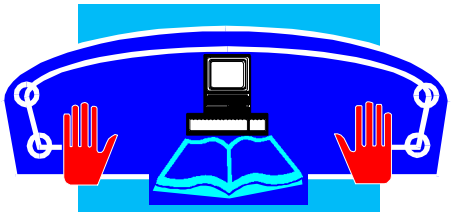

Considerations For Future Transplants Of Reindeer And Muskox In The Northwest Territories Wildlife Products, Nwt Wildlife General

Date of Report: 1985

Author: Boreal Ecology Services Ltd.

Catalogue Number: 5-1-26

5-1-26

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prepared for
Department of Economic Development and Tourism

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Yellowknife

March 1986

TABLE OF CONTENTS

Introduction

Transplants and introductions of species to new ranges is a subject often attended by a debate that goes to the core of conservation. A recent description of conservation used in the "World Conservation Strategy" developed by the International Union for the Conservation of Nature (1980) reads:

> "Human beings, in their quest for economic development and enjoyment of the riches of nature, must come to terms with the reality of resource limitation and the carrying capacities of ecosystems, and must take account of the needs of future generations. This is the message of conservation. For if the object of development is to provide for social and economic welfare, the object of conservation is to ensure Earth's capacity to sustain development and to support all life."

The advocates of species transplants and introductions often highlight the social and economic benefits of species introductions. The detractors - armed with many examples where the purposes of conservation were not served by introducing new species - often view species introductions as a form of faunal pollution and ecological vandalism. The introduction of reindeer to North America has not escaped this debate despite the fact that reindeer are the genetic and ecological equivalent to the native caribou. Many a wildlife manager's professional "mind set" is characterised by the following quote:

> "To me there is a certain majesty in the biological world which we are inescapably related to - the great sweep of hundreds of thousands of geese going over in the spring, the inconceivable noises from a great herd of caribou on the move..., - these things are, I think, part of the wealth and the breadth of the lives of most of us who are here. We are not interested in a kind of a scheme to provide half tame animals. I think all of us will believe that if we can not keep great areas of wilderness... necessary to keep some great herds of caribou moving across the tundra..., our lives, all of us will be impoverished and we will have done a

great disservice to our children and our children's children."[1]

These subjects are not repeated here to discourage the further development of the concept of reindeer and muskox transplants in the Northwest Territories but rather to describe the stage for debate which may greet formal proposals for monies and lands required for future introductions of these species.

The considerations described above must be contrasted against the social and economic circumstances of the Northwest Territories now and in the future. First, dietary protein from all indigenous sources will be required to meet protein demands by the year 2000 (Fuller and Hubert 1981). Second, the population of the Northwest Territories is doubling every 18 years (Fuller and Hubert 1981) whereas the rate of growth for total number of persons employed is increasing at one half the rate of that for the population generally (Statistics Canada data for 1961 and 1981). The economic implications of this disparity demand a protein source whose production and processing provide local jobs and income. Introduced reindeer have achieved this task in both northern Canada and Alaska.

1. Ian McTaggart Cowan addressing the First International Reindeer and Caribou Symposium 9-11 August 1972 Fairbanks, Alaska.

REINDEER

History of Reindeer Production

> "It might be said that the reindeer/caribou have been the rungs of man's social climb throughout the centuries, at least in the vast areas-the animals inhabited".[2]

A reindeer/man relationship developed many centuries ago in Europe and Asia that saw a form of domestication of reindeer requiring a nomadic herding culture. The equivalent did not take place in North America with the caribou. Nor were/are caribou amenable to herding and as a result reindeer were introduced to Alaska in 1892.

The circumstances in Alaska at the time involved a food shortage for Eskimo on the Seward Peninsula due to a decline in traditional endemic sources - caribou. The initial efforts were sponsored by church interests, however within two years the American government assumed the effort in order to extend the local food base and to create local employment in rural Alaska. By 1915 the Alaska reindeer herd totalled 70,000 and increased to 600,000 in the 1930"s during the Great Depression. Herd losses to migrating caribou, overgrazing, mismanagement, and predation are cited to have been the agents causing a decline which by 1948 left only 50,000 animals. The industry retreated to the Seward Peninsula as a village based semi-subsistence activity with approximately 25,000 animals (Klein 1980).

There is now a resurgence of the industry in Alaska as a result of native land settlements providing both lands and capital. Markets for both meat and antler products have resulted

2. Dudley-Rowley M. 1983. Scientific implications of a catalog depicting Rangifer tarandus in folklore, graphics, and implementation from earliest times to the era of United States settlement of Alaska. Acts Zool. Fennica. 167-168.

in a demand for lands and new resource management schemes (Klein, 1980) . In 1976 the Alaska Reindeer Herder Association began a program of mapping lands for reindeer grazing areas. Completion of a 7 million hectare survey and range management plan were expected to be completed in 1984. (Swanson et al, 1983. Zool. Fennica p.39)

Similar economic conditions as those experienced in Alaska in 1892 led to the introduction of reindeer to Canada. Several early attempts to introduce rein-deer to Newfoundland, Baffin Island and near Great Slave Lake failed (Scotter, 1972). Aherd purchased in Alaska in 1932 and herded to the Mackenzie Delta was established there in 1935 and has been a local source of meat ever since. Several attempts at establishing additional herds in the area however, failed (Nasogaluak and Billingsley, 1981). Following forty years of government efforts at establishing a local reindeer industry, the remaining herd (consisting of 5200 animals) and physical assets were sold to the chief herder in 1974. Despite cash flow and marketing problems in the early years this private venture, Canadian Reindeer Ltd. has grown to become a major employer and meat producer in the region. The herd has numbered as many as 13,000 animals in 1980. Range management studies show that the reindeer grazing preserve could carry as many as 20,373 reindeer (Sims, 1983).

The introduction of reindeer to the Mackenzie Delta in 1935 was preceded by intensive debate by a Royal Commission established in 1919. It recon-unended that experimental reindeer herds be established. That reconnnendation was followed by an extensive survey of arctic vegetation from the Alaska/Yukon border east to the Coppermine River and south to the north shore of Great Bear Lake (Porsild, 1954).

The reindeer stock (40 females and 10 males) released on the Belcher Islands in March 1978 were purchased from Canadian Reindeer Ltd. Unlike the first successful introduction of reindeer in Canada, the release on the Belcher Islands was not preceded by any range studies. Nor was the transplant of caribou from Coates Island to Southampton Island in 1967 precededby range studies there. Both releases were onto ranges formerly occupied by caribou and both to date have been successful and productive.

The remainder of this report describes an approach that may be used to investigate ways and means of establishing new reindeer herds in the Northwest Territories.

Physical Features of Reindeer Range

Unlike the caribou, reindeer do not undertake extensive seasonal migrations. Wild reindeer in Scandinavia may migrate from forest to alpine and back but their annual distribution is restricted to a fixed geographic region. Despite individual herds more restricted distribution, reindeer nevertheless occupy both taiga and tundra biomes in both Europe and Asia. Their distribution in North America is restricted to the maritime and arctic tundra of Alaska and the Northwest Territories. Table 1 provides several physical parameters that describe tundra ranges occupied by reindeer. These parameters describe the gross physical features of several tundra ranges presently occupied by reindeer. Another feature common to all these sites is an open landscape with relatively low physiographic relief.

Table 1. Selected Physical parameters of several tundra ranges occupied by reindeer.

Location	Latitude	Winter		Summer	
		Jan. mean temp.	Precip.	July mean temp.	Precip.
	°N	°C.	mm.	°C.	mm.
Taimyr, USSR'	75	-28		6	
Svalbard[1]	80	-10	70	4	80
Hammerfest, Norway[1]	70	-10		10	
Seward, Pen. Alaska[1]	58	-10		12	
Tuktoyaktuk[2] [3]	69	-28	60	10.6	65
Belcher Islands[3]	56	-22	300	10	250

Sources:

' Central Intelligence Agency Atlas 1978.

[2] Sims, R.A. 1983. Ground-truth and large-scale 70mm aerial photographs in the study of reindeer winter rangeland, Tuktoyaktuk Peninsula area, N.W.T.

[3] The National Atlas of Canada 1974.

At the macro scale the parameters described in Table 1 describe most of the mainland tundra of the Northwest Territories. This is hardly surprising since all of these mainland ranges are presently, or have been within historic times occupied by caribou.

What additional features then are required at the micro or local scale for tundra ranges 'to sustain a reindeer herd?

1. Forage for both summer and winter grazing within a manageable proximity.

Numerous studies have described the forage resources of reindeer range. Sims (1983) provides data on the Tukherd's range and presents carrying capacities for winter grazing lands. It is generally accepted that summer ranges are not limiting factors for reindeer herds in that forage is abundant and nutrient content high. Care must be taken however, to prevent extensive and frequent trampling of lichen which is the dominant forage item in the reinder winter diet.

Ideally, reindeer range should include the following features with respect to forage and foraging behavior:

- extensive moist to wet meadows producing a lush growth of grasses and sedges for summer grazing;
- foreslopes and backslopes of ridges producing shrubs, forbs and lichen for summer and winter browsing;
- ridges and uplands where animals can rest in dry surroundings and get respite from insects in summer;
  shrub and lichen heath for winter grazing.

Swanson et al (1983) describe a multi-phase range inventory procedure developed in Alaska in order to map 1-2 million hectares per season.

2. Caribou

A feature that is important for North American reindeer ranges is the herders' ability to remove the reindeer from ranges likely to be occupied seasonally by caribou. This is possible on the Seward Peninsula and, with vigilance, with the Tuk herd. It is not a problem in the case of the Belcher Islands, they being an insular range.

The importance of this aspect for site selection cannot be overstated. Not only are migrating caribou a threat to the integrity of a reindeer herd, the presence of reindeer on caribou range can pose serious land use conflicts as have been described for Alaska (Thomas and Arabio, 1983) and the Northwest Territories (Nasogaluak and Billingsley, 1981).

3. Local acceptance

Land use conflicts will be largely overcome if there is local support for establishing a reindeer herd. Discussions in the community leading up to that support should cover all related subjects including:

- herd ownership
- herding options
- herd management requirements
- range management requirements
  implications for caribou in the area
- harvesting regimes for reindeer herd
- short term and long term social and economic implications

These discussions did not take place with Sanikiluaq

residents since the concept enjoyed overwhelming community support from the outset, because caribou no longer occupied the Belcher Islands. The matter may not be that simple, however, in communities which either occasionally or regularly hunt caribou, as is the case at Tuktoyaktuk.

Target Sites

Given these criteria, are there sites which on their superficial appearance warrant further examination? Perhaps the most obvious sites are major islands that produce forage in adequate amounts. Two islands in Hudson Bay (Southampton in 1967 and the Belchers in 1978) have received caribou and reindeer respectively. Other islands that may warrant further investigation include:

Island	Area (mi^2)*(km^2)		Target Community (pop)
King William Island	7000	18200	Gjoa Haven *(550)*
Mansel Island	750	1950	Cape Dorset (750)/ Coral Harbour (450)
Prince Charles Island	2000	5200	Hall Beach (450)/ Igloolik (800)
Air Force Island	375	975	Hall Beach (450)/ Igloolik (800)
Nottingham Island	600	1560	Cape Dorset (750)
Salisbury Island	350	910	Cape Dorset (750)
Rowley Island	400	1040	Hall Beach (450)/ Igloolik (800)

*These are rough estimates of area.

Areas of the mainland which may provide habitat and terrain that is amenable to herding strategies to avoid conflict with

caribou include the Kent Peninsula (2000 mi2), near the communities of Cambridge Bay and Bathurst Inlet and the Adelaide Peninsula (2500 mi2) near Gjoa Haven. Examination of aerial photographs (microfiche) show that all sites show variable terrain that could provide a variety of habitats and grazing conditions. A cursory examination of Landsat V imagery reveals surface conditions similar to areas in the Reindeer Grazing Preserve. A comparison of available imagery is provided in Appendix A.

Target areas have been restricted to tundra sites because of the relative ease of habitat determination using remote sensing imagery. While this technology is also available for forested ranges, determining ground cover in forest habitat can be more expensive and time consuming than on open tundra for the same level of accuracy in the final product. Also, in the event of a reindeer transplant, herding animals should be much easier in open country than in forested country. The probability of land use conflicts on forested lands is likely to be higher due to a greater number of land uses and harvestable game species for example:

barren ground caribou on winter range,
moose,
woodland caribou, and
numerous furbearers.

Pursuing predators would also be much simpler on tundra ranges.

Survival of calves is crucial to the growth of a herd. Table 2 summarizes the cause of death in reindeer fawns as documented in a study done in the U.S.S.R. (Baskin, Acts Zool. Fennica. No. 175 1983 p.134.)

Table 2. Factors causing death of newborn reindeer calves in the first monthof life on the tundra and taige (%).

Cause of Death	Tundra	Taiga
Total deaths	4797	4926
Teratogenesis	3.2	2.1
Born weak	21.7	10.0
Abandoned	16.6	18.0
Mothers without milk	2.4	1.5
Trampled by mothers	1.2	1.4
Drowned	1.3	2.7
Frozen during blizzards	12.8	6.4
Killed by predators	4.2	12.2
Killed by dogs	1.2	0.8
Died of diseases	21.3	29.6
Broken legs	1.6	3.9
Lost (cause of death unknown)	12.5	11.3

Stocking Rates and Productivity

Established reindeer herds have stocking rates that are usually based on the grazing capacity of the winter range. Sims (1983) provides the following summary for winter range types found in the Tuk Peninsula (Table 3). These data show the information required to establish carrying capacities of selected and geographically defined ranges. The following procedure could be used:

1. Define geographic extent of range.
2. Define and map ecological units that are relevant to reindeer grazing.
3. Determine forage quantity or standing crop.
4. Determine seasonal availability and aerial extent of ecological units.
5. Establish rates of primary production.

Table 3. Estimation of winter range carrying capacity (method adapted from Parker 1976).

Reindeer management zone	'top' lichen standing crop ($kg.ha^{-1}$)	range available under snow cover[1] (x .5)	provision for a 4-year rotation[2] (x .25)
A	41.6	20.8	5.2
B	18.8	9.4	2.4
C	52.8	26.4	6.6
D	286.4	143.2	35.8
E	200.0	100.0	25.0
F	61.6	30.8	7.7
G	302.4	151.2	37.8

[1] estimated 50% of lichen forage is unavailable due to snow c
[2] 4yr grazing rotation allows for continuous use at one-qua
[3] based on daily lichen forage requirements of 5 kg for adu
in Parker 1976], DesMeules & Heyland 1969, Holleman *et al.*
[4] for management zones A, B and C based on year-round (365 d
31 (240 day) winter use.

6. Determine the annual or seasonal stocking rate for each ecological unit.
7. Establish grazing rotation and seasonal grazing intensity for range management.

Sims (1983) found that tinter stocking rates varied from 0.14 to 3.17 reindeer/km2. Stocking rates in northern Finland range from less than 0.6 to 2 reindeer/km 2 (Siuruainen, 1981). Porsild (1954) estimated that reindeer in a close herding regime require 42 acres of tundra range; this is equivalent to a stocking rate of 16 reindeer per km2. This is generally now considered to be too high but shows the range of estimates offered when scientific range management for reindeer was in the formative stages.

Reindeer productivity is not very different from that experienced on a cattle range. Under proper management the pregnancy rate is over 99%. Early fawn mortality varies with Weather Conditions at the time. Astudyby Nowosad (1975) documented the fate of 3459 calves born in the Tuk reindeer herd between 1969 and 1971. At least 69% of the males and 66% of the females survived to 4 months of age in 1969, 54% and 58% respectively in 1970 and 65 and 61% respectively in 1971.

Population growth of the Belcher Island herd provides another example of productivity. In 1978, 50 females and 10 males were released. A survey in 1982 estimated that the herd totalled 287 animals (M. Ferguson, pers. tom.). It is estimated that that herd is doubling every two years. This rapid population growth rate is not unexpected for a species when the pregnancy rate can be 100% of all adult females; also many females one year old will breed and produce a calf. Predation on the Belcher Islands is expected to be very low so significant mortality factors would be

human (which is controlled by local consensus) and weather. When the herd has reached a population size that is either at the carrying capacity of the range or satisfies the local demand for meat, productivity can be regulated by the adult sex ratio in order to provide the annual harvest. A sex ratio of 10 females for each adult male is adequate to achieve complete breeding success. Under such a regime a breeding herd of 450 could produce a harvest of 350+ animals annually.

It is suspected that the Belcher Island herd has reached a size where it must be controlled. Although detailed population and range surveys have not been completed, the winter distribution of the reindeer has changed drastically and suggests that the winter range occupied during the initial years post introduction has been depleted (M. Ferguson, pers. comm.) Domesticated reindeer are more persistent, intensive grazers than are wild reindeer and caribou (Klein, 1980). Citing Andrew (1975) Klein describes how domestic reindeer will crop twice as much lichen from a winter feeding crater than their wild counterpart. Also, while wild reindeer will crater only 5-7% of their pasture area, domesticated reindeer will crater 25-35% of the winter pasture. Andrew concluded that wild reindeer will use 3-4% of the food supply in winter and less than 1% in summer whereas domestic reindeer will use 35-40% in winter and 5-7% in summer. In the Soviet north, when grazing area exceeds 0.15 hectares (0.015 km') per animal per day, herding becomes unmanageable. Considering these factors it is assumed that winter conditions on tundra ranges at the sites proposed for further study can support reindeer herds.

Grazing intensity will in part depend on the herding regime. A loose herding strategy could be adopted in an insular herd, and so the grazing intensity may not be as high as described by

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harvesting scenarios
site specific considerations

Only on a thorough understanding of the issues by the community leadership and their participation in the development of and approval of herd and land management principles should a project be launched.

3. Range Inventory and Carrying Capacity

The reindeer and caribou literature abounds with range investigation techniques for determining reindeer carrying capacity. Sims (1983) describes a multi-stage approachhe used on the ranges occupied by the Canadian Reindeer Ltd. herd. Swanson et al (1983) described methods used to establish a data base for expanding the range in northwestern Alaska and Eriksson (1979) described a low cost method used in northern Sweden. Numerous aspects are common to each effort described:

establish the boundaries of the range to be studied.
reconnaissance and mapping using aerial photography, satellite imagery and field data
determine available biomass for grazing as well as annual production by field examinations
verify the vegetation maps and biomass distribution by low level overflight for visual inspection.
additional data of a site specific nature, ie. soil, relief, exposure, should also be documented where appropriate.

Persons who will be responsible for herd management should participate in the data collection and analysis so that the basis of carrying capacity and range management are understood and practised.

4. Establish range monitoring procedures.

Fixed plots whose vegetation has been described in detail and photographed, are an invaluable asset for monitoring range response to grazing.

5. Select a source of stock and arrange a transfer.

-'Ibis is an exercise in logistics that involves capture, containment and shipping, receiving, inspection and release. Animals should not be confined for more than 24 hours if possible and a veterinarian should be available to supervise the containment and administer tranquilizers in the case of prolonged confinement or aggravated harassment while in crates. Aholding pen should be prepared for receiving the animals so that all can be released en masse. Forage should be collected so that some is available for animals while in the holding pen. On release, the animals should be directed to suitable range.

Projected Schedule and Cost Estimates

Much of the preparatory work for a transfer of reindeer from an existing herd to a new range can be done by government officials. In the case of the Belcher Islands, officials of the Wildlife Service conducted the entire planning and preparations. The supplier of the reindeer assisted in the capture and crating and loading. Residents of Sanikiluaq built the receiving/holding pen and prepared a winter ice strip for landing DC-3 and Electra aircraft bearing the crated reindeer. Sixty adult reindeer (50 females and 10 males) were transferred. Expenditures (not including cost of planning and preparations by government staff, their travel and associated expenses) are reported to have been $66,000. A follow-up cost for a cursory range study (incomplete as of this date) amounted to $12,000.

The following schedule and cost estimates assume that the entire project would be executed by a consultant. Services and costs that could be undertaken by government are marked (*). The transplant would involve 60 adult reindeer.

Table 4: Schedule and cost estimates

Function/Month	1	2	3	4	5	6	7	8	Summer 9	10	11	12	13	14	15	March 16	17	18	19	20	21
a. Rationale for a new herd	a ---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
b. Selecting target community			b ---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
c. Community discussions					c ---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
d. Range inventory & mapping							d ---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
e. Herd/range management plan													e ---	---	---	---	---	---	---	---	---
f. Capture/transfer/release															f ---	---	---	---	---	---	---
g. Herd surveillance																9 ---	---	---	---	---	---
Costs & cash flow			5000*		7500*		5000*				50000*				12500*	75000			nil		

Total estimates **75,000** **as a government project**
155,000 **as a contract**

* indicates costs that could be offset by government personnel conducting the indicated work.

Preliminary Range Assessment

The most critical factor for establishing reindeer on new ranges is adequacy and accessibility of winter range. Vegetation must be present in adequate' amounts and snow conditions must permit reindeer to graze. Since the overall climate is endured by caribou it is assumed that the climatic conditions are amenable to reindeer husbandry.

Aerial photography for all sites mentioned in Table 5 were scrutinized for gross physiographic features. On the basis of features determined in aerial photography overall costs of a transplant to the range and accessibility to existing communities, two sites, the Kent Peninsula and the Adelaide Peninsula and adjacent King William Island were selected for more detailed comparison with known reindeer range.

Landsat 5 imagery for known reindeer range on the Tuk Peninsula and Belcher Islands was ordered to compare with imagery for prospective sites.

Images from two different sensors are generally available from the Canada Centre for Remote Sensing:

1. Thematic Mapper (TM) where each pixel represents a resolution of 30 m x 30 m on the ground, and
2. Multi spectral Scanner (MS) where each picture element (Pixel) represents 80 m x 80 m on the ground,

Pseudo - colour composite images are available

for the purposes of comparing vegetative ground cover.

Imagery from the thematic mapper (TM) was ordered for the Tuk Peninsula to get better resolution of known reindeer range. TM coverage is not available for the Kent Peninsula or Adelaide Peninsula so the TM for Tuk cannot be used for direct comparison to these sites.

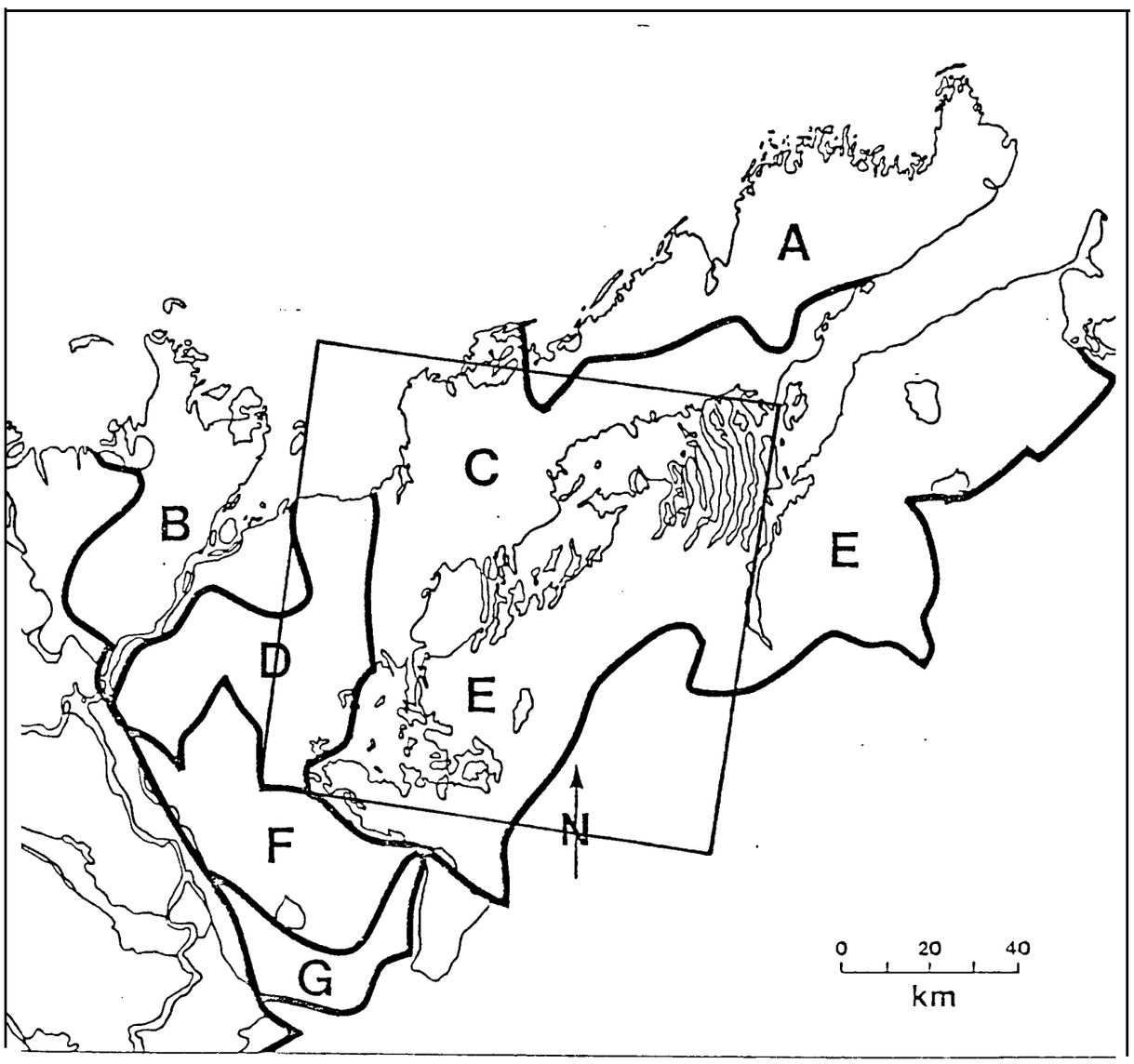
The study of reindeer range on the Tuk Peninsula by Sims (1983) described seven basic reindeer grazing units. Three of these are represented on the imagery received. Their grazing characteristics are described in Table 5. (see also Figure 1.)

Table 5. Selected characteristics of Winter Reindeer range on Tuk Peninsula

Area	Lichen Mass kg/ha	% of Total Range	Grazing days/ha
A	86.8	14	1.0
B	107 ● 2	15	1.3
c	572.0	11	7.2
E	386.0	38	5.0

On a range of 14,410 km² land area Sims (1983) calculated a winter carrying capacity of 20,373 animals or 1.4 reindeer per km². This was based on a lichen forage intake of 5 kg per adult reindeer per day taken from range where a four year grazing rotation was planned under winter conditions where not more than one half of the lichen mass is available. This means that under the regime described by Sims, not more than one eighth of the

Figure 1. Reindeer management zones in the Tuk Peninsula as described by Sims (1983), showing the approximate area covered by the imagery used for comparative purposes.



per hectare to 7.6 reindeer grazing days per hectare.

Imagery for the Belcher Islands range shows numerous areas that are more productive than any area in the scene from the Tuk Peninsula. However, many other areas on the Belchers appear much less productive than the poorest range in the Tuk scene. These coincide with areas of surface rock outcropping as seen from black and white aerial photographs. The Belcher Islands imagery shows two basic range types, a highly productive vegetative mat and a very low or unproductive rock surface.

The imagery for the Kent and Adelaide Peninsulas shows range types more resembling the Tuk ranges than those of the Belcher Islands. Both are described below.

The Kent Peninsula

This portion of the central arctic coast is low lying with numerous lakes, ponds and intervening ridges. 'Ibis lowland has extensive meadows that appear to be best developed in the well drained portions of the Peninsula . CumParing the imagery to that of the Tuk Peninsula roughly one quarter to one third of that portion of the Peninsula covered by the image has range with vegetation development that appears similar to types A and C on the Tuk range. From the imagery it is impossible to tell what the ratio of lichen to vascular plants is but it is not likely to be drastically different from the ratio at Tuk. The total production, however, is not expected to be as high as the Tuk ranges.

The area of the Kent Peninsula covered by the image is roughly 4,000 km². Eliminating the water surface reduces the range by 30% to 2800 km². Approximately one half of that appears

to be covered with sufficient vegetation to result in some colour separation in the image.

These observations are confirmed by the biophysical data provided by the Land Use Information Series maps for the area. They report habitats suitable for caribou and muskox winter range in the areas that appear to be a tan/buff colour on the image of the Kent Peninsula appearing in the appendix.

Adelaide Peninsula

All available data on the Adelaide Peninsula indicate that vegetation suitable for large ungulate habitat is very poorly developed. Although the imagery available shows large amounts of cloud cover, there is very little evidence of colour separation in cloud free areas. Where there is evidence of vegetation its aerial extent is very small. These observations are confirmed by descriptions of habitats provided by the Land Use Information Series map sheets.

Summary and Conclusions - Reindeer

The history of the reindeer industry in the Northwest Territories shows a contrast "between absolute and total failure as with the introduction near Amadjuak Lake in the 1920's; and outstanding success as in the case of Canadian Reindeer Limited under its present management. It is still too early to judge the Belcher Islands introduction. It is not however too early to learn from it and apply the lessons to a plan for the next reindeer transplant in the Northwest Territories.

The early stages of the reindeer herding at Tuk was not unlike that experienced by the Belcher Islands herd in the following areas.

1. Herd management and surveillance

This essential feature of reindeer husbandry was not well executed in Tuk until the herd was turned over to private bands. In the Belcher Islands now there does not appear to be a responsible party that monitors and documents herd activities and distribution on a regular and organized manner.

2. Government Supervision

In the early days of the Tuk herd government supervision was minimal with respect to direct involvement with the herd. This changed to a government manager and herdsman in the 1950's and 60's. The herd did not appear to thrive until government involvement ceased and a private owner managed the herd in a businesslike manner.

Similarly with the Belcher Islands herd, the government introduced the herd but there has been little direct follow-up in developing a herd management plan either by the government or by the community. The roles of government and community in herd management have not been firmly defined in a functional way.

3. Range Management

Detailed range studies at Tuk following the reconnaissance by Porsild were not conducted until concern was expressed for range quality and possible range damage in the 1960's. It was then that thorough scientific studies were done over the entire reindeer range to document and determine total range carrying capacity and incorporate the best summer and winter range into a grazing plan and grazing rotation. These studies have continued intermittently for the last twenty years.

In the Belcher Islands a similar pattern has emerged. An initial survey of a small portion of the range is the only documentation of range conditions. Despite concerns for range quality and possible overstocking, there is now (February 1986) eight years following the introduction of reindeer to this island range no plan in place for herd and range management. Furthermore there is not a clear understanding on who is responsible for range management. In order to avert serious range damage an agreement is required between the following parties:

- The Government of the Northwest Territories who transplanted the reindeer,
- The community of Sanikiluaq who are the beneficial owners of the herd,

- The Department of Indian Affairs and Northern Development who is the land manager.

Once an agreement is in place, the roles and responsibilities of each party must be established and funds allocated to meeting these on an ongoing basis to establish a scientifically based herd and range management plan. The management plan should include roles and responsibilities for routine circumstances and for contingency and emergency situations.

Although the outline of a transplant sequence above recommends a management plan be prepared prior to the transplant, it must be repeated and emphasized in light of the Tuk and Belchers herd's history. The author goes further and would recommend that short to medium term herd and range management plans (5-15 years) be developed for these two existing herds in the Northwest Territories before a new herd is established.

Recommendations

Despite a rather rigourous requirement for both suitable range and disciplined husbandry practices, the potential for reindeer production in the Northwest Territories must be rated as very good. At this point in time there are two basic recommendations that can be made to take the preliminary actions for enhancing the reindeer industry here.

1. Government must establish a policy framework that permits herd and range management plans that clearly set out the role of herd owner, land owner (in most cases government or native claimants) and government in its role as public guardian and steward.

2. Further steps be taken to identify potential herding areas that provide suitable range and access to communities. An initial field reconnaissance of the Kent Peninsula is therefore recommended to ascertain more precisely the suitability and extent of summer and winter range types there.

MUSKOX

Unlike reindeer, muskox have not had the history of intimate evolution with human cultures. First captured for zoos in the late 1800's, muskox have only recently (1960's) become the subject of attempted husbandry.

The earliest attempt at a muskox transplant was 1926 when calves were captured in Greenland, transported by ship and rail to Alaska where they were placed into a farm setting. They did not thrive and were released on Nunivak Island in the Bering Strait in 1935 as a free ranging herd. This herd survived and increased to 750 by 1968 (Spencer and Lensiuk 1970). It has since been the source of stock for numerous transplants to other Alaskan ranges from which muskox were extirpated in the 19th century, and a transplant of 40 animals to Wrangel Island and the Taimyr Peninsula of the U.S.S.R.

Nunivak Island was also the source of animals used to start the muskox farm at College, Alaska. This muskox husbandry experiment was launched in 1964 in an attempt to domesticate this beast for commercial wool production in rural Alaska. In 1976, 178 animals were transferred to an enclosed 500 acre pasture near Unalakleet on the west coast of Alaska. Poor range and herd mismanagement resulted in lack of breeding success, emaciation and parasitism (Wilkinson, pers. tom.) In 1984, 100 remaining animals were transported to a new range near Susitna in the Alaska interior north of Anchorage. The animals have prospered and in 1985 produced calves.

A muskox husbandry venture at Chimo in northern Quebec also failed to achieve commercial results and in 1974 the animals were released and became the source of a small free ranging population

in the area (Ian Juniper, Quebec Wildlife Service, pers. comm.)

A transplant of ten animals from the Northwest Territories in 1974 and 40 animals from Nunivak Island in 1975 to the Soviet Union has apparently been successful though not without some mortality. In both cases animals were initially introduced to enclosed pastures but were subsequently released and are now free ranging herds.

The capture for this export to the U.S.S.R. was conducted in summer using tranquilizer and helicopter. Yearlings were the largest animals that could be contained in crates and loaded into a DHC-6 twin otter aircraft at an "off-strip" location. In Alaska, yearlings and two year olds were captured in winter using rodeo technique from snowmobiles. According to Soviet officials, this harassment resulted in respiratory problems which ultimately caused some mortality after release in the U.S.S.R. Although there was no mortality among the animals received from the Northwest Territories, at least one abandoned the herd and was last seen 800 km south of its release point.

This anecdotal record is repeated to demonstrate that the problems and challenges of establishing a muskox herd for either commercial and/or subsistence purposes is radically different from similar objectives for reindeer.

Objectives of a Muskox Transplant

The purposes of an introduced herd must be clearly stated since that would determine the management strategy pursued. Unlike reindeer production for commercial purposes, muskox production for commercial sale does not give the manager a

choice of herding strategies. The animals must be confined to a range from which they cannot escape. Normal geographic boundaries like mountains or coast lines do not restrict muskox movement (Miller et al 1977). Since muskox are slow growing they do not make as productive meat producers as reindeer and so the end product of a commercial undertaking would be wool. Also, the meat from muskox does not enjoy as high an acceptance rating among Inuit as that of caribou. The herd must therefore be managed and either restrained for wool gathering or tamed to the point where gathering can be done with unrestrained animals. While the latter is possible, it could be done only with a very small herd making the unit cost quite high and the volume of wool quite low. Even tame animals need to be contained in a pasture. This requires fencing which requires high annual maintenance time due to the "jacking" of fence posts by the permafrost. Stone walls cannot be used because the barrier would create snow drifts on which the animals could cross the wall in winter.

If on the other hand, the new muskox herd is to provide an alternate meat source or a source of trophy animals for hunters, none of these considerations apply. Under such circumstances the only considerations are for suitable range on which release facilities can be prepared. In Alaska, yearlings and two year olds have been released at numerous locations with good results considering the lower reproductive rate displayed by muskox in the wild. If the resulting herd is to achieve a social and economic result for a specific community, as with reindeer, that community must be prepared for the introduction.

Although competition between muskox and caribou has not been proven by field studies, residents of Sachs Harbour believe muskox displace caribou on the caribou winter range. Since any muskox herd resulting from a release on the mainland Northwest

Territories or for example, Baffin Island, could over time encroach on caribou range, this aspect should be discussed with the target community.

In her review of muskox "transplants, Ann Gunn (1983) recommends the following sequence for future muskox transplants in the Northwest Territories.

"1. Full and detailed community consultation should be part of the planning for a transplant, especially to gain acceptance for transplants as a long-term project.

2. No transplant should be considered without planning and a commitment to the long-term monitoring and management of that transplant.

3. Prior to a transplant, summer field work should be done to evaluate winter and summer range, including estimation of range extent and ground sampling. Winter range snow conditions should be evaluated including areas of shallow snow and snow conditions.

4. The release area should be chosen in consultation with the Habitat Management Section to avoid;
   a) sea coasts with cliffs,
   b) areas of potential industrial activities, and
   c) the possibility of competition with other ungulates.

5. The snowmachine-net capture method should be used in the fall using local hunters, a veterinarian, and advisers from Nunivak Island. Radio-collars should be fitted to some animals and all animals should have eartags before being released.

6. Chases during capture should be limited to minimize the possibility of causing capture myopathy to either the animals being caught or others in the herd.

7. The transplant should number 20-40 yearling muskoxen with 4-8, three and four year--old cows.

8. The released population should be monitored by aerial and ground surveys on an annual basis. The first release should be treated as a pilot experiment and evaluated before other transplants are considered.

9. The health status of the source herd should be determined. Capture and transplant to virgin areas present an excellent opportunity to establish a disease-free group (R. Dieterich pers. comm.)."

The author must reinforce the essential nature of recommendations 1, 2 and 3 above. Also, all affected parties must agree on the purpose of the transplant and be emitted to the long term implications and management requirements if the stated purposes are to be realized.

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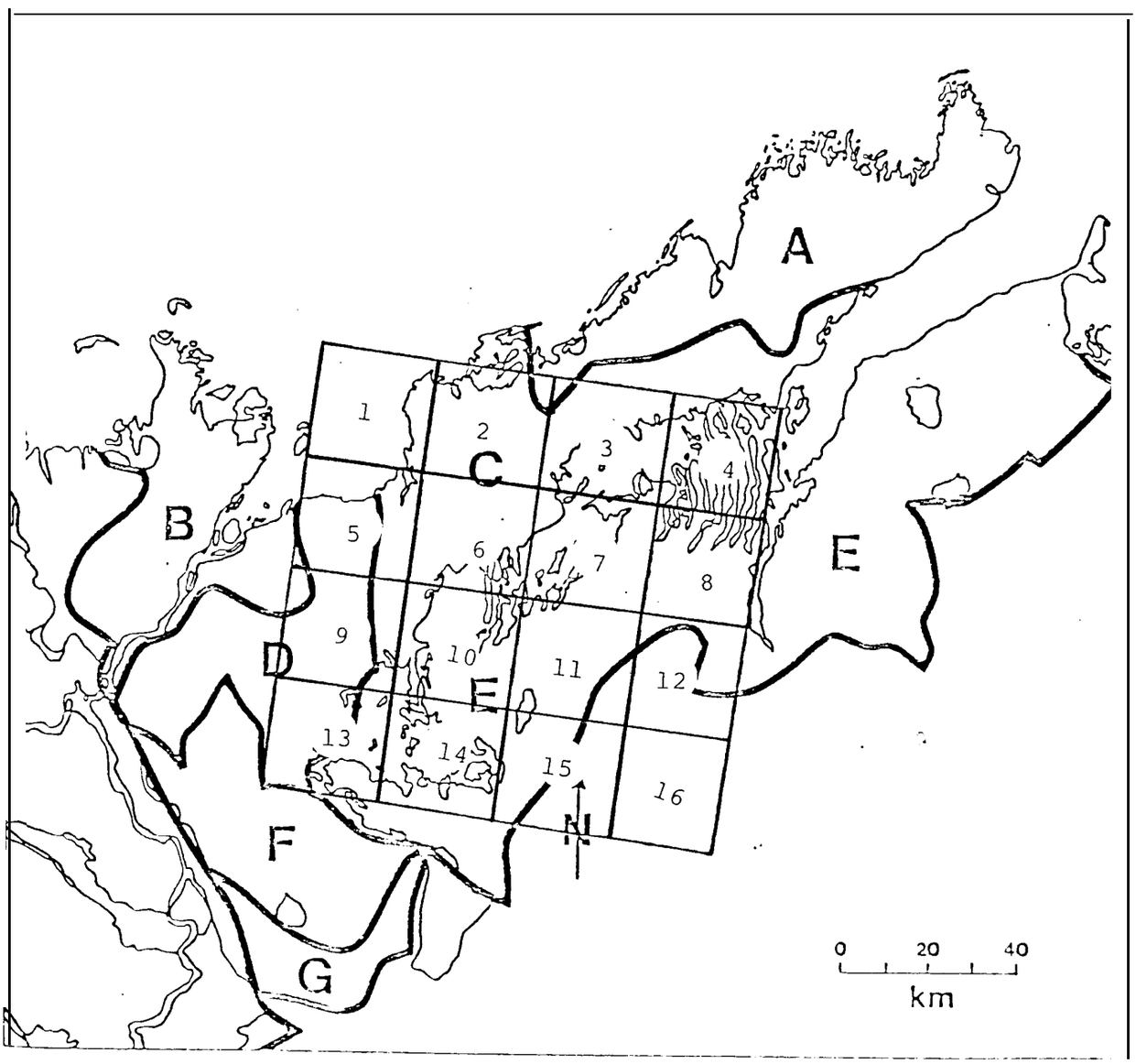
Appendix A.1

Thematic Mapper image of Reindeer Range near Tuktoyaktuk, Northwest Territories.

This image was taken at 20:04:24 on 27 June 1985 by the Landsat 5 Thematic Mapper. The resolution is 1 pixel = 30m x 30m. In this image bands 3, 4 and 5 are exposed. These provide the best image for vegetation. The red/brown range shows areas of organic material. Grens and blues indicate a colder surface such as bare soil or water/ice. Light green is probably sparse vegetation.

Contrast this image against Appendix A.2 which is an image from the multi-spectral scanner for the same range on the same date and time.

Legend A.1 Thematic Mapper image of Reindeer Range near Tuktoyaktuk, Northwest Territories.

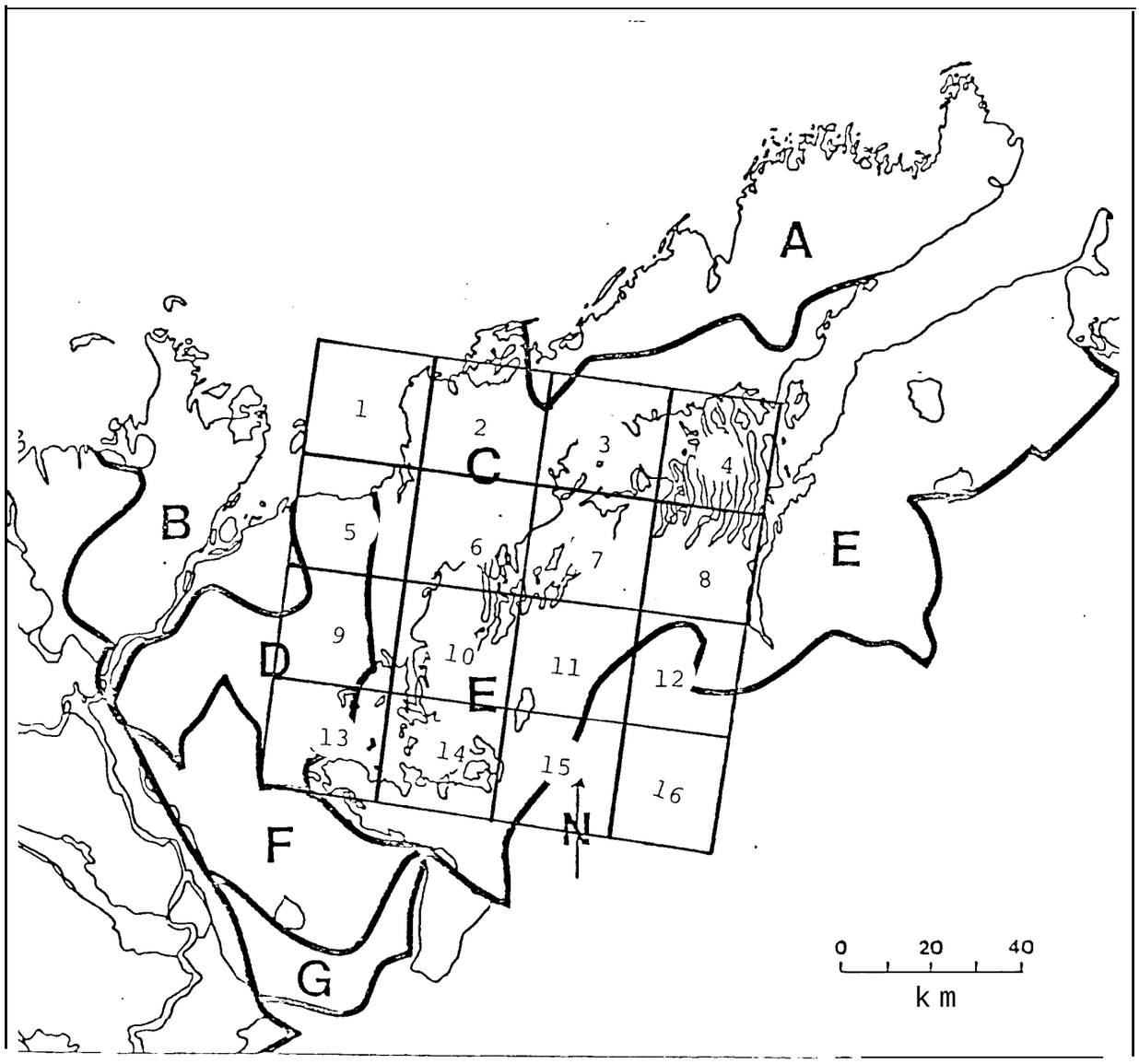


Appendix A.2

Multi-spectral scanner image of Reindeer Range near Tuktoyaktuk, Northwest Territories.

This image was taken with-the multi-spectral scanner whose pixel resolution is 80m x 80m. The effect is obvious in the grainier appearance of the image and the fuzzy contrast of lake margins compared to TM images which have almost seven times the resolution. As in A.1 the reds and browns show areas of vegetation.

Legend A.2 Multi-spectral scanner image of Reindeer Range near Tuktoyaktuk, Northwest Territories.

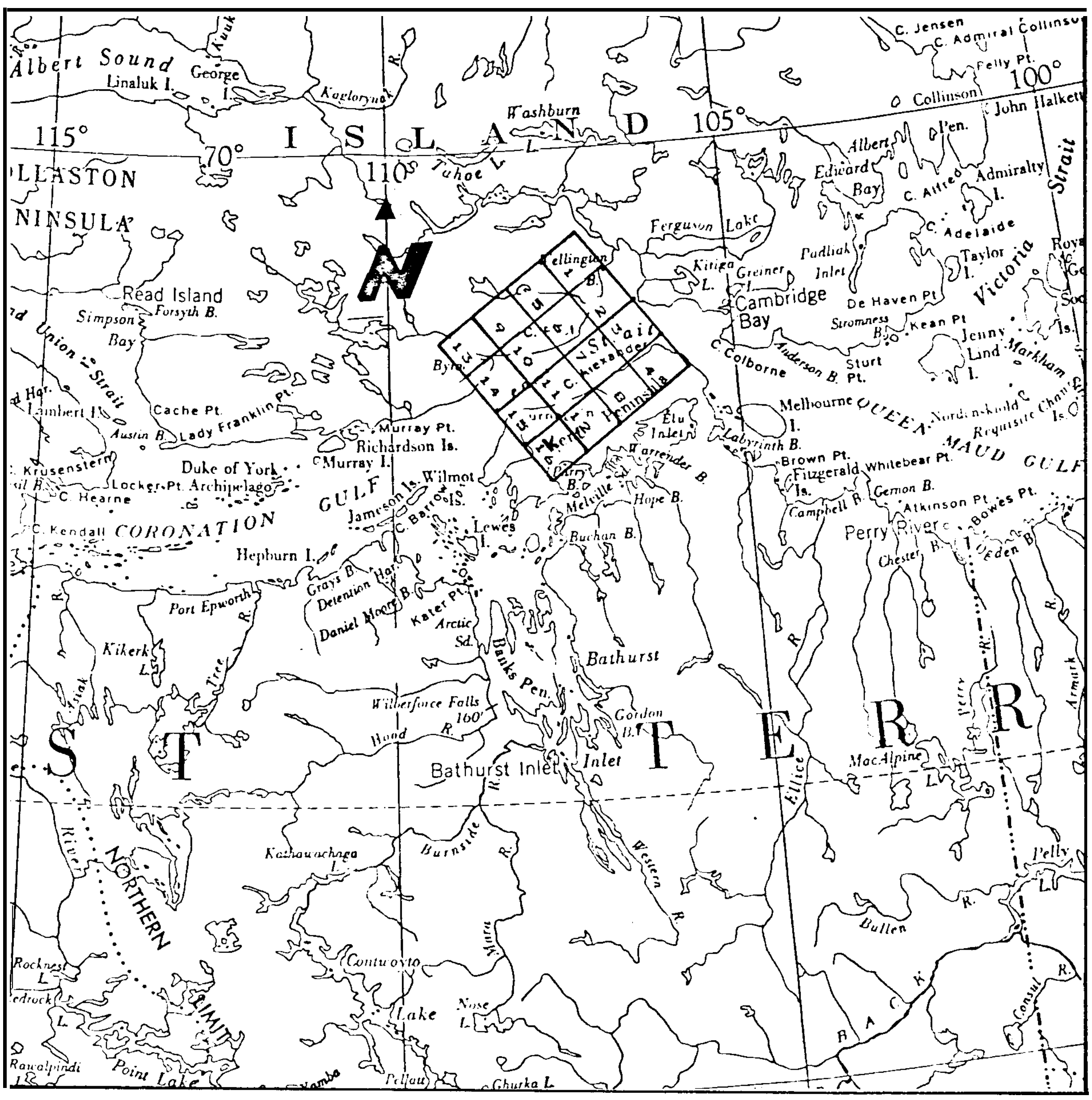


Appendix B

Multi-spectral scanner image of habitat on the Kent Peninsula, Northwest Territories.

This image from the multi-spectral scanner was taken on 4 July, 1984. The colour separation is not as strong between brown and green, indicating- less vegetation than the images for Tuk ranges show. The browns in the drainages near the centre of the peninsula show habitats that bear further examination. Considering that the image is taken very early in the arctic growing season, it is probably worthwhile trying to get imagery for late July or early August for comparison.

Legend B. Multi-spectral scanner image of habitat on the Kent Peninsula, Northwest Territories.

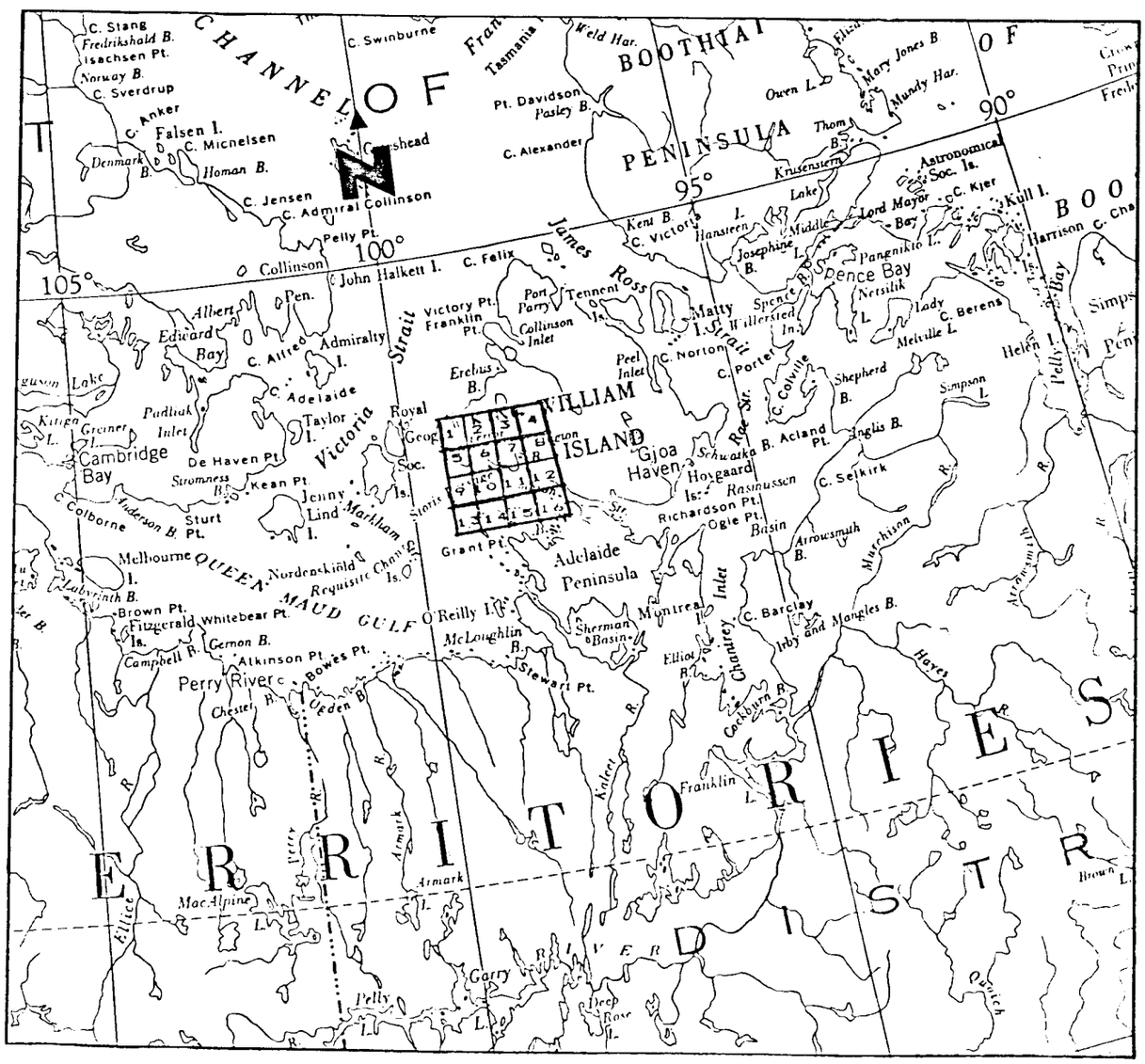


Appendix C

Multi-spectral scanner image of habitat on King William Island and the Adelaide Peninsula, Northwest Territories.

This multi-spectral scanner image was taken 10 July, 1984. It shows very little colour separation indicating very little growth at that time of year"."- Further field examination is probably not required.

Legend C. Multi-spectral scanner image of habitat on King William Island and the Adelaide Peninsula, Northwest Territories.



Appendix D

Multi-spectral scanner image of reindeer range on the Belcher Islands, Northwest Territories.

This image from the Landsat 5 multi-spectral scanner was taken on 8 August 1985. The numerous pockets of bright red show vigorous growth on the reindeer range. It shows range that is either productive or barren. This is not suprising considering the physiographic features of the Belcher Islands, which include a great deal of exposed rock. .

Legend D. Multi-spectral scanner image of reindeer range on the Belcher Islands, Northwest Territories.