11 species made up the remaining 19.1%. Table 13 lists the species of browse sampled in each stand and their relative densities. From the relative densities of the individual species in each stand and from the preference ratings listing in Table 4, a browse condition index, preference rating index and browse pressure index were computed for each stand (Table 14).

Stands 1, 2, and 3 had browse condition indices of approximately 3 (2.8, 3.1 and 3.1 respectively) which indicate a high degree of browsing damage in the three stands. A value of 4.0 would indicate all available stems were totally browsed while a 0.0 value would indicate no damage to any stems sampled. Stand 4, located on St. Joseph Island, had a browse condition index of 0.3, indicating little browse damage.

According to the browse preference indices, Stand 3 with a value of 2.8 had the poorest quality of available browse, though Stands 1, 2 and 4 had similar values (2.5, 2.5, and 2.4 respectively). Based on these indices (Table 14) Stand 4 is in the best condition followed by Stands 1, 2, and 3. The lower the value of the pressure index the better the browse condition (quantity and quality) of the stand.

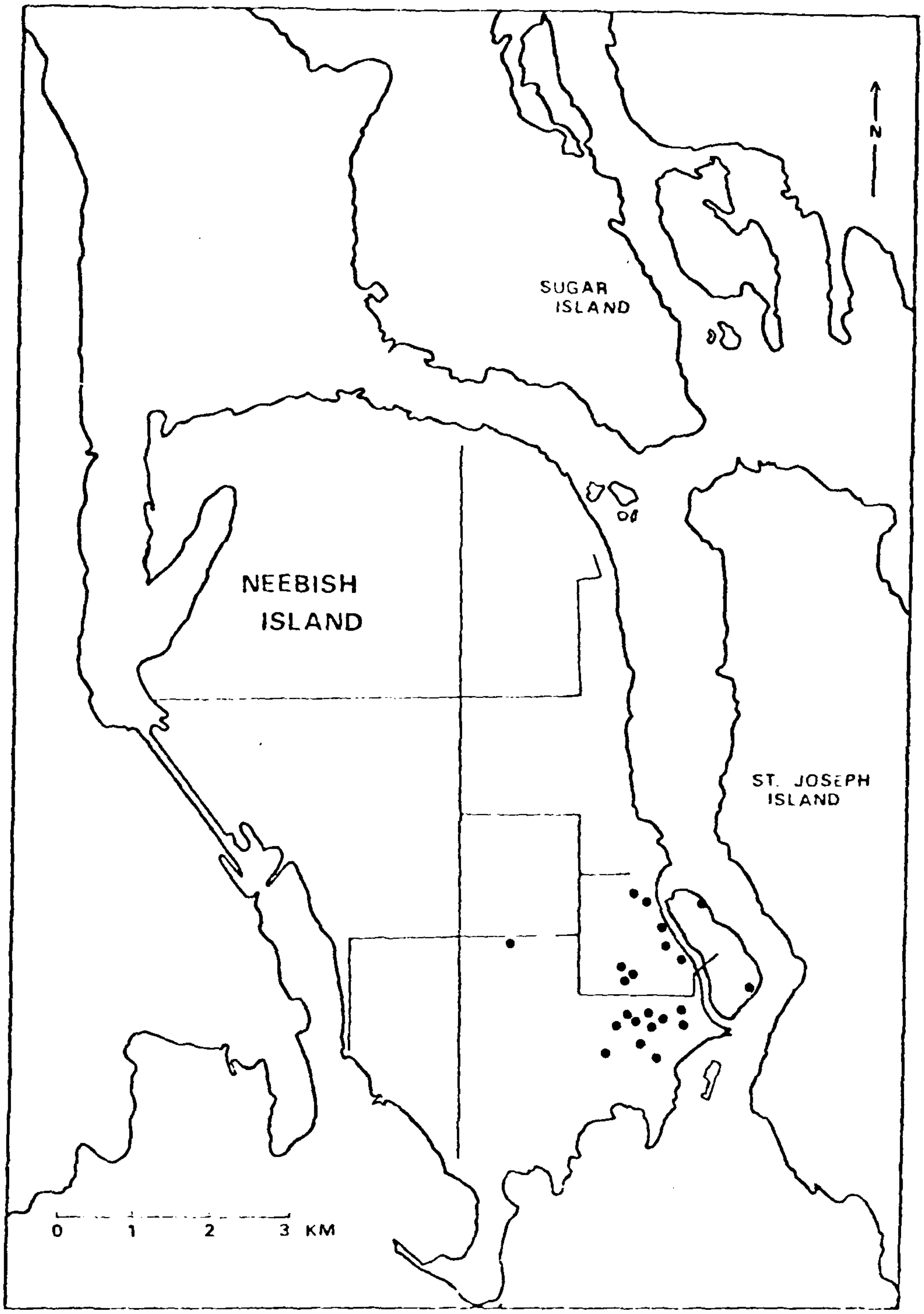

Figure 17. Locations of deer mortalities in the Neebish Island deeryard, winter 1982.

Table 13. Relative Densities for the Species of Browse Sampled at Three Locations on Southern Neebish Island and One Location on St. Joseph Island, Winter 1982.

Species	Number of Stems Sampled	Relative Density % 1	2	3	4
Balsam Poplar (*Populus balsamifera*)	54	28.8	5.0	15.0	18.8
Mountain Maple (*Acer spicatum*)	51	16.3	32.5	15.0	0.0
Balsam Fir (*Abies balsamea*)	47	7.5	3.7	2.5	45.0
Beaked Hazel (*Corylus rostrata*)	28	0.0	1.2	33.7	0.0
Quaking Aspen (*Populus tremuloides*)	27	6.2	17.5	8.7	1.2
White Cedar (*Thuja occidentalis*)	27	5.0	0.0	0.0	28.8
Fly Honeysuckle (*Lonicera canadensis*)	25	10.0	16.2	5.0	0.0
Sugar Maple (*Acer saccharum*)	13	0.0	8.8	7.5	0.0
White Birch (*Betula papyrifera*)	13	2.5	11.3	0.0	2.5
Red Maple (*Acer rubrum*)	10	8.8	0.0	3.7	0.0
Black Ash (*Fraxinus nigra*)	9	6.2	3.8	1.2	0.0
Alder (*Alnus rugosa*)	6	5.0	0.0	2.5	0.0
Michigan Holly (*Ilex verticillata*)	3	3.8	0.0	0.0	0.0
Serviceberry (*Amelanchier sp.*)	2	0.0	0.0	1.2	1.2
Red-osier Dogwood (*Cornus stolonifera*)	2	0.0	0.0	1.2	1.2
Chokecherry (*Prunus virginiana*)	2	0.0	0.0	5.0	0.0
White Spruce (*Picea glauca*)	1	0.0	0.0	0.0	1.2
Totals	320	100%	100%	100%	100%

Table 14. Browse Data for the Four Stands Sampled in 1982. Values From the 1981 Browse Survey are Shown in Parentheses. (See Figure 6 for Locations of the Stands).

Stand no.	Browse Condition Index	Preference Rating	Pressure Index	Minimum Browse Stems per Hectare
1 (Tally-Ho Swamp)	2.8 (1.9)	2.5 (2.5)	7.0 (4.8)	694 (775)
2 (SE Neebish Island)	3.1 (1.8)	2.5 (2.4)	7.7 (4.3)	546 (1563)
3 (Rains Island)	3.1 (3.0)	2.8 (2.7)	8.7 (8.1)	1235 (2222)
4 (St. Joseph Island)	0.3 (0.1)	2.4 (3.2)	0.7 (0.4)	2222 (1923)

PART V: DISCUSSION

Mammal Activity on the Ice

Locations of mammal movements across various channels of the St. Mary's River in the winter of 1981-82 were consistent with those of the two previous winters. In particular, over 90% of the crossings each winter took place on channels adjacent to Neebish Island. Table 7 compares the estimated total number of mammal crossings (across winter shipping channels) on the St. Mary's River in 1980, 1981, and 1982.

Deer

Patterns of deer movement on the St. Mary's River in 1981-82 were similar to those observed in the two previous winters, although the number of observed and estimated crossings were highest in 1981-82. Data from the three winters of study indicate that deer migrate south from Sugar Island to Neebish Island, during January and early February. Travel across the lower Munuscong Channel between Neebish and St. Joseph Islands is frequent throughout the winter with no observed preference to travel in one direction over the other. This would indicate that the deer traveled to St. Joseph Island, fed there, then returned some time later.

Four explanations for the increase in deer activity in 1982 are (1) an increased demand for food by deer during the severe winter of 1982, causing them to cross from Neebish Island to St. Joseph Island where cedar is plentiful, (2) a possible resumption of traditional movement patterns after three winters of virtually no winter shipping following six years of shipping, (3) lack of ridges of ice which were caused by early winter shipping in 1981 but not in 1982, and (4) a possible increase in deer reproduction. It is also possible that poor tracking conditions in 1981 may have resulted in an underestimate of crossings. We do not believe this to be the case however; on those days in 1981 in which good tracking conditions occurred, activity was still low.

It is apparent from our browse surveys conducted on Neebish Island and St. Joseph Island in 1981 and 1982 that the food resources for deer are greater and of better quality on St. Joseph Island. The winter of 1981-82, with a value of 116.4, was considered more severe than either 1979-80 or 1980-81 with values of 99.6 and 84.9, respectively, based on the winter severity index, (Verme 1968) calculated at the Dunbar Forest Research Station (across the West Neebish Channel from Neebish Island). The winter severity index taken into account temperature, wind chill factor, snow depth, and snow compaction and a value above 100 is indicative of a winter that is hard on deer populations. In 1981 mild weather in February decreased snow depths in fields on Neebish Island so that deer were grazing by late February. In 1982 deep snow was present on Neebish Island well into April. In the period between 16-31 March the average snow depth was 51.8 cm compared with the 1942-78 average of 23.7 cm (Table 1). The high total snowfall in 1982, 250.4 cm, compared to the 1942-78 average of 156.3 cm covered up much of the browse available in the winter yard. Demand for high quality cedar browse available on St. Joseph Island very likely was the cause of large numbers of channel crossings in 1982 (Figure 7).

Part of the increase in mammal activity on the ice in 1982 may be due to the re-establishment of traditional movement pattern to pre-winter shipping levels. Because no studies were done before winter shipping began, the extent of mammal activity on the St. Mary's River before commercial winter shipping (from 1974 through April 1979) is unknown. It is apparent from our studies that mammals regularly traverse the river channels throughout the winter. One line of evidence that may indicate a change in deer activity since winter shipping ceased in April, 1979 are the observations made on the southern end of Sugar Island in early March, 1979 and 17 April 1982. In early March, 1979, during a winter when shipping took place, several deer were seen and evidence of deer activity was abundant on southern Sugar Island. On 17 April 1982, a survey through the same area indicated that there was little deer activity. No carcasses, fresh tracks or fresh pellet groups were found in four hours of searching. This suggests that deer, unable to cross Middle Neebish Channel because of ship traffic in 1979 remained on southern Sugar island. In 1981-82, when deer were able to cross, deer migrated to Neebish Island, leaving few on southern Sugar Island. Casual inspection suggested that browse was available on Sugar Island both in 1979 and 1982, and was likely not a factor in deer occupancy.

In 1980, thick ice formed in December, and commercial shipping (until 31 December) caused the formation of high ridges of ice along the ship track. These ridges, not present in 1982, may have prevented crossings by deer early in the winter of 1981 until it eroded through weathering and icebreaker activity. In January 1981, tracks of six of 11 deer attemping to cross Middle Neebish Channel from Sugar Island, showed that deer turned back from the ship tracks even though the track was frozen and safe to cross. Though the ridges of ice may have prevented a number of crossings in 1981, regular ship traffic might eliminate the ridge. Such traffic, however also would keep the ice thin making deer crossings more hazardous.

In 1980-81 we estimated the population of deer wintering on Neebish Island at 300-350 animals. This estimate was made by observing the number of deer feeding in fields on southern Neebish Island and taking into account the percentage of open fields visible from roadsides. Rongstad and Tester (1969) estimated that 25 percent of deer present under similar circumstances in Minnesota were visible. We used that figure to arrive at our estimate of 300-350 deer. This method is crude, and probably resulted in an underestimate, judging from the 1982 estimate based upon pellet counts. The 1982 population probably was higher than the 1981 population because of the favorable winter of 1980-81. This increase in deer numbers may have contributed to the increase in deer activity observed in 1982 on the ice of the St. Mary's River.

The number of deer estimated from pellet surveys to be wintering on southern Neebish island in 1982 ranged from 702-1088 animals or 54-84 deer/km^2. In comparing this range of density to other reported winter deer densities in the Grest Lakes Region (Table 15, Jensen 1982) it seems that the density of deer on Neebish Island is quite high, especially at the upper confidence level of 84 deer/km^2. Based on Robinson's experience with the high deer densities in Beaver Basin, Michigan from 1975-1980, we feel that the actual deer density on Neebish Island is closer to the lower confidence level of 54 deer/km^2. With a population of deer on Neebish Island of 700 animals the winter mortality in 1982 would have been at least 14 percent. The winter of 1981-82 was severe on the deer on Neebish Island with at least eight of 15 mortalities (excluding illegally shot and the accidental trap killed deer) in very poor nutritional condition at the time of death.

Table 16 compares daily movements and winter home range sizes of radio-collared deer. Average daily movements were smaller in 1982 than in 1981 ($t = 2.917$ $p < .05$), suggesting the influence of deep snow inhibiting movements. Drolet (1976) in southern New Brunswick and Rongstad and Tester (1968) in Minnesota reported that winter home range sizes decreased as snow depths increased. Home range sizes of radio-collared fawns in our study tended to be smaller in 1982 than in 1981, but the difference was not significant ($t = 1.853$; $.20 > p > .10$). Deer 135, collared as a female fawn in February, 1981 returned to its winter range in 1981-82 but expanded its range from about 50 ha to 155 ha. Ozoga (1972) and Nelson and Mech (1981) suggested that with limited food available in a yard, competition for food would increase and dominant deer would probably assert themselves over subordinates. Such competition might force some young deer to move farther to obtain food thus expending more of their energy reserves. In 1981, the winter home range of deer 135 was limited to the thick cedar lowlands on southern Neebish Island. In 1982, this animal was located in the same area of the lowlands as in 1981 but in February and March it regularly traveled in and out of these lowlands. Part of its winter range in 1982 was mixed deciduous-conifer and deciduous habitat in addition to the cedar swamp.

Three of four deer radio-collared in 1982 apparently have summer ranges on the northern part of Neebish Island. The fourth deer (400) was last located on St. Joseph Island and probably summers on St. Joseph Island, as it was last located on 21 March moving east on St. Joseph Island. In 1981, four of five deer had summer ranges on Neebish Island and one had a summer range on Sugar Island. Based on track surveys on Middle Neebish Channel and the proportion of radio-collared deer (25%) summering off Neebish Island, a crude estimate of the number of deer crossing shipping channels to get to the Neebish Island yard would be 100-150 animals. Radio-telemetry data, track evidence, and sightings of deer indicate that deer cross to Neebish Island by walking on the ice, but the return trip in early spring is made by swimming after the river is free of ice.

Coyote

Coyote activity on the ice in 1982 was greater than in 1981 (78 and 10 crossings , respectively)but was similar to 1980 levels (83 crossings). We believe that 1980 and 1982 were typical and that coyote activity was low in 1981. Travel on ice by canids affords them relief from deeper snow in the

Table 15. Summary of Winter Deer Densities in the Great Lakes Region.

Location	Year	Density (deer/km^2)	Reference
Upper Michigan	1969	8	Westover 1971
	1970	5	Westover 1971
Minnesota	1959	55	Mech and Karns 1977
	1973	45	Mech and Karns 1977
	1976	39	Mech and Karns 1977
Minnesota	1959	64	Krefting and Shiue 1960
Minnesota	1964	27	Frenzel 1965
Ontario	1949	64	Bartlett 1955
Ontario	1957	16-24	Pimlott et al. 1969
Quebec	1969	19	Huot 1974
	1970	15	Huot 1974
Wisconsin	1971-74	30-42	Larson et al. 1978
Upper Michigan (Beaver Basin)	1975	113	Robinson et al. 1980
	1976	109	Fanter 1977
	1977	146	Fanter 1977
	1978	102	Robinson et al. 1980
	1979	86	Jensen 1982
	1980	61	Jensen 1982

Table 16 . Comparison of Home Range and Movement Data for Deer Radio-collared on Neebish Island in 1981 and 1982.

Deer No.	Date Trapped	Sex	Area of Winter Home Range (ha)	Average Daily Movement (km)	Approximate Distance Between Winter and Summer Ranges (km)	Number of Radio Locations
004	2/7/81	Male	50	.30	14	35
135	2/12/81	Female	50	.40	9	42
122	2/14/81	Male	140	.70	9	32
092	3/17/81	Male	100	.85	10	17
103	3/17/81	Male	150	.90	9	22
Average	--	--	98	.63	10.2	30
135	2/12/81	Female	155	.40	9	87
772	1/25/82	Female	70	.40	9	50
122	2/27/82	Female	9	.20	9	25
400	2/4/82	Female	49	.40	--	31
Average	--	--	71	.35	9	48

forests. Ozoga and Harger (1966) found that deep snow hampers coyote movements. It is reasonable to believe that canids spent less time traveling on the ice in late winter 1981 when snow depths in the woods were shallow.

Red Foxes

In 1982, 24 crossings were counted, compared to one in 1981 and 34 in 1980. As with coyotes the low activity in 1981 could be attributed to the mild winter.

Dogs

In 1980, 1981 and 1982 (24, 8, and 22 crossings, respectively) dog activity was greatest on the lower Munuscong Channel, south of Johnson Point. In each year crossings were probably made by one or two dogs crossing and recrossing the channel.

Wolves

No wolves or wolf sign was seen during the winter of 1981-82. All ground surveys were conducted in the vicinity of Neebish Island where no wolf sign had been encountered in the previous two winters. It was, therefore, unlikely that we would have found wolf evidence. Limited aerial coverage of the St. Mary's River and no coverage of Whitefish Bay reduced the probability of locating wolf sign, which was found only rarely, even with concentrated effort the previous year (Robinson et al. 1981). The Ontario Ministry of Natural Resources in October, 1981, again hired trapper Erwin Mitchell to trap wolves on Cockburn Island, 1 km east of Drummond Island (Scott Jones, OMNR, pers. comm.). Funding for wolf trapping on Cockburn Island comes from the Ontario Ministry of Agriculture, in response to requests from sheep herders on Manitoulin Island, 1 km east of Cockburn Island. Mitchell trapped one timber wolf, one coyote, and two animals identified by Jones as wolf x coyote hybrids. A summary of trapping success on Cockburn Island since 1978 is given in Table 17. Jones (OMNR) believes that the low wolf trapping success in the fall of 1981 does not mean that the wolves of Cockburn Island have been trapped out but judging from sign present a small pack remains. The future of control efforts is uncertain, and so the Cockburn Island wolf pack could expand or it could diminish. This pack would continue to be the most likely reservoir of wolves in the St. Mary's River-Whitefish Bay area to supply potential immigrants to the United States. Our conclusions, based on our literature study and personal knowledge as stated in our previous report (Robinson et al. 1981), are that attempted crossings by wolves of once every 1-2 winters remains the same.

Potential Impact of Winter Shipping

Deer

Three winters of tracking surveys on the ice of the St. Mary's River have shown that even infrequent ship traffic, such as the passages of ice-breakers, will temporarily inhibit, delay or possibly prevent the movement of deer across shipping channels. Delaying or preventing the migration of deer from Sugar Island to Neebish Island and the frequent crossings between

Table 17. Summary of the Trapping Success of Erwin Mitchell on Cockburn Island During the Autumns of 1978-1981.

Year	No. of Timber Wolves Captured	No. of Coyotes Captured	No. of Wolf x Coyote Hybrids Captured
1978	1	13	0
1979	2	4	0
1980	3	3	0
1981	1	1	2

St. Joseph Island and Neebish Island would decrease the fitness of the animals during the harsh winter period. The estimated number of winter mortalities on Neebish Island was high in 1982 (100) compared to 37 in 1981 indicating that the 1982 winter was detrimental to deer wintering on southern Neebish Island. In 1981, a mild winter with low mortality, we reasoned that any mortality caused by winter shipping would be additive to other winter mortality. In 1982, with perhaps 700 deer in the Neebish Island population, severe weather, and malnutrition common, a reduction of deer by other causes would reduce pressure on Neebish Island food reserves. Any mortality caused by prevention of deer reaching Neebish Island would then be compensatory; that is those deer, or an equivalent number, would probably die anyway. With regard to the 30-40 deer which regularly cross from Neebish Island to obtain food on St. Joseph Island, mortality associated with winter shipping would probably be additive. Shipping would prevent the use of the St. Joseph food reserves, i.e., late fall and early winter shipping would hold the deer on Sugar Island relieving the high population density on Neebish Island while all winter shipping would impede travel to St. Joseph Island food supplies.

Canids

Our data shows that coyotes and foxes are able to cross the ship track soon after the ice is refrozen (often within 12 hours, depending on temperature) so winter navigation would have little or no effect on their movements. This would only hold true if shipping was not continuous and there is time (about 12 hours) for the ship track to refreeze.

We made no direct observations of the effects of shipping on movements of wolves and none have been reported in the literature. L.D. Mech of the U.S. Fish and Wildlife Service and R.O. Peterson of Michigan Technological University, have made observations of wolves turning back from natural ice ridges on Lake Superior near Isle Royale. This suggests that wolves may be more sensitive to irregularities in ice cover than coyotes and foxes and their movements may therefore be more affected by winter shipping.

PART VI: CONCLUSIONS

(1) During the 3 January - 27 March 1982 period, 626 sets of mammal tracks were observed crossing the channels of the St. Mary's River. Of these, 441 (70.4%) were of deer, 73 (12.5%) were of coyotes, 40 (6.4%) were of unidentified canids, 24 (3.8%) were of foxes, 22 (3.5%) were of domestic dogs, and 21 (3.4%) were of snowshoe hare. No tracks of wolves were found in 1982. The number of counted crossings in 1982 was similar to the number of crossings in 1979-80, but much greater than the number of mammal crossings recorded in 1980-81.

(2) Adjusting for days in which tracks were not recorded we estimated a total of 1384 animals crossing shipping channels of the St. Mary's River in the winter of 1981-82. Of these we estimated crossings by 885 deer, 205 coyotes, 107 unidentified canids, 69 red foxes, 59 dogs, and 59 hares. The estimated totals for the winters of 1979-80 and 1980-81 were 1144 and 508, respectively.

(3) In all three winters of study deer migrated from Sugar Island on the ice across Middle Neebish Channel, to the winter yard on southern Neebish Island in January and early February. They returned to Sugar Island in early spring by swimming across the channel.

(4) Browse surveys conducted in 1981 and 1982 indicated that the food resources on St. Joseph Island are better than the food resources on Neebish Island.

(5) Deer crossed the lower Munuscong Channel frequently (409 crossings) during the winter of 1981-82 in order to reach the food resources on St. Joseph Island. The crossings are made by an estimated 30-40 deer.

(6) A pellet group survey estimated the population of deer wintering on southern Neebish island to be between 702 and 1088 animals. The population is probably closer to the lower confidence limit of 702 animals. The estimated population in 1980-81 was 300-350 animals. That was probably an underestimate but the population did increase between 1981 and 1982.

(7) In 1981-82, estimated mortality in the winter yard on Neebish Island was 100 animals, at least 14% of the wintering population. Of 22 deer carcasses found, eight died of possible malnutrition, seven of undetermined causes, and seven of miscellaneous causes. Estimated number of winter mortality in 1980-81 was 37 deer. The winter of 1981-82 was more severe than in the winter of 1980-81.

(8) Three of four deer radio-collared in 1982 remained on Neebish Island during the winter and into late spring. One deer made three trips across the Munuscong Channel during the winter and was last located on 21 March moving east on St. Joseph Island. Of eight deer radio-collared over two winters of study, six remained on Neebish Island and two left the island to get to their summer ranges. One of those leaving the island traveled to Sugar Island in April 1981 and the other went to St. Joseph Island in March 1982.

(9) Based upon studies done in 1980-81, wolves along the Canadian shore of Whitefish Bay exist in relatively low densities and attempts to cross Whitefish Bay might occur at a frequency of about once per ten years.

(10) In 1981-82, a small pack of wolves are believed to reside on Cockburn Island, 30 km east of the lower St. Mary's River. If these wolves assume a stable or increasing population, some may attempt to cross the shipping lane once every one or two winters.

(11) Winter navigation could delay or prevent the movement of deer migrating from Sugar Island to the winter yard on southern Neebish Island and impede regular crossings between St. Joseph Island and Neebish Island.

(12) During mild winters any deer mortality associated with winter shipping would probably be additive to other winter mortality. During severe winters, competition for food would limit deer numbers as well as winter navigation limiting deer movement to available food supplies on St. Joseph Island.

(13) Winter navigation would probably have little effect on small canid movements. The possible exception may be the occasional wolves which may attempt to disperse from nearby small Canadian populations.

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APPENDIX A:

Frequencies of Radio-Collars, Michigan Department of Natural Resources Identification Numbers, and Numbers of Cattle Tags for Deer Trapped on Neebish Island, Winter 1982. Deer are Numbered According to Date Trapped. See Table 8 For Physical Data Collected on Each Deer.

Date Trapped	Radio Frequency (mHz)	DNR Ear Tag Number	Cattle Tag Number
14 January	--	50570	--
17 January	--	50575	--
25 January[1]	150.772	--	--
27 January	--	50572	--
4 February[2]	151.092	--	32
6 February	--	50573[3]	--
12 February[4]	151.135	49132	--
17 February	--	4913	--
23 February	--	50592	--
28 February[5]	150.122	--	36
3 March	--	--	27
13 March	--	50573[3]	--

[1]Referred to deer 722 in text

[2]Referred to deer 400 in text

[3]Tag No. 50573 was used again after the deer tagged on 6 Feb was found dead.

[4]Referred to as deer 135 in text

[5]Referred to as deer 122 in text

APPENDIX B: Summary of Deer Mortalities on Neebish Island in the Winter 1981-82.

Carcass Number	Estimated Date of Death	Sex	Age	Cause of Death	Chemical Analysis of Bone Marrow Fat (percent)	Estimated Marrow Fat From Visual Inspection (percent)
1	7 January	Male	Adult	Poached	95	>70
2	7 January	Male	Adult	Poached	96	>70
3	7 January	Male	Adult	Poached	96	>70
4	Unknown[1]	Unknown	Unknown	Unknown	91	>70
5	15 April	Male	Fawn	Poached	97	>70
6	16 February	Male	Fawn	Possible Malnutrition	85	<20
7	Unknown	Unknown	Unknown	Unknown	97	>70
8	March	Male	Fawn	Possible Malnutrition	83	<20
9	16 April	Male	Fawn	Possible Malnutrition	57	<20
10	February	Male	Fawn	Predation	90	>70
11	3 March	Male	Fawn	Possible Malnutrition	82	<20
12	Unknown	Male	Fawn	Unknown	95	>70
13	24 January	Female	Fawn	Trap kill	97	>70
14	Unknown	Unknown	Unknown	Unknown	97	>70
15	March	Male	Fawn	Possible Malnutrition	62	<20
16	March	Male	Fawn	Possible Malnutrition	54	<20
17	February	Unknown	Unknown	Predation	95	>70
18	March-April	Female	Fawn	Possible Malnutrition	50	<20
19	February	Male	Fawn	Possible Malnutrition	73	<20
20	Unknown	Unknown	Unknown	Unknown	95	>70
21	Unknown[2]	Female	Fawn	Unknown	--	--
22	Unknown[3]	Unknown	Unknown	Unknown	--	--

[1]Unknown time of death means at sometime during the winter of 1981-82.
[2]Only skull found.
[3]Only rumen found.