LINKING TWO WAYS OF KNOWING TO UNDERSTAND CLIMATE CHANGE IMPACTS ON GEESE AND FIRST NATIONS IN THE HUDSON BAY LOWLAND

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ABSTRACT

Linking two ways of knowing to understand climate change impacts on geese and First Nations in the Hudson Bay Lowland, Ontario, Canada

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Drawing on two ways of knowing, I investigated how climate and habitat changes may be impacting Canada goose (*Branta canadensis interior*) and lesser snow goose (*Anser caerulescens caerulescens*) populations in terms of abundance and distribution, and how these changes affect Cree communities in terms of access to and harvest of geese. Using a mixed methods approach, I conducted semi-directed interviews with northern residents in the Cree First Nation communities of Moose Factory and Peawanuck, and linked local observations with quantitative historical harvest, habitat and goose population analyses.

Results indicate agreement between local observations and technical data sources that there have been changes with respect to goose habitat, abundance and distribution in the last 30 to 40 years, and more pronounced in the last 20 years. There have been changes in climate, vegetation, composition of wildlife on the coast, and timing and pattern of goose migration. There have also been changes in hunter demographics, hunting locations, timing and duration of the goose hunt, and changes in harvest of geese by both communities.

Keywords: Hudson Bay Lowland, Cree, science, Traditional Ecological Knowledge, Indigenous Knowledge, Canada geese (*Branta canadensis interior*), lesser snow geese (*Anser caerulescens caerulescens*), climate change, harvest, habitat, access, Peawanuck, Moose Factory

EXECUTIVE SUMMARY IN CREE, N DIALECT (WEENUSK)

ᓂᐧᓴᔦᐠ ᐃᑌᑫ ᐁᔑ ᐊᓇᐢᑯᓂᑲᑌᐠ ᑲ ᐃᔑ ᓂᓯᑐᒋᑲᑌᐠ ᑲ ᐊᑎ ᐊᒋᐸᓂᐠ ᐁᔑ ᑭᔑᑲᐠ
ᑲ ᐃᑐᑕᑯᒋᐠ ᐱᓀᓯᐧᐊᐠ ᓀᐢᑕ ᐅᓂᐢᑕᒪᐢᑲᓀᓯᐧᐊᐠ ᐊᐟᓯᐣ ᐯ ᐧᐊᓴᐃᐯᔭᐠ
ᒉᓂ'ᐱᐦ ᑮᐸᐢ ᑲ ᑭ ᒪᓯᓇᐊᐠ

ᓂᑲᓂ ᐊᔭᒥᐧᐃᐣ
ᐅᒪ ᐊᐸᑎᓯᐧᐃᐣ ᓂᐧᓴᔦᐠ ᑭ ᐅᑎᓂᑲᑌᐤ ᑫᐧᑲᐣ ᑲᑭᓇᐤ ᐃᓂᓂᐠ ᓀᐢᑕ ᒥᑐᓂᓯᐧᐃ
ᑭᐢᑫᓂᑕᒧᐧᐃᐣ ᑭᒋ ᐅᒋ ᐊᐧᐊᓯᑌ ᓂᓯᑐᒋᑲᑌᐠ ᑲ ᐃᑐᑕᑯᒋᐠ ᐱᓀᓯᐧᐊᐠ ᑲ ᐃᐢᐱᒋ
ᒥᒉᑎᒋᐠ ᓀᐢᑕ ᑲ ᐃᔑ ᑕᔑᐧᐃᒋᐠ ᓀᐢᑕ ᑲ ᐅᒋ ᐱᒪᒋᐅᒋᐠ ᐅᒪ ᑲ ᐊᑎ ᐊᒋᐸᓂᓂᐠ ᐁᐃᔑ ᑭᔑᑲᓂᐠ ᐅᒋ
ᐊᐣᑌ ᐊᐟᓯᐣ ᐯ ᐧᐊᓴᐃᐯᔭᐠ ᓀᐢᑕ ᑲ ᐃᑐᑕᑯᒋᐠ ᐊᓂᐃ ᓇᓀᐤ
ᐃᑕᐧᐃᓇ ᑫ ᑭ ᐅᒋ ᐊᐸᒋᐊᐧᐊᐧᑫ ᓀᐢᑕ ᓇᑕᒥᓇᐅᒋᐠ ᐊᓂᐃ ᐱᓀᓯᐧᐊ᙮ ᐊᓂᐃ ᐃᑕᐧᐃᓇᑲ ᐊᔑᒋᐸᓂᑭ ᐁᐧ
ᑲᓂᐃ ᒧᓯᓂᐧᐃ ᒥᓂᐢᑎᑯ ᐅᓂᐢᑕᒪᐢᑲᓀᓯᐧᐃᐣ ᒧᓯᓂᐧᐃ ᒥᓂᐢᑎᑯᐠ ᐁ ᐊᑎ ᑭᔑᐸᐠ ᒉᒥᐢ ᐯ ᐧᐊᓴᐃᐯᔭᐠ
ᓀᐢᑕ ᐊᓂᑭ ᐧᐁᓂᐢᐠ ᐅᓂᐢᑕᒪᐢᑲᓀᓯᐧᐊᐠ ᐊᐣᑕ
ᐱᐧᐊᓇᑯᐠ ᒪᐧᐊᒋ ᓴᐧᐊᓄᐠ ᐁ ᐃᔑ ᑭᔑᐸᐠ ᓇᓀᐤ ᐊᐟᓯᐣ ᐯ ᐧᐊᓴᐃᐯᔭᐠ᙮

ᐅᑕᓇᐠ ᑎᐸᒋᒧᐧᐃᐣ
ᐊᓂᑭ ᐅᓂᐢᑕᒪᐢᑲᓀᓯᐧᐊᐠ ᐅᒪᐡᑫᑯᐧᐊᐠ ᐊᐣᑌ ᐊᐟᓯᐣ ᐯ ᐧᐊᓴᐃᐯᔭᐠ ᒥᐢᑕᐃ
ᒪᒥᔑᑐᑕᐧᐁᐧᐊᐠ ᐊᓂᐃ ᐱᓀᓯᐧᐊ ᐁ ᐅᒋ ᐱᒪᑎᓯᐧᐊᑫᒋᐠ ᐯᔭᐧᑲᐣ ᐃᓂᑯᐠ ᑲ ᐃᔑ
ᒪᒥᔑᑐᐧᐊᒋᐠ ᒧᐧᓭ ᓀᐢᑕ ᐱᑯ ᐊᑎᐧᑲ᙮ ᐊᓂᑭ ᐃᓂᓂᐧᐊᐠ ᐊᓂᐃ ᐃᑕᐧᐃᓇ ᑲ
ᓇᑕᒥᓇᐅᒋᐠ ᐱᓀᓯᐧᐊ ᐁ ᓯᐧᑲᓂᓂᐠ ᑭᔭᐱᐨ ᒥᒉᑎᐧᐊᐠ ᐧᐁᓭ ᐊᐢᑭᐧᐃ ᐊᓂᐢᑫ
ᐱᒪᑎᓯᐧᐃᐣ ᓀᐢᑕ ᓇᓇᑕᐧᐁᓂᒋᑫᐧᐃᐣ ᑭᔭᐱᐨ ᐁ ᑭᐢᑌᓂᑕᐧᑲᐠ ᐃᓂᓂᐧᐃ ᐃᑕᐢᑲᓀᓯᐧᐃᓂᐠ᙮

ᐊᓂᐃ ᑭᑕᐯᔭᐧᐊ ᐊᐣᑌ ᐧᐊᓴᐃᐯᔭᐠ ᑲᑭᓇᐤ ᓂᑕᐧᐃᑭᐃᑐᐧᐊᐠ ᓀᐢᑕ ᑕᔑᐧᐃᐧᐊᐠ ᐊᑎᐟ
ᓇᓇᑲᐤ ᑲ ᐃᔑᓇᑯᓯᒋᐠ ᐱᓀᓯᐧᐊᐠ ᐊᓂᑭ ᒥᓯᓯᐱᐠ ᑲ ᐅᒋᐸᓂᒋᐠ ᓀᐢᑕ ᓂᐢᑲᐠ ᐊᐣᑌ
ᒥᓯᓯᐱᐠ ᐁᔑ ᓇᓯᐯᔭᐠ ᑲ ᑕᔑᐧᐃᒋᐠ ᓀᐢᑕ ᐊᓂᑭ ᓴᐧᐊᓄᐠ ᒉᒥᐢ ᐯ ᑲ ᑕᔑᐧᐃᒋᐠ
ᐊᔑᐨ ᐊᓂᑭ ᐧᐁᐁᐧᐊᐠ ᐊᐱᑕᐅᐢᑲᒥᑲᐠ ᑲ ᑕᔑᐧᐃᒋᐠ ᑲ ᐱᑦᐸᓂᒋᐠ ᐅᑌ ᐃᑌᐢᑲᒥᑲᐠ
ᓀᐢᑕ ᑲ ᐧᐊᒋᐢᑐᓂᒋᐠ ᐊᐣᑕ ᑲ ᐃᔑ ᓇᑕᒥᓇᐅᒋᐠ ᐊᓂᐃ ᓇᓀᐤ ᐃᑕᐧᐃᓇ᙮ ᐊᑎ
ᐊᒋᐸᓂᓂᐤ ᑲ ᐃᔑ ᐣᑕᐧᐃ ᐱᐳᓂᔑᒋᐠ ᐊᐣᑌ ᒥᔑ ᒧᑯᒪᐣ ᐊᐢᑭᐠ ᓀᐢᑕ ᑲ ᐃᔑ
ᐱᑦᐸᓂᒋᐠ ᐊᔑᐨ ᓀᐢᑕ ᑲ ᐃᔑ ᓂᑕᐧᐃᑭᐃᑐᒋᐠ᙮ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᐊᐣᑌ ᐊᐟᓯᐣ ᐯ
ᐃᑌᑫᐢᑲᒥᑲᐠ ᓀᐢᑕ ᓄᐧᑲᐣ ᐁ ᐊᑎ ᑭᒋ ᑭᔑᐸᓂᐠ ᐁ ᐊᑎ ᐊᒋᐸᓂᐠ᙮ ᒪᒣᐣ ᐊᐣᑕ
ᑲ ᐃᑐᑕᑯᐧᐊᐧᑫ ᐅᒪ ᑲ ᐊᑎ ᐊᒋᐸᓂᓂᐠ ᐁ ᐃᔑ ᑭᔑᑲᓂᐠ ᐊᐣᑌ ᐧᐊᓴᐃᐯᐠ ᒧᓇ
ᓯᑭ ᑭᐢᑫᓂᒋᑲᑌᐤ ᐊᔑᐨ ᑲ ᐃᑐᑕᑯᐧᐊᐧᑫ ᐊᓂᐃ ᐃᓂᓂᐧᐃ ᐃᑕᐧᐃᓇ ᑲ ᑭ
ᐊᐸᒋᐊᐧᐊᐧᑫ ᓀᐢᑕ ᓇᑕᒥᓇᒋᐠ ᐊᓂᐃ ᐱᓀᓯᐧᐊ᙮

ᓇᓇᑕᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᓇ ᐊᐸᑎᓯᐧᐃᐣ
ᑭ ᐊᔭᒥᐊᑲᓂᐧᐃᐧᐊᐠ ᐃᓂᓂᐧᐊᐠ ᐊᐣᑕ ᒧᓯᓂᐧᐃ ᒥᓂᐢᑎᑯᐠ ᓀᐢᑕ ᐱᐧᐊᓇᑯᐠ ᓀᐢᑕ ᑭ
ᑲᓇᐧᐊᐸᒋᑲᑌᐧᐊ ᓇᓇᑲᐤ ᑫᔑᐧᐊᐠ ᐅᑕᓇᐠ ᓇᓇᑕᐧᐁᓂᒋᑫᐧᐃᐣ ᓀᐢᑕ ᑲ ᐅᒋ ᐱᒪᒋᐅᒋᐠ
ᓀᐢᑕ ᐁ ᑲᓇᐧᐊᐸᒥᒋᐠ ᑲ ᑕᔑᒋᐠ ᐊᓂᑭ ᐱᓀᓯᐧᐊᐠ᙮ ᐊᓂᑭ ᑲ ᑭ ᐊᔭᔑᒋᒋᐠ ᑭ
ᐅᓇᐸᒪᑲᓂᐧᐃᐧᐊᐠ ᐁᑭ ᐧᐃᒋᐧᑕᒋᐠ ᑲ ᑭ ᐊᔭᒥᐃᒋᐠ ᐃᓂᓂᐧᐃ ᐃᑕᐧᐃᓇ ᓀᐢᑕ ᑲ
ᐃᔑ ᑭᐢᑫᓂᑕᑭᐠ ᐸᐧᑲᑕᐢᑭᓂᐤ᙮ ᓇᐢᐱᐨ ᑭᒋ ᑭᐢᑌᓂᑕᐧᑲᐣ ᑭᒋ ᑕᐧᐯᒪᑲᐠ ᐊᓂᐃ
ᐧᐃᑕᒪᑫᐧᐃᓇ ᑲ ᒪᐧᐊᑐᓂᑲᑌᑭ ᓀᐢᑕ ᓂᐧᓴ ᓂᐢᐧᑕ ᑭ ᒪᐧᐊᐱᐢᒋᑲᑌᐧᐊ ᐊᓂᐃ ᐃᑕᐧᐃᓇ᙮ᑲᑲ ᑭ ᐃᔑ ᐊᓂᒧ
ᑕᑭᐠ ᐊᓂᐃ ᐃᑕᐧᐃᓇ ᑫᔑᐧᐊᐠ ᐯᐡᑭᐡ ᑭ ᑲᓇᐧᐊᐸᒋᑲᑌᐧᐊ ᐊᓂᐃ
ᒪᒪᐧᐃ ᐊᑭᒋᑫᐧᐃᓇ ᐯᔭᐧᑲᐣ ᐃᓂᑯᐠ ᐁ ᐃᔑ ᑲᓇᐧᐊᐸᒋᑲᑌᑭ᙮ ᐊᓂᐃ ᑎᐸᐊᑲᒋᑲᓇ

ᐊᔑᒥᓂᐧᐊ ᑲ ᑭ ᐃᑭᓄᐧᑫ ᑫᐧᑳᐤ ᓀᐢᑕ ᐊᐢᑭ ᓀᐢᑕ ᐁ ᐊᓂᒧᒥᑲᑌᑭ ᐊᓂᐃ ᐯᔭᐧᑳᐤ
ᑫᐧᑲᓇ ᐯᔭᐧᑳᐤ ᐊᐤᑕ ᓀᐢᑕ ᐃᐢᐱ ᑲ ᐃᑭᓄᐧᑫ᙮ ᓂᐢᑕᐨ ᑭ ᑲᓇᐧᐊᐸᒥᑲᑌᐧᐊ ᐊᓂᐃ
ᐯᔭᐧᑳᐤ ᑲ ᐃᔑ ᒥᐢᑭᑲᑌᑭ ᓀᐢᑕ ᐁᑯ ᑲ ᓇᑕᐧᐃ ᑭᐢᑫᓂᒥᑲᑌᐠ ᑭᓴᐢᐱᐤ ᐊᓂᒪ
ᐧᐃᑕᒪᑫᐧᐃᐤ ᐯᔭᐧᑳᐤ ᑲ ᐃᔑᓇᐧᑲᓄᐧᑫ ᓀᐢᑕ ᐯᔭᐠ ᑫᐧᑳᐤ ᑲ ᐱᑐᔑᓇᐧᑲᓄᐧᑫ ᓀᐢᑕ ᐱᑯ
ᐱᑐᐡ ᑲ ᐃᐧᐅᒪᑲᓄᐧᐊᐧᑫ᙮ ᒪᒥᐦ ᒪᑲ ᑭ ᓇᑕᐧᐃ ᑭᐢᑫᓂᒥᑲᑌᐤ ᑕᐤᑕ ᐁᔑ
ᐧᐃᑫᐧᐃᑐᒪᑲᓄᐧᑫ ᓀᐢᑕ ᐱᑯ ᐁ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓂᒥᑲᑌᐠ ᓀᐢᑕ ᑲ ᐃᑌᓂᒥᑲᑌᐧᑫ ᑫᐧᑳᐤ
ᐁᑲ ᐧᐁᒥ ᐧᐃᑫᐧᐃᑐᒪᑲᓄᐧᑫ ᐊᓂᐃ ᑫᐧᑲᓇ ᑲ ᓇᑕᐧᐃ ᑭᐢᑫᓂᒥᑲᑌᑭ᙮

ᑲ ᑭ ᐃᔑ ᒥᐢᑭᑲᑌᐠ

ᐊᐤᑌ ᒧᓯᓂᐧᐃ ᒥᓂᐢᑎᑯ ᐅᓂᐢᑕᒪᓀᓯᐧᐃᓂᐠ ᑫᔑᐧᐊᐠ ᑫᐧᑲᓇ ᑲ ᑭ ᑲᓇᐧᐊᐸᒥᑲᑌᑭ ᓀᐢᑕᐃᐡᐱᒥᐠ ᑲ ᑭ ᐅ
ᒥ ᐊᑭᒥᒥᐠ ᐱᓀᓯᐧᐊᐠ ᑕᐧᐯᒪᑳᐤ ᐁ ᐧᐊᐸᒥᒥᐠ ᐁᑭ ᐊᑎ ᓇᒪᑌᒥᐠ
ᐧᐁᐧᐁᐧᐊᐠ ᐊᐢᐱᐤ 1980 ᐱᐳᓇ᙮ ᑲ ᐃᔑ ᐧᐊᐸᒥᒥᐠ ᑫᔑᐧᐊᐠ ᓂᐢᑲᐠ ᓀᐢᑕ ᐧᐃᑕᒧᒪᑳᐤ
ᐁᑭ ᐯᒥ ᓇᒪᑌᒥᐠ ᐊᐢᐱᐤ 1980 ᐱᐳᓇ᙮ ᐃᐢᐱᒥᐠ ᐁ ᐅᒥ ᐊᑭᒥᒥᐠ ᐊᓂᑭ ᑯᒥᐢᐯ
ᓂᐢᑲᐠ ᐁᑭ ᐊᑎ ᓇᒪᑌᒥᐠ ᐊᐢᐱᐤ 1970 ᐱᐳᓇ ᓴᑯᐦ ᐁᑭ ᐊᑎ ᐱᒥᒥᐸᓂᒥᐠ ᐊᐢᐱᐤ
1990 ᐱᐳᓇ᙮ ᓀᐢᑕ ᐧᐊᐸᒪᑲᐧᓇᐧᓇᐠ ᑫᔑᐧᐊᐠ ᐱᑐᐡ ᐁ ᐃᑐᑕᑭᐠ ᓂᐢᑲᐠ ᐃᐢᐱ ᑲ
ᑕᑯᐸᓂᐧᐊᐧᑫ ᑲ ᓯᐧᑲᓂᓂᐠ ᐁ ᐧᐊᐸᒥᒥᐠ ᓂᐢᑲᐠ ᓄᒥᒥᐠ ᐁ ᐱᒥᓇᒥᐠ ᐃᐢᐱᐦ ᐧᐃᓇ
ᓇᓀᐤ ᐧᐃᓂᐯᑯᐠ ᐅᑕᓇᐠ ᑲ ᐃᑐᑕᒧᐧᐊᑯᐸᓀ᙮ ᒥᓇ ᒪᑲ ᑲ ᐤᑕᒥᓇᐅᒥᐠ ᐁ ᐧᐊᐸᒪᒥᐠ
ᓂᐢᑲᐧᐊ ᐁ ᐱᒥᒥᓴᐊᒥᓂᒥ ᐊᓂᐃ ᒥᓂᐢᑭᐧᐃᔭᐱᔭ ᓇᓀᐤ ᓇᑲᐯᐊᓄᐠ ᐃᑌᑫᑲᐨ ᐊᐤᑕ
ᑫᒥᐢ ᐯ ᐧᐃᓂᐯᑯᐠ᙮ ᐅᒪ ᑲ ᐃᔑ ᐧᐊᐸᒥᒥᐠ ᒧᓇ ᐃᑕᐧᑳᐤ ᑫ ᐧᐃᑫᐧᐃᑐᒪᑲᐠ ᒥᑐᓂᒋᐧᐃ
ᓇᓇᑕᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᐤ ᑕᐧᐯᐧᐃᐤ ᐅᒥ ᓴᑯᐦ ᒪᑲ ᒪᐡᑯᐦ ᐧᐁᒥ ᐃᑐᑕᒧᐧᐊᑫ ᐊᐤᑕ ᑲ ᐃᔑᐱᒪᐱᑯᒥᓂᓂᑭ ᐊ
ᓂᐃ ᐅᒥᓂᐢᑭᐧᐃᔭᐱᔭ ᐧᐃᐸᐦ ᐁ ᓂᐱᐧᐊᓂᓂᐠ ᓀᐢᑕ ᐁ ᐃᑐᑕᑯᒥᐠ
ᓂᐢᑲᐠ ᐧᐃᐸᐦ ᑭᒥ ᒥᒥᔑᒥᐠ ᐊᐤᑕ ᓇᓀᐤ ᐧᐃᓂᐯᑯᐠ᙮ ᑲ ᐤᑕᒥᓇᐅᒥᐠ ᓀᐢᑕ ᐧᐃᑕᐧᓚᐠ ᐁ
ᑭᐧᓴᔭᓂ ᓯᐧᑲᐠ ᒧᓯᓂᐧᐃ ᓯᐱ ᐁ ᑭᐢᑫᓂᒥᑲᑌᑲ ᐧᐃᐸᐦ ᐁ ᒪᒥᐢᑕᐠ᙮ ᐅᒪ ᑲ ᐃᔑ
ᐧᐊᐸᒥᑲᑌᐠ ᑕᐧᐯᒪᑲᐧᓇ ᐁ ᐧᐃᑕᒧᒪᑲᑭ ᑕᐟᑐ ᑭᔑᑳᐤ ᑲ ᐃᔑ ᑭᐢᑫᓂᒥᑲᑌᐠ ᑲ ᐃᔑ
ᑭᔑᑲᐠ ᓀᐢᑕ ᐧᐃᑕᒪᑫᐧᐃᓇ ᐃᐢᐱ ᑲ ᒪᒥᐢᑕᐠ ᓯᐱ᙮ ᑲ ᐃᔑ ᐧᐊᐸᒥᑲᑌᐠ ᑲ ᐊᒥᐸᓂᑭ
ᐊᓂᐃ ᒪᐡᑯᔑᔭ ᐊᐤᑌ ᓇᓀᐤ ᐧᐃᓂᐯᑯᐠ ᓀᐢᑕ ᑕᐧᐯᒪᑲᐧᓇ ᐅᐢᑳᐨ ᑫᔑᐧᐊᐠ ᑲ ᐃᔑ
ᓇᓇᑕᐧᐃ ᑭᐢᑫᓂᒥᑲᑌᐠ ᐊᐤᑌ ᓇᓀᐤ ᐧᐃᓂᐯᑯᐠ ᑲ ᓂᑕᐧᐃᑭᑭ ᑫᐧᑲᓇ᙮

ᐊᐤᑕ ᐧᐃᓂᐦᐠ ᐅᓂᐢᑕᒪᐢᑲᓀᓯᐧᐃᓂᐠ ᑲ ᐤᑕᒥᓇᐅᒥᐠ ᐧᐃᑕᒪᐠ ᐁ ᐊᑎ ᒥᑫᑎᒥᐠ ᑲᑭᓇᐤ
ᐧᐁᐧᐁᐧᐊᐠ ᓀᐢᑕ ᓂᐢᑲᐠ ᐊᐢᐱᐤ 1970 ᐱᐳᓇ ᒪᑲ ᐁ ᑕᐧᐯᒪᑲᑭ ᐧᐃᑕᒪᑫᐧᐃᓇ ᐃᐢᐱ
ᐃᐡᐱᒥᐠ ᑲ ᐅᒥ ᐊᔭᒥᒥᐠ ᐊᐤᑕ ᑫᔑᐧᐊᐠ᙮ ᑲ ᐤᑕᒥᓇᐅᒥᐠ ᓀᐢᑕ ᐧᐃᑕᐧᓚᐠ ᐱᑐᐡ ᐁ
ᐃᑐᑕᒥᓂᒥ ᑲ ᑕᐧᑲᑭᓂᓂᐠ ᐧᐁᐧᐁᐧᐊᐠ ᐁ ᑭᒥᐸᓂᒥᐠ ᐅ'ᐸᐅᐧᐃ ᐱᒥᓚ ᓀᐢᑕ ᐧᐃᐸᐦ
ᐧᐁᐧᐁ ᐱᒥᓚ ᐃᐢᐱᐦ ᐧᐃᓇ ᐁ ᐊᐱᑕᐅᑯᒥᓂᒥ ᐅᐱᒪᐊᒧᐧᐃ ᐱᒥᓚ᙮ ᑲ ᐤᑕᒥᓇᐅᒥᐠ
ᐁᐧᑲᓂ ᐁᐧᑌᐤᑕᑭᐠ ᐅᒪ ᐱᑐᐡ ᑲ ᐃᑐᑕᒥᓂᒥ ᐊᓂᐃ ᑫᐧᑲᓇ ᑲ ᒥᒥᒥᐠ ᑲ ᐃᔑ
ᓂᐱᓂᔑᒥᐠ ᐅᑯ ᐱᓀᓯᐧᐊᐠ᙮ ᒧᓇ ᑕᐧᑲᐧᓇ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᓇ ᐊᓂᐃ ᐅᒥ ᑫᔑᐧᐊᐠ
ᑫᐧᑲᓇ ᑲ ᓂᑕᐧᐃᑭᑭ ᑫ ᑭ ᐅᒥ ᑭᐢᑫᓂᒥᑲᑌᐠ ᑕᐧᐯ ᐅᒪ ᑲ ᐃᑭᓂᐧᑫ ᓴᑯᐦ ᐅᒪ
ᑲ ᐃᔑ ᑭᐢᑫᓂᒥᑲᑌᐠ ᒥᒥᐧᐁ ᐊᐤᑌ ᓇᓀᐤ ᐧᐃᓂᐯᑯᐠ ᐁᑭ ᐯᒥ ᒪᒥᓇᐃᑲᑌᐠ ᐁ ᐊᑎ
ᐊᒥᐸᓂᑭ ᐊᓂᐃ ᑫᐧᑲᓇ ᑲ ᓂᑕᐧᐃᑭᑭ᙮ ᐯᔭᐧᑳᐤ ᐃᔑ ᐧᐊᐸᑕᒪᐠ ᐊᓂᑭ ᑲ ᐤᑕᒥᓇᐅᒥᐠ ᐁᑭᐧᓴᔭᓂ ᓯᐧᑲᐠ ᓀ
ᐢᑕ ᐁ ᑕᐧᐯᒪᑲᐠ ᑲ ᐃᔑ ᑭᐢᑫᓂᒥᑲᑌᐠ ᐧᐃᑕᒪᑫᐧᐃᐤ ᑲ ᐃᔑ ᑭᔑᑲᐠ
ᑕᐟᑐ ᑭᔑᑳᐤ ᐁ ᓄᐧᑲᐠ ᐊᐧᐊᒥᑌ ᐁ ᐊᑎ ᑭᔑᑌᐠ᙮

ᑲ ᑭ ᐊᔭᒥᐃᒥᐠ ᐃᓂᓂᐧᐊᐠ ᓀᐢᑕ ᐧᐃᑕᒧᒪᑳᐤ ᐁ ᐊᑎ ᐱᑐᔑᓇᑯᒥᒥᐠ ᑲ ᐤᑕᒥᓇᐅᒥᐠ
ᓀᐢᑕ ᑕᐤᑕ ᐁ ᐃᔑ ᐤᑕᒥᓇᐅᒥᐠ ᓀᐢᑕ ᐃᐢᐱ ᓀᐢᑕ ᐃᓂᑯᐠ ᑲ ᐤᑕᒥᓇᐅᓇᓂᐧᐊᐠ ᓀᐢᑕ
ᐁ ᐊᑎ ᐊᒥᐸᓂᐠ ᓇᑕᒥᓇᐅᐧᐃᐧᐃᐤ ᐱᓀᓯᐧᐊᐠ ᐅᒥ ᑲᑭᓇᐤ ᒧᓯᓂᐧᐃ ᒥᓂᐢᑎᑯ
ᐅᓂᐢᑕᒪᐢᑲᓀᓯᐧᐊᐠ ᐅᒥ ᓀᐢᑕ ᐧᐁᓂᐢᑭᐧᐃ ᐅᓂᐢᑕᒪᐢᑲᓀᓯᐧᐊᐠ᙮

ᒪᒋ ᐊᔭᒥᐧᐃᐣ
ᐃᓂᓂᐧᐊᐠ ᓀᐢᑕ ᒥᑐᓂᓯᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᐣ ᑲᑭᓇᐤ ᐧᐃᑕᒧᒪᑲᐣ ᐁ ᐊᑎ ᐊᒋᐸᓂᐠ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᓀᐢᑕ ᐊᐧᐊᓯᑌ ᐁ ᐊᑎ ᒥᑯᐢᑲᒋᑕᐟ ᐃᓂᓂᐤ ᐅᒪ ᑲ ᐊᑎ ᐊᒋᐸᓂᒋᐠ ᐱᓀᓯᐧᐊᐠ ᐊᐣᑌ ᐧᐊᓴᐃᐯᔭᐠ᙮ ᑲ ᐊᑎ ᐊᒋᐸᓂᐠ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᓀᐢᑕ ᐊᐧᐊᓯᑌ ᑲ ᒥᑯᐦᑲᒋᑕᐟ ᐃᓂᓂᐤ ᐁ ᐊᑎ ᒥᒣᑎᐟ ᐃᓂᓂᐤ ᑲ ᐣᑕᒥᓇᐅᐟ ᑕ ᐊᒋᐸᓂᐤ ᓀᐢᑕ ᑲ ᐅᒋ ᐱᒪᒋᐅᐟ ᐱᓀᓯᐤ᙮ ᑲ ᒥᐧᓇᔑᓂᓂᐠ ᑲ ᐅᒋ ᐱᒪᒋᐅᐟ ᑕ ᐅᒋ ᒥᒣᑎᐤ ᑲ ᑕᔑᐟ ᐱᓀᓯᐤ ᐊᔑᐨ ᑲ ᐃᔑ ᐧᐊᒋᐢᑐᓂᐟ ᓀᐢᑕ ᐃᐢᐱ ᑲ ᑕᑯᐸᓂᒋᐠ ᓀᐢᑕ ᑲ ᐃᑐᑕᑭᐠ ᑲ ᐃᔑ ᐱᑦᐸᓂᒋᐠ᙮ ᒥᓯᐧᐁ ᐅᐅ ᑫᐧᑲᓇ ᐊᔑᒋᐸᓂᐧᐊ ᐃᓂᑯᐠ ᑲ ᐃᑕᒋᐠ ᐱᓀᓯᐧᐊᐠ ᓀᐢᑕ ᐅᓇᑕᒥᓇᐅᐧᐊᐠ ᑲ ᐊᐸᒋᐊᒋᐠ ᐊᓂᐃ ᐱᓀᓯᐧᐊ᙮

ᐅᒪ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᐣ ᑭ ᒥᐢᑲᑌᐤ ᒥᒣᐧᑕᓱᐠ ᐁ ᐧᐃᒣᐧᐃᑐᒪᑲᓂᓂᐠ ᑲ ᐃᔑ ᑭᐢᑫᓂᑕᑭᐠ ᑫᔑᐧᐊᐠ ᐃᓂᓂᐧᐊᐠ ᓀᐢᑕ ᒥᑐᓂᓯᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᐣ᙮ ᐊᓂᐃ ᐊᑎᐟ ᑫᐧᑲᓇ ᐱᑐᐦ ᑲ ᐃᔑᓇᐧᑲᑭ ᐅᓴᑦ ᐁ ᓄᑌᐸᓂᐠ ᐧᐃᑕᒪᑫᐧᐃᐣ ᐯᔭᐧᑲᐣ ᐃᓂᑯᐠ᙮ ᓀᐢᑕ ᑭ ᐧᐊᐸᒋᑲᑌᐤ ᐁ ᓄᑌᐸᓂᐠ ᒥᑐᓂᓯᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᐣ ᐊᓂᒪ ᑲ ᐊᑎ ᐃᔑ ᐊᒋᐸᓂᐠ ᐊᐣᑌ ᓇᓀᐤ ᐧᐃᓂᐯᑯᐠ ᓀᐢᑕ ᐧᐊᐸᒋᑲᑌᐤ ᐁ ᐣᑕᐧᐁᓂᑕᐧᑲᐠ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᐣ ᓂᑲᐣ ᐃᑌᑫ᙮ ᐅᒪ ᓇᑕᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᐣ ᓇᑕᒪᑫᒪᑲᐣ ᐊᓂᐃ ᑲᑭᓇᐤ ᑲ ᐊᑎ ᐊᒋᐸᓂᐠ ᑲ ᐊᑎ ᐱᑐᔑᐸᓂᐠ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᓀᐢᑕ ᑲ ᐅᒋ ᐱᒪᒋᐅᐟ ᐱᓀᓯᐤ ᐊᐣᑌ ᐊᐟᓯᐣ ᐯ ᐧᐊᓴᐃᐯᔭᐠ ᓀᐢᑕ ᑲ ᐃᐢᐱ ᒥᒣᑎᐟ ᐱᓀᓯᐤ ᓀᐢᑕ ᑲ ᐃᔑ ᐊᐃᑕᐟ ᓀᐢᑕ ᑲ ᐃᔑ ᓇᓇᑕᒥᓇᐅᓇᓂᐧᐊᐠ᙮ ᑲ ᑭ ᐊᔭᒥᐃᒋᐠ ᐃᓂᓂᐧᐊᐠ ᑭ ᒐᑲᐢᑌ ᐊᓂᒧᒋᑲᑌᐧᐊ ᑲ ᐊᑎ ᐱᑐᔑᐸᓂᑭ ᐊᓂᐃ ᑫᐧᑲᓇ ᑲ ᓂᑕᐧᐃᑭᑭ ᓀᐢᑕ ᑲ ᐊᑎ ᑭᔑᑌᐠ ᓀᐢᑕ ᐁ ᑭᐢᑌᓂᑕᐧᑲᐠ ᑭᒋ ᓂᓯᑐᒋᑲᑌᑭ ᐊᓂᐃ ᑫᐧᑲᓇ ᑲ ᐊᑎ ᐊᒋᐸᓂᑭ ᑫ ᑯᐦᑯᐸᓂᐠ ᑲ ᐃᔑ ᒥᒋᓯᐟ ᓀᐢᑕ ᑲ ᐃᑐᑕᑭᐠ ᐃᐢᐱ ᑲ ᐧᐊᒋᐢᑐᓂᒋ ᐊᓂᑭ ᐱᓀᓯᐧᐊᐠ᙮ ᐊᑕ ᒪᑲ ᐁᑲ ᐁ ᑯᐦᑯᐸᓂᐠ ᑲ ᒥᓄᐸᓂᐠ ᐁ ᐣᑕᒥᓇᐅᓇᓂᐧᐊᐠ ᐁ ᓯᐧᑲᐠ ᒍᓇ ᒪᐦᑯᐨ ᐁᐢᐧᑲ ᐅᑎᒋᐸᓂᐤ ᑫ ᐅᒋ ᐸᔭᑌᓇᐧᑲᓂᓂᐠ ᑲ ᐃᔑ ᐱᑐᔑᐸᓂᒋᐠ ᑲ ᐃᐢᐱᒋ ᒥᒣᑎᒋᐠ ᐱᓀᓯᐧᐊᐠ᙮ ᐅᒪ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓂᑕᒧᐧᐃᐣ ᒥᐧᓇᔑᐣ ᐁ ᐊᐸᒋᑕᓂᐧᐊᑭ ᓇᓇᑲᐤ ᑭᐢᑫᓂᑕᒧᐧᐃᓇ ᐁ ᐅᒋ ᒥᐧᓇᔑᐠ ᑲ ᐃᔑ ᓂᓯᑐᑕᒪᐠ ᐁᔑ ᐧᐃᒋᐃᑐᒋᐠ ᐱᓀᓯᐧᐊᐠ ᓀᐢᑕ ᐃᑕᐧᐃᐣ ᓀᐢᑕ ᐸᐧᑲᑕᐢᒥᐠ᙮ ᑭᐢᑌᓂᑕᐧᑲᐧᓇ ᐊᓂᐃ ᑲ ᐃᔑ ᐊᓇᐢᑯᐸᓂᑭ ᒥᓴᐧᐊᐨ ᑭᒋ ᐅᒋ ᐊᐧᐊᓯᑌ ᒪᒪᐤ ᓂᓯᑐᒋᑲᑌᐠ ᑲ ᐃᔑ ᐱᑐᔑᐸᓂᐠ ᐸᐧᑲᑕᐢᑲᒥᐠ ᐊᐣᑌ ᓇᓀᐤ ᐧᐊᓴᐃᐯᔭᐠ᙮

EXECUTIVE SUMMARY IN CREE, L DIALECT (MOOSE CREE)

ᓂᐧᓴᔦᐠ ᐃᑌᑫ ᐁᔑ ᐊᓇᐢᑯᓓᑲᑌᐠ ᑲ ᐃᔑ ᓓᓯᑐᒋᑲᑌᐠ ᑲ ᐊᑎ ᐊᒋᐸᓓᐠ ᐁᔑ ᑭᔑᑲᐠ
ᑲ ᐃᑐᑕᑯᒋᐠ ᐱᒧᓯᐧᐊᐠ ᓄᐢᑕ ᐅᓓᐢᑕᒪᐢᑲᒧᓯᐧᐊᐠ ᐊᑦᓯᐣ ᐯ ᐧᐊᓴᐃᐯᔭᐠ
ᒉᓓᑉᐱᐃ ᕈᐸᐢ ᑲ ᑭ ᒪᓯᓇᐊᐠ

ᓂᑲᓓ ᐊᔭᒥᐧᐃᐣ
ᐅᒪ ᐊᐸᑎᓯᐧᐃᐣ ᓂᐧᓴᔦᐠ ᑭ ᐅᑎᓓᑲᑌᐤ ᑫᐧᑲᐣ ᑲᑭᓚᐤ ᐃᓓᓓᐠ ᓄᐢᑕ ᒥᑐᓓᓯᐧᐃ
ᑭᐢᑫᓓᑕᒧᐧᐃᐣ ᑭᒋ ᐅᒋ ᐊᐧᐊᓯᑌ ᓓᓯᑐᒋᑲᑌᐠ ᑲ ᐃᑐᑕᑯᒋᐠ ᐱᒧᓯᐧᐊᐠ ᑲ ᐃᐢᐱᒋ.
ᒥᑫᑎᒋᐠ ᓄᐢᑕ ᑲ ᐃᔑ ᑕᔑᐧᐃᒋᐠ ᓄᐢᑕ ᑲ ᐅᒋ ᐱᒪᒋᐅᒋᐠ ᐅᒪ ᑲ ᐊᑎ ᐊᒋᐸᓂᓓᐠ ᐁᐃᔑ ᑭᔑᑲᓓᐠ ᐅᒋ
ᐊᐣᑌ ᐊᑦᓯᐣ ᐯ ᐧᐊᓴᐃᐯᔭᐠ ᓄᐢᑕ ᑲ ᐃᑐᑕᑯᒋᐠ ᐊᓂᐃ ᓇᓄᐤ
ᐃᑕᐧᐃᓇ ᑫ ᑭ ᐅᒋ ᐊᐸᒋᐊᐧᐊᐧᑫ ᓄᐢᑕ ᓇᑕᒥᓚᐅᒋᐠ ᐊᓂᐃ ᐱᒧᓯᐧᐊ᙮ ᐊᓂᐃ ᐃᑕᐧᐃᓇ
ᑲ ᐊᔑᒋᐸᓓᑭ ᐁᐧᑲᓓᐃ ᒧᓯᓓᐧᐃ ᒥᓓᐢᑎᑯ ᐅᓓᐢᑕᒪᐢᑲᒧᓯᐧᐃᐣ ᒧᓯᓓᐧᐃ ᒥᓓᐢᑎᑯᐠ ᐁ
ᐊᑎ ᑭᔑᐸᐠ ᑫᒥᐢ ᐯ ᐧᐊᓴᐃᐯᔭᐠ ᓄᐢᑕ ᐊᓓᑭ ᐧᐁᓓᐢᐠ ᐅᓓᐢᑕᒪᐢᑲᒧᓯᐧᐊᐠ ᐊᐣᑕ
ᐱᐧᐊᓇᑯᐠ ᒪᐧᐊᒋ ᓴᐧᐊᔪᐠ ᐁ ᐃᔑ ᑭᔑᐸᐠ ᓇᓄᐤ ᐊᑦᓯᐣ ᐯ ᐧᐊᓴᐃᐯᔭᐠ᙮

ᐅᑕᓇᐠ ᑎᐸᒋᒧᐧᐃᐣ
ᐊᓂᑭ ᐅᓓᐢᑕᒪᐢᑲᒧᓯᐧᐊᐠ ᐅᒪᐢᑫᑯᐧᐊᐠ ᐊᐣᑌ ᐊᑦᓯᐣ ᐯ ᐧᐊᓴᐃᐯᔭᐠ ᒥᐢᑕᐃ
ᒪᒥᔑᑐᑕᐧᐁᐧᐊᐠ ᐊᓂᐃ ᐱᒧᓯᐧᐊ ᐁ ᐅᒋ ᐱᒪᑎᓯᐧᐊᑫᒋᐠ ᐯᔭᐧᑲᐣ ᐃᓓᑯᐠ ᑲ ᐃᔑ
ᒪᒥᔑᑐᐧᐊᒋᐠ ᒧᐧᔭ ᓄᐢᑕ ᐱᑯ ᐊᑎᐧᑲ᙮ ᐊᓂᑭ ᐃᓓᓓᐧᐊᐠ ᐊᓂᐃ ᐃᑕᐧᐃᓇ ᑲ
ᓇᑕᒥᓚᐅᒋᐠ ᐱᒧᓯᐧᐊ ᐁ ᓯᐧᑲᓂᓓᐠ ᑭᔭᐱᒼ ᒥᑫᑎᐧᐊᐠ ᐧᐁᓭ ᐊᐢᑭᐧᐃ ᐊᓓᐢᑫ
ᐱᒪᑎᓯᐧᐃᐣ ᓄᐢᑕ ᓇᓇᑕᐧᐁᓓᒋᑫᐧᐃᐣ ᑭᔭᐱᒼ ᐁ ᑭᐢᑌᓓᑕᐧᑲᐠ ᐃᓓᓓᐧᐃ ᐃᑕᐢᑲᒧᓯᐧᐃᓓᐠ᙮

ᐊᓂᐃ ᑭᑕᐯᔭᐧᐊ ᐊᐣᑌ ᐧᐊᓴᐃᐯᔭᐠ ᑲᑭᓚᐤ ᓓᑕᐧᐃᑭᐃᑐᐧᐊᐠ ᓄᐢᑕ ᑕᔑᐧᐃᐧᐊᐠ ᐊᑎᑦ
ᓇᓇᑲᐤ ᑲ ᐃᔑᓚᑯᓯᒋᐠ ᐱᒧᓯᐧᐊᐠ ᐊᓂᑭ ᒥᓯᓯᐱᐠ ᑲ ᐅᒋᐸᓓᒋᐠ ᓄᐢᑕ ᓓᐢᑲᐠ ᐊᐣᑌ
ᒥᓯᓯᐱᐠ ᐁᔑ ᓇᓯᐯᔭᐠ ᑲ ᑕᔑᐧᐃᒋᐠ ᓄᐢᑕ ᐊᓓᑭ ᓴᐧᐊᔪᐠ ᑫᒥᐢ ᐯ ᑲ ᑕᔑᐧᐃᒋᐠ
ᐊᔑᒼ ᐊᓂᑭ ᐧᐁᐧᐁᐧᐊᐠ ᐊᐱᑕᐅᐢᑲᒥᑲᐠ ᑲ ᑕᔑᐧᐃᒋᐠ ᑲ ᐱᒼᐸᓓᒋᐠ ᐅᑌ ᐃᑌᐢᑲᒥᑲᐠ
ᓄᐢᑕ ᑲ ᐧᐊᒋᐢᑐᓓᒋᐠ ᐊᐣᑕ ᑲ ᐃᔑ ᓇᑕᒥᓚᐅᒋᐠ ᐊᓂᐃ ᓇᓄᐤ ᐃᑕᐧᐃᓇ᙮ ᐊᑎ
ᐊᒋᐸᓂᓓᐤ ᑲ ᐃᔑ ᐣᑕᐧᐃ ᐱᐳᓓᔑᒋᐠ ᐊᐣᑌ ᒥᔑ ᒧᑯᒪᐣ ᐊᐢᑭᐠ ᓄᐢᑕ ᑲ ᐃᔑ
ᐱᒼᐸᓓᒋᐠ ᐊᔑᒼ ᓄᐢᑕ ᑲ ᐃᔑ ᓓᑕᐧᐃᑭᐃᑐᒋᐠ᙮ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᐊᐣᑌ ᐊᑦᓯᐣ ᐯ
ᐃᑌᑫᐢᑲᒥᑲᐠ ᓄᐢᑕ ᔪᐧᑲᐣ ᐁ ᐊᑎ ᑭᒋ ᑭᔑᐸᓓᐠ ᐁ ᐊᑎ ᐊᒋᐸᓓᐠ᙮ ᒪᒉᐣ ᐊᐣᑕ
ᑲ ᐃᑐᑕᑯᐧᐊᐧᑫ ᐅᒪ ᑲ ᐊᑎ ᐊᒋᐸᓂᓓᐠ ᐁ ᐃᔑ ᑭᔑᑲᓓᐠ ᐊᐣᑌ ᐧᐊᓴᐃᐯᐠ ᒧᓚ
ᓱᑭ ᑭᐢᑫᓓᒋᑲᑌᐤ ᐊᔑᒼ ᑲ ᐃᑐᑕᑯᐧᐊᐧᑫ ᐊᓂᐃ ᐃᓓᓓᐧᐃ ᐃᑕᐧᐃᓇ ᑲ ᑭ
ᐊᐸᒋᐊᐧᐊᐧᑫ ᓄᐢᑕ ᓇᑕᒥᓚᒋᐠ ᐊᓂᐃ ᐱᒧᓯᐧᐊ᙮

ᓇᓇᑕᐧᐃ ᑭᐢᑫᓓᑕᒧᐧᐃᓇ ᐊᐸᑎᓯᐧᐃᐣ
ᑭ ᐊᔭᒥᐊᑲᓓᐧᐃᐧᐊᐠ ᐃᓓᓓᐧᐊᐠ ᐊᐣᑕ ᒧᓯᓓᐧᐃ ᒥᓓᐢᑎᑯᐠ ᓄᐢᑕ ᐱᐧᐊᓚᑯᐠ ᓄᐢᑕ ᑭ
ᑲᓇᐧᐊᐸᒋᑲᑌᐧᐊ ᓇᓇᑲᐤ ᑫᔑᐧᐊᐠ ᐅᑕᓇᐠ ᓇᓇᑕᐧᐁᓓᒋᑫᐧᐃᐣ ᓄᐢᑕ ᑲ ᐅᒋ ᐱᒪᒋᐅᒋᐠ
ᓄᐢᑕ ᐁ ᑲᓇᐧᐊᐸᒥᒋᐠ ᑲ ᑕᔑᒋᐠ ᐊᓂᑭ ᐱᒧᓯᐧᐊᐠ᙮ ᐊᓂᑭ ᑲ ᑭ ᐊᔭᔑᒋᒋᐠ ᑭ
ᐅᓇᐸᒪᑲᓓᐧᐃᐧᐊᐠ ᐁᑭ ᐧᐃᒋᐧᑕᒋᐠ ᑲ ᑭ ᐊᔭᒥᐃᒋᐠ ᐃᓓᓓᐧᐃ ᐃᑕᐧᐃᓇ ᓄᐢᑕ ᑲ
ᐃᔑ ᑭᐢᑫᓓᑕᑭᐠ ᐸᐧᑲᑕᐢᑭᓓᐤ᙮ ᓇᐢᐱᒼ ᑭᒋ ᑭᐢᑌᓓᑕᐧᑲᐣ ᑭᒋ ᑕᐧᐯᒪᑲᐠ ᐊᓂᐃ
ᐧᐃᑕᒪᑫᐧᐃᓇ ᑲ ᒪᐧᐊᑐᓓᑲᑌᑭ ᓄᐢᑕ ᓂᐧᓴ ᓂᐢᐧᑕ ᑭ ᒪᐧᐊᐱᐢᒋᑲᑌᐧᐊ ᐊᓂᐃ ᐃᑕᐧᐃᓇ᙮
ᑲᑲ ᑭ ᐃᔑ ᐊᓓᒧᑕᑭᐠ ᐊᓂᐃ ᐃᑕᐧᐃᓇ ᑫᔑᐧᐊᐠ ᐯᐢᑭᐢ ᑭ ᑲᓇᐧᐊᐸᒋᑲᑌᐧᐊ ᐊᓂᐃ

ᒪᒪᐧᐃ ᐊᑭᒋᑫᐧᐃᓇ ᐯᔭᐧᑲᐣ ᐃᓀᑯᐠ ᐁ ᐃᔑ ᑲᓇᐧᐊᐸᒋᑲᑌᑭ᙮ ᐊᓂᐃ ᑎᐸᐊᑲᒋᑲᓇ ᐊᔑᒋᓀᐧᐊ ᑲ ᑭ ᐃᑭᓗᐧᑫ ᑫᐧᑲᐣ ᓂᐢᑕ ᐊᐢᑭ ᓂᐢᑕ ᐁ ᐊᓀᒧᒋᑲᑌᑭ ᐊᓂᐃ ᐯᔭᐧᑲᐣ ᑫᐧᑲᓇ ᐯᔭᐧᑲᐣ ᐊᐣᑕ ᓂᐢᑕ ᐃᐢᐱ ᑲ ᐃᑭᓗᐧᑫ᙮ ᓂᐢᑕᒼ ᑭ ᑲᓇᐧᐊᐸᒋᑲᑌᐧᐊ ᐊᓂᐃ ᐯᔭᐧᑲᐣ ᑲ ᐃᔑ ᒥᐢᑭᑲᑌᑭ ᓂᐢᑕ ᐁᑯ ᑲ ᓇᑕᐧᐃ ᑭᐢᑫᓀᒋᑲᑌᐠ ᑭᓴᐢᐱᐣ ᐊᓂᒪ ᐧᐃᑕᒪᑫᐧᐃᐣ ᐯᔭᐧᑲᐣ ᑲ ᐃᔑᓇᐧᑲᓗᐧᑫ ᓂᐢᑕ ᐯᔭᐠ ᑫᐧᑲᐣ ᑲ ᐱᑐᔑᓇᐧᑲᓗᐧᑫ ᓂᐢᑕ ᐱᑯ ᐱᑐᐡ ᑲ ᐃᐧᑌᒪᑲᓗᐧᐊᐧᑫ᙮ ᒪᒋᒡ ᒪᑲ ᑭ ᓇᑕᐧᐃ ᑭᐢᑫᓀᒋᑲᑌᐤ ᑕᐣᑕ ᐁᔑ ᐧᐃᒉᐧᐃᑐᒪᑲᓗᐧᑫ ᓂᐢᑕ ᐱᑯ ᐁ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓀᒋᑲᑌᐠ ᓂᐢᑕ ᑲ ᐃᑌᓀᒋᑲᑌᐧᑫ ᑫᐧᑲᐣ ᐁᑲ ᐧᐁᒋ ᐧᐃᒉᐧᐃᑐᒪᑲᓗᐧᑫ ᐊᓂᐃ ᑫᐧᑲᓇ ᑲ ᓇᑕᐧᐃ ᑭᐢᑫᓀᒋᑲᑌᑭ᙮

ᑲ ᑭ ᐃᔑ ᒥᐢᑭᑲᑌᐠ

ᐊᐣᑌ ᒧᓯᓀᐧᐃ ᒥᓀᐢᑎᑯ ᐅᓀᐢᑕᒪᒍᓯᐧᐃᓀᐠ ᑫᔑᐧᐊᐠ ᑫᐧᑲᓇ ᑲ ᑭ ᑲᓚᐧᐊᐸᒋᑲᑌᑭ ᓂᐢᑕ ᐃᐡᐱᒥᐠ ᑲ ᑭ ᐅᒋ ᐊᑭᒥᒋᐠ ᐱᒍᓯᐧᐊᐠ ᑕᐧᐯᒪᑲᐣ ᐁ ᐧᐊᐸᒥᒋᐠ ᐁᑭ ᐊᑎ ᓇᒪᑌᒋᐠ ᐧᐁᐧᐁᐧᐊᐠ ᐊᐢᐱᐣ 1980 ᐱᐳᓇ᙮ ᑲ ᐃᔑ ᐧᐊᐸᒥᒋᐠ ᑫᔑᐧᐊᐠ ᓀᐢᑲᐠ ᓂᐢᑕ ᐧᐃᑕᒧᒪᑲᐣ ᐁᑭ ᐯᒋ ᓇᒪᑌᒋᐠ ᐊᐢᐱᐣ 1980 ᐱᐳᓇ᙮ ᐃᐡᐱᒥᐠ ᐁ ᐅᒋ ᐊᑭᒥᒋᐠ ᐊᓂᑭ ᒉᒥᐢᐯ ᓀᐢᑲᐠ ᐁᑭ ᐊᑎ ᓇᒪᑌᒋᐠ ᐊᐢᐱᐣ 1970 ᐱᐳᓇ ᓴᑯᒡ ᐁᑭ ᐊᑎ ᐱᒋᒋᐸᓀᒋᐠ ᐊᐢᐱᐣ 1990 ᐱᐳᓇ᙮ ᓂᐢᑕ ᐧᐊᐸᒪᑲᐧᓚᐧᓚᐠ ᑫᔑᐧᐊᐠ ᐱᑐᐡ ᐁ ᐃᑐᑕᑭᐠ ᓀᐢᑲᐠ ᐃᐢᐱ ᑲ ᑕᑯᐸᓀᐧᐊᐧᑫ ᑲ ᓯᐧᑲᓂᓀᐠ ᐁ ᐧᐊᐸᒥᒋᐠ ᓀᐢᑲᐠ ᓗᒋᒥᐠ ᐁ ᐱᒥᓚᒋᐠ ᐃᐢᐱᒡ ᐧᐃᓚ ᓇᓄᐤ ᐧᐃᓀᐯᑯᐠ ᐅᑕᓇᐠ ᑲ ᐃᑐᑕᒧᐧᐊᑯᐸᓄ᙮ ᒥᓚ ᒪᑲ ᑲ ᐣᑕᒥᓚᐅᒋᐠ ᐁ ᐧᐊᐸᒪᒋᐠ ᓀᐢᑲᐧᐊ ᐁ ᐱᒥᒋᓴᐊᒥᓀᒋ ᐊᓂᐃ ᒥᓀᐢᑭᐧᐃᔭᐱᔭ ᓇᓄᐤ ᓇᑲᐯᐊᓗᐠ ᐃᑌᑫᑲᒼ ᐊᐣᑕ ᒉᒥᐢ ᐯ ᐧᐃᓀᐯᑯᐠ᙮ ᐅᒪ ᑲ ᐃᔑ ᐧᐊᐸᒥᒋᐠ ᒧᓚ ᐃᑕᐧᑲᐣ ᑫ ᐧᐃᒉᐧᐃᑐᒪᑲᐠ ᒥᑐᓀᓯᐧᐃ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓀᑕᒧᐧᐃᐣ ᑕᐧᐯᐧᐃᐣ ᐅᒋ ᓴᑯᒡ ᒪᑲ ᒪᐡᑯᒡ ᐧᐁᒋ ᐃᑐᑕᒧᐧᐊᐧᑫ ᐊᐣᑕ ᑲ ᐃᔑᐱᒪᐱᑯᒥᓂᓀᑭ ᐊ ᓂᐃ ᐅᒥᓀᐢᑭᐧᐃᔭᐱᔭ ᐧᐃᐸᒡ ᐁ ᓀᐱᐧᐊᓂᓀᐠ ᓂᐢᑕ ᐁ ᐃᑐᑕᑯᒋᐠ ᓀᐢᑲᐠ ᐧᐃᐸᒡ ᑭᒋ ᒥᒋᓯᒋᐠ ᐊᐣᑕ ᓇᓄᐤ ᐧᐃᓀᐯᑯᐠ᙮ ᑲ ᐣᑕᒥᓚᐅᒋᐠ ᓂᐢᑕ ᐧᐃᑕᐧᒪᐠ ᐁ ᑭᐧᓴᔭᓀ ᓯᐧᑲᐠ ᒧᓯᓀᐧᐃ ᓯᐱ ᐁ ᑭᐢᑫᓀᒋᑲᑌᑲ ᐧᐃᐸᒡ ᐁ ᒪᒋᐢᑕᐠ᙮ ᐅᒪ ᑲ ᐃᔑ ᐧᐊᐸᒋᑲᑌᐠ ᑕᐧᐯᒪᑲᐧᓇ ᐁ ᐧᐃᑕᒧᒪᑲᑭ ᑕᐦᑐ ᑭᔑᑲᐤ ᑲ ᐃᔑ ᑭᐢᑫᓀᒋᑲᑌᐠ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᓂᐢᑕ ᐧᐃᑕᒪᑫᐧᐃᓚ ᐃᐢᐱ ᑲ ᒪᒋᐢᑕᐠ ᓯᐱ᙮ ᑲ ᐃᔑ ᐧᐊᐸᒋᑲᑌᐠ ᑲ ᐊᒋᐸᓀᑭ ᐊᓂᐃ ᒪᐡᑯᔑᔭ ᐊᐣᑌ ᓇᓄᐤ ᐧᐃᓀᐯᑯᐠ ᓂᐢᑕ ᑕᐧᐯᒪᑲᐧᓚ ᐅᓴᒼ ᑫᔑᐧᐊᐠ ᑲ ᐃᔑ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓀᒋᑲᑌᐠ ᐊᐣᑌ ᓇᓄᐤ ᐧᐃᓀᐯᑯᐠ ᑲ ᓀᑕᐧᐃᑭᑭ ᑫᐧᑲᓇ᙮

ᐊᐣᑕ ᐧᐃᓀᐢᐠ ᐅᓀᐢᑕᒪᐢᑲᒍᓯᐧᐃᓀᐠ ᑲ ᐣᑕᒥᓚᐅᒋᐠ ᐧᐃᑕᐧᒪᐠ ᐁ ᐊᑎ ᒥᒉᑎᒋᐠ ᑲᑭᓇᐤ ᐧᐁᐧᐁᐧᐊᐠ ᓂᐢᑕ ᓀᐢᑲᐠ ᐊᐢᐱᐣ 1970 ᐱᐳᓇ ᒪᑲ ᐁ ᑕᐧᐯᒪᑲᑭ ᐧᐃᑕᒪᑫᐧᐃᓇ ᐃᐢᐱ ᐃᐡᐱᒥᐠ ᑲ ᐅᒋ ᐊᔭᒥᒋᐠ ᐊᐣᑕ ᑫᔑᐧᐊᐠ᙮ ᑲ ᐣᑕᒥᓚᐅᒋᐠ ᓂᐢᑕ ᐧᐃᑕᐧᒪᐠ ᐱᑐᐡ ᐁ ᐃᑐᑕᒥᓀᒋ ᑲ ᑕᐧᑲᑭᓂᓀᐠ ᐧᐁᐧᐁᐧᐊᐠ ᐁ ᑭᒋᐸᓀᒋᐠ ᐅᐸᐸᐅᐧᐃ ᐱᓯᐧᒪ ᓂᐢᑕ ᐧᐃᐸᒡ ᐧᐁᐧᐁ ᐱᓯᐧᒪ ᐃᐢᐱᒡ ᐧᐃᓚ ᐁ ᐊᐱᑕᐅᑯᒋᓀᒋ ᐅᐱᒪᐊᒧᐧᐃ ᐱᓯᐧᒪ᙮ ᑲ ᐣᑕᒥᓚᐅᒋᐠ ᐁᐧᑲᓀ ᐁᐧᑌᐣᑕᑭᐠ ᐅᒪ ᐱᑐᐡ ᑲ ᐃᑐᑕᒥᓀᒋ ᐊᓂᐃ ᑫᐧᑲᓇ ᑲ ᒥᒋᒋᐠ ᑲ ᐃᔑ ᓀᐱᓀᔑᒋᐠ ᐅᑯ ᐱᒍᓯᐧᐊᐠ᙮ ᒧᓚ ᑕᐧᑲᐧᓚ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓀᑕᒧᐧᐃᓚ ᐊᓂᐃ ᐅᒋ ᑫᔑᐧᐊᐠ ᑫᐧᑲᓇ ᑲ ᓀᑕᐧᐃᑭᑭ ᑫ ᑭ ᐅᒋ ᑭᐢᑫᓀᒋᑲᑌᐠ ᑕᐧᐯ ᐅᒪ ᑲ ᐃᑭᓀᐧᑫ ᓴᑯᒡ ᐅᒪ ᑲ ᐃᔑ ᑭᐢᑫᓀᒋᑲᑌᐠ ᒥᓯᐧᐁ ᐊᐣᑌ ᓇᓄᐤ ᐧᐃᓀᐯᑯᐠ ᐁᑭ ᐯᒋ ᒪᓯᓚᐃᑲᑌᐠ ᐁ ᐊᑎ ᐊᒋᐸᓀᑭ ᐊᓂᐃ ᑫᐧᑲᓇ ᑲ ᓀᑕᐧᐃᑭᑭ᙮ ᐯᔭᐧᑲᐣ ᐃᔑ ᐧᐊᐸᑕᐧᒪᐠ ᐊᓀᑭ ᑲ ᐣᑕᒥᓚᐅᒋᐠ ᐁᑭᐧᓴᔭᓀ ᓯᐧᑲᐠ ᓀ ᐢᑕ ᐁ ᑕᐧᐯᒪᑲᐠ ᑲ ᐃᔑ ᑭᐢᑫᓀᒋᑲᑌᐠ ᐧᐃᑕᒪᑫᐧᐃᐣ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᑕᐦᑐ ᑭᔑᑲᐤ ᐁ ᓗᐧᑲᐠ ᐊᐧᐊᓯᑌ ᐁ ᐊᑎ ᑭᔑᑌᐠ᙮

ᑲ ᑭ ᐊᔭᒥᐃᒋᐠ ᐃᓀᓀᐧᐊᐠ ᓂᐢᑕ ᐧᐃᑕᒧᒪᑲᐣ ᐁ ᐊᑎ ᐱᑐᔑᓚᑯᓯᒋᐠ ᑲ ᐣᑕᒥᓚᐅᒋᐠ ᓂᐢᑕ ᑕᐣᑕ ᐁ ᐃᔑ ᐣᑕᒥᓚᐅᒋᐠ ᓂᐢᑕ ᐃᐢᐱ ᓂᐢᑕ ᐃᓀᑯᐠ ᑲ ᐣᑕᒥᓚᐅᓇᓀᐧᐊᐠ ᓂᐢᑕ ᐁ ᐊᑎ ᐊᒋᐸᓀᐠ ᓚᑕᒥᓚᐅᐧᐃᐧᐃᐣ ᐱᒍᓯᐧᐊᐠ ᐅᒋ ᑲᑭᓚᐤ ᒧᓯᓀᐧᐃ ᒥᓀᐢᑎᑯ

ᐅᓕᐢᑕᒪᐢᑲᓓᓯᐧᐊᐠ ᐅᒋ ᓀᐢᑕ ᐧᐁᓕᐢᑭᐧᐃ ᐅᓕᐢᑕᒪᐢᑲᓓᓯᐧᐊᐠ᙮

ᒪᒋ ᐊᔭᒥᐧᐃᐣ

ᐃᓕᓕᐧᐊᐠ ᓀᐢᑕ ᒥᑐᓕᓯᐧᐃ ᑭᐢᑫᓕᑕᒧᐧᐃᐣ ᑲᑭᓇᐤ ᐧᐃᑕᒧᒪᑲᐣ ᐁ ᐊᑎ ᐊᒋᐸᓕᐠ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᓀᐢᑕ ᐊᐧᐊᓯᑌ ᐁ ᐊᑎ ᒥᑯᐢᑲᒋᑕᐨ ᐃᓕᓕᐤ ᐅᒪ ᑲ ᐊᑎ ᐊᒋᐸᓕᒋᐠ ᐱᓓᓯᐧᐊᐠ ᐊᐣᑌ ᐧᐊᓭᐃᐯᔭᐠ᙮ ᑲ ᐊᑎ ᐊᒋᐸᓕᐠ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᓀᐢᑕ ᐊᐧᐊᓯᑌ ᑲ ᒥᑯᔥᑲᒋᑕᐨ ᐃᓕᓕᐤ ᐁ ᐊᑎ ᒥᒣᑎᐨ ᐃᓕᓕᐤ ᑲ ᐣᑕᒥᓚᐅᐨ ᑕ ᐊᒋᐸᓕᐤ ᓀᐢᑕ ᑲ ᐅᒋ ᐱᒪᒋᐅᐨ ᐱᓓᓯᐤ᙮ ᑲ ᒥᐧᓚᔑᓂᓕᐠ ᑲ ᐅᒋ ᐱᒪᒋᐅᐨ ᑕ ᐅᒋ ᒥᒣᑎᐤ ᑲ ᑕᔑᐨ ᐱᓓᓯᐤ ᐊᔑᒼ ᑲ ᐃᔑ ᐧᐊᒋᐢᑐᓕᐨ ᓀᐢᑕ ᐃᐢᐱ ᑲ ᐧᑕᑯᐸᓕᒋᐠ ᓀᐢᑕ ᑲ ᐃᑐᑕᑭᐠ ᑲ ᐃᔑ ᐱᒼᐸᓕᒋᐠ᙮ ᒥᓯᐧᐁ ᐅᐅ ᑫᐧᑲᓇ ᐊᔑᒋᐸᓕᐧᐊ ᐃᓕᑯᐠ ᑲ ᐃᑕᒋᐠ ᐱᓓᓯᐧᐊᐠ ᓀᐢᑕ ᐅᓚᑕᒥᓚᐅᐧᐊᐠ ᑲ ᐊᐸᒋᐊᒋᐠ ᐊᓂᐃ ᐱᓓᓯᐧᐊ᙮

ᐅᒪ ᓇᑕᐧᐃ ᑭᐢᑫᓕᑕᒧᐧᐃᐣ ᑭ ᒥᐢᑲᑌᐤ ᒥᒣᐧᑕᔦᐠ ᐁ ᐧᐃᒣᐧᐃᑐᒪᑲᓂᓕᐠ ᑲ ᐃᔑ ᑭᐢᑫᓕᑕᑭᐠ ᑫᔑᐧᐊᐠ ᐃᓕᓕᐧᐊᐠ ᓀᐢᑕ ᒥᑐᓕᓯᐧᐃ ᑭᐢᑫᓕᑕᒧᐧᐃᐣ᙮ ᐊᓂᐃ ᐊᑎᐨ ᑫᐧᑲᓇ ᐱᑐᔥ ᑲ ᐃᔑᓚᐧᑲᑭ ᐅᓴᒼ ᐁ ᓗᑌᐸᓕᐠ ᐧᐃᑕᒪᑫᐧᐃᐣ ᐯᔭᐧᑲᐣ ᐃᓕᑯᐠ᙮ ᓀᐢᑕ ᑭ ᐧᐊᐸᒋᑲᑌᐤ ᐁ ᓗᑌᐸᓕᐠ ᒥᑐᓕᓯᐧᐃ ᑭᐢᑫᓕᑕᒧᐧᐃᐣ ᐊᓂᒪ ᑲ ᐊᑎ ᐃᔑ ᐊᒋᐸᓕᐠ ᐊᐣᑌ ᓇᓀᐤ ᐧᐃᓕᐯᑯᐠ ᓀᐢᑕ ᐧᐊᐸᒋᑲᑌᐤ ᐁ ᐣᑕᐧᐁᓕᑕᐧᑲᐠ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓕᑕᒧᐧᐃᐣ ᓂᑲᐣ ᐃᑌᑫ᙮ ᐅᒪ ᓇᑕᐧᐃ ᑭᐢᑫᓕᑕᒧᐧᐃᐣ ᓇᑕᒪᑫᒪᑲᐣ ᐊᓂᐃ ᑲᑭᓚᐤ ᑲ ᐊᑎ ᐊᒋᐸᓕᐠ ᑲ ᐊᑎ ᐱᑐᔑᐸᓕᐠ ᑲ ᐃᔑ ᑭᔑᑲᐠ ᓀᐢᑕ ᑲ ᐅᒋ ᐱᒪᒋᐅᐨ ᐱᓓᓯᐤ ᐊᐣᑌ ᐊᐨᓯᐣ ᐯ ᐧᐊᓭᐃᐯᔭᐠ ᓀᐢᑕ ᑲ ᐃᐢᐱ ᒥᒣᑎᐨ ᐱᓓᓯᐤ ᓀᐢᑕ ᑲ ᐃᔑ ᐊᐃᑕᐨ ᓀᐢᑕ ᑲ ᐃᔑ ᓇᓇᑕᒥᓚᐅᓇᓕᐧᐊᐠ᙮ ᑲ ᑭ ᐊᔭᒥᐃᒋᐠ ᐃᓕᓕᐧᐊᐠ ᑭ ᒐᑲᐢᑌ ᐊᓕᒧᒋᑲᑌᐧᐊ ᑲ ᐊᑎ ᐱᑐᔑᐸᓕᑭ ᐊᓂᐃ ᑫᐧᑲᓇ ᑲ ᓕᑕᐧᐃᑭᑭ ᓀᐢᑕ ᑲ ᐊᑎ ᑭᔑᑌᐠ ᓀᐢᑕ ᐁ ᑭᐢᑌᓕᑕᐧᑲᐠ ᑭᒋ ᓕᓯᑐᒋᑲᑌᑭ ᐊᓕᐃ ᑫᐧᑲᓇ ᑲ ᐊᑎ ᐊᒋᐸᓕᑭ ᑫ ᑯᔥᑯᐸᓕᐠ ᑲ ᐃᔑ ᒥᒋᓱᐨ ᓀᐢᑕ ᑲ ᐃᑐᑕᑭᐠ ᐃᐢᐱ ᑲ ᐧᐊᒋᐢᑐᓕᒋ ᐊᓂᑭ ᐱᓓᓯᐧᐊᐠ᙮ ᐊᑕ ᒪᑲ ᐁᑲ ᐁ ᑯᔥᑯᐸᓕᐠ ᑲ ᒥᓗᐸᓕᐠ ᐁ ᐣᑕᒥᓚᐅᓇᓕᐧᐊᐠ ᐁ ᓯᐧᑲᐠ ᒧᓚ ᒪᔥᑯᒡ ᐁᐢᐧᑲ ᐅᑎᒋᐸᓕᐤ ᑫ ᐅᒋ ᐸᔭᑌᓚᐧᑲᓂᓕᐠ ᑲ ᐃᔑ ᐱᑐᔑᐸᓕᒋᐠ ᑲ ᐃᐢᐱᒋ ᒥᒣᑎᒋᐠ ᐱᓓᓯᐧᐊᐠ᙮ ᐅᒪ ᓇᓇᑕᐧᐃ ᑭᐢᑫᓕᑕᒧᐧᐃᐣ ᒥᐧᓚᔑᐣ ᐁ ᐊᐸᒋᑕᓕᐧᐊᑭ ᓇᓇᑲᐤ ᑭᐢᑫᓕᑕᒧᐧᐃᓚ ᐁ ᐅᒋ ᒥᐧᓚᔑᐠ ᑲ ᐃᔑ ᓕᓯᑐᑕᒪᐠ ᐁᔑ ᐧᐃᒋᐃᑐᒋᐠ ᐱᓓᓯᐧᐊᐠ ᓀᐢᑕ ᐃᑕᐧᐃᐣ ᓀᐢᑕ ᐸᐧᑲᑕᐢᒥᐠ᙮ ᑭᐢᑌᓕᑕᐧᑲᐧᓚ ᐊᓂᐃ ᑲ ᐃᔑ ᐊᓚᐢᑯᐸᓕᑭ ᒥᓴᐧᐊᒼ ᑭᒋ ᐅᒋ ᐊᐧᐊᓯᑌ ᒪᒪᐤ ᓕᓯᑐᒋᑲᑌᐠ ᑲ ᐃᔑ ᐱᑐᔑᐸᓕᐠ ᐸᐧᑲᑕᐢᑲᒥᐠ ᐊᐣᑌ ᓇᓀᐤ ᐧᐊᓭᐃᐯᔭᐠ᙮

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GLOSSARY

CAGO: Canada geese: (*Branta canadensis interior)*, also known as "niskas" by the Cree.

CWS: Canadian Wildlife Service.

IK: Indigenous Knowledge: "The local knowledge held by indigenous peoples or local knowledge unique to particular cultural groups" (Warren 1995).

MCFN: Moose Cree First Nation, in Moose Factory, Ontario.

MERC: Mushkegowuk Environmental Research Centre.

MVP: Mississippi Valley Population of Canada geese.

OMNR: Ontario Ministry of Natural Resources.

SJBP: Southern James Bay Population of Canada geese.

Small Canada geese (also known as Cackling geese): (*Branta hutchinsii*), also known as "small heads" or lesser Canada geese by the Cree.

SNGO: Snow geese: *(Anser caerulescens caerulescens),* also known as "wavies" by the Cree.

TEK: Traditional Ecological Knowledge: "Cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" Berkes (2000: 1252).

WFN: Weenusk First Nation, in Peawanuck (formerly Winisk), Ontario.

Definitions for Tree Nodes (Themes) used in NVivo qualitative analysis coding:

Hunting Practices: *Practices related to the goose hunt*
Spring: The spring hunting season, from April to June
Fall: The fall hunting season, from August to October
Number Killed: The number of geese killed in a given season, specific to Canada geese and snow geese
Number of Days Spent Hunting: The total number of days (duration) spent hunting in a given season
Timing: The timing of the hunting trip

Geese: *Observations related to the geese*
Number: Observations on the abundance of geese seen in specific hunting locations
Condition: Observations on the appearance and taste of the geese

Migration: *Observations relating to the migration of the geese*
Spring: Observations specific to the spring migration
Fall: Observations specific to the fall migration
Timing: Observations on when the geese are migrating through a given area
Pattern: Observations on patterns or behaviours of the geese while they are flying/migrating.

Environmental Factors: *Weather, Vegetation and Wildlife*
Weather: Observations on changes in the weather
Warmer/earlier: Observations that spring is arriving earlier, or that it is warmer
Unpredictable: Observations that the weather is increasingly unpredictable, varied, and unsafe (i.e. river ice)
Other: Other weather related observations

Vegetation: Observations on changes in vegetation

Wildlife: Observations in changes in wildlife species composition

Definitions of quantitative terminology for qualitative comparisons (in Discussion chapter):
Few: less than 25% of n
Some: between 25 and 40% of n
Many or several: between 40 and 50% of n
More: where n is the larger of the two values
Less: where n is the smaller of two values
Most/majority: over 50% of n

1.0 INTRODUCTION

Climate is changing at an accelerated pace in arctic and sub-arctic regions, and impacts are expected to be rapid and profound (Arctic Climate Impact Assessment (ACIA) 2005, Prowse et al. 2009). Responses and consequences are already occurring, including increased temperatures; changes in precipitation; and changes in plant and animal phenology (McCarty 2001, Walther et al. 2002, Visser and Both 2005). Changes in carbon dioxide levels, cloud cover, soil moisture and water and nutrient availability are also expected (Ayres 1993). Other responses include changes to climate variability and frequency and magnitude of extreme events (McCarty 2001). These changes will impact terrestrial and aquatic biodiversity, as well as species range, distribution, abundance, behaviour and habitat (Visser and Both 2005, Prowse et al. 2009).

While many of these changes are global, regional changes are more relevant to local ecological responses (Walther et al. 2002). In the Hudson Bay region, global circulation models (GCMs) predict average land temperatures to increase from 4.4°C to 6.5°C in the next century (Gough and Wolfe 2001). These changes will likely affect ecosystem interactions, including animal behaviour and vegetation growth (Ayres 1993, Prowse et al. 2009).

It is important to track these changes, as they typically impact entire ecosystems and in turn human populations. Northern First Nation communities in particular are among some of the populations most vulnerable to effects of climate fluctuations and environmental change, as they rely heavily on the land for both diet and economy (ACIA, Furgal et al. 2006). A changing climate will affect the distribution of animals and resources, and in turn human-ecological interactions between communities and the land (Berkes and Fast 1998, Prowse et al. 2009). Studies have documented changing environment-wildlife-community interactions, including the relationships between sea ice and Inuit in the Arctic (Laidler 2006), and wildlife with Inupait Eskimos in Alaska (McBeath and Shepro 2007). There have also been a few studies in the Hudson Bay Lowland, focusing on the impact of climate change on fish and fishing subsistence (Ho

2003, Hori 2010), and adaptability and resilience of First Nations to climate change (Lemelin et al. 2010).

The First Nations (Cree) of the Lowland rely heavily on waterfowl for subsistence, as much in overall weight as moose or caribou (Thompson and Hutchison 1987, Berkes et al. 1992). The wetlands of the Lowland are important breeding and staging grounds for several goose species of the Mississippi Flyway, where individuals acquire critical reproductive fat reserves before reaching their arctic breeding grounds (Thomas and Prevett 1982). The most numerous and important are the Canada geese (*Branta canadensis interior*) of the Mississippi Valley Population and Southern James Bay Population, as well as lesser snow geese (*Anser caerulescens caerulescens*) of the mid-continent population, both migrate through the region, nesting within hunting range of the coastal communities.

There are two types of changes taking place which affect geese: habitat disturbance and climate change. Habitat changes have occurred in the wintering grounds and migration corridors in the southern United States, including altered land use in the form of increased agriculture and use of fertilizers, as well as loss of coastal habitat (Abraham et al. 2005, Ward et al. 2005). These changes have led to shifts in the distribution of geese in the wintering grounds as well as increased goose populations (Jefferies et al. 2003). There have also been habitat changes in the breeding grounds farther north in the Hudson Bay Lowland, due to intensive foraging by an increased lesser snow goose population (Abraham and Jefferies 1997). There has been substantial habitat degradation in certain coastal areas of the Lowland. Cape Henrietta Maria, at the crux of James and Hudson Bays, and Churchill, in Manitoba, are two regions which have been extensively grubbed (Jano et al. 1998, Jefferies et al. 2006). These most severe impacts are not, however, occurring in all areas of the Lowland, and have not been documented in coastal regions in close proximity to the communities. So although coastal degradation by geese is an issue in several regions of the Lowland, the changes to vegetation discussed in this thesis are specific to areas within hunting proximity of the two communities, and changes are focused on climatic and human influences.

The specific impacts of climatic change on the breeding grounds of the Hudson Bay Lowland are not well known. The role that climate change plays, directly or indirectly through effects on habitat in James and Hudson Bay, is not well understood and yet is critical to the lives of Cree communities in this region.

This study was conducted as part of the circumpolar IPY (International Polar Year) project ArcticWOLVES (Arctic Wildlife Observatories Linking Vulnerable Ecosystems). ArcticWOLVES was funded by IPY through both NSERC (Natural Science and Engineering Research Council) and the Government of Canada. ArcticWOLVES aimed to assess the current conditions and impacts of climate change on terrestrial Arctic ecosystems on a large scale. My project consisted of a hybrid between two project components under the theme of wildlife abundance, distribution and use by northern people in relation to climatic change (ArcticWOLVES 2009). It also built on a preliminary harvest survey conducted by Mushkegowuk Environmental Research Centre (MERC) in conjunction with Canadian Wildlife Service (CWS) and the Ontario Ministry of Natural Resources (OMNR) from 2003 to 2005. At that time, community members expressed an interest in sharing their experiences and working together in the future on the topic of habitat changes in coastal communities.

The understanding of the goose-lowland system at the outset of the study is described in Figure 1.1. This model was designed in consultation with experts and the literature. It identifies relationships, for example between climate change, goose habitat, and timing of migration (Kery et al. 2006, McCarty 2001, Murphy-Klassen et al. 2009). But there are also gaps in this understanding, for example with respect to human-ecological relationships. One relationship that has not been examined is that between climate change, goose abundance and goose availability to First Nations hunters. Another relationship that has not been examined is the potential shift in timing of migration leading to changes in goose availability (and in turn goose harvest by hunters).

This study aimed to expand on this conceptual model, using multiple sources of information in a mixed methods design to more fully address and understand the complex issues surrounding the goose-lowland system. My research question was to investigate what the impacts of a changing climate were on goose ecology, and in turn the goose harvest by First Nations in the Hudson Bay Lowland. To address this question I had two objectives. The first was to examine how climate and goose habitat in the Lowland may be changing, and how these changes may be impacting Canada goose and lesser snow goose populations in terms of abundance and distribution. A second objective was to examine if and how these changes affect coastal Cree communities in terms of their access to and harvest of geese. I used information that linked local knowledge with technical information, through a combination of sources, including: interviews with northern residents who have acquired knowledge based on years of experience on the land; historical harvest data; climate records; vegetation studies, and goose population surveys.

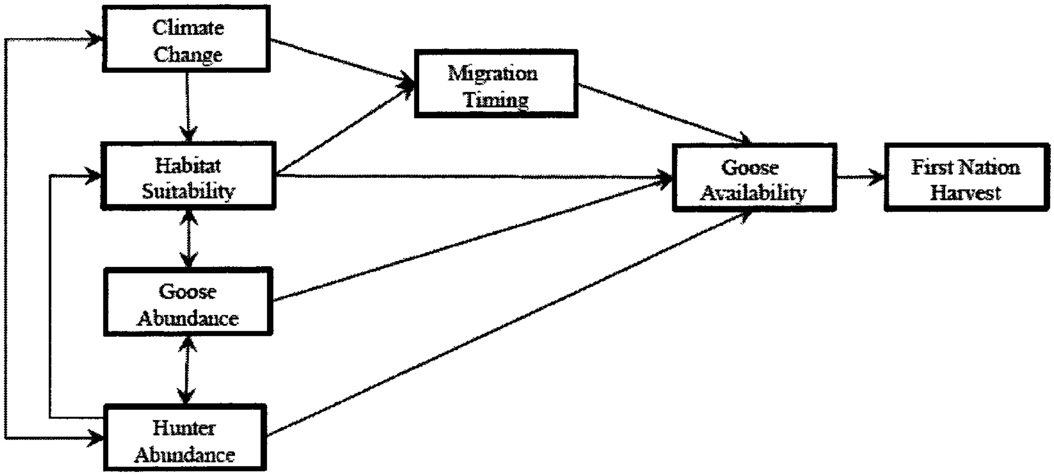


Figure 1.1. Conceptual model of the Goose-Lowland system and interactions, as understood at the outset of the study.

Communities for the study were chosen based on their geographical representation of regions of the Lowland experiencing different kinds of both ecological as well as social change. Moose Factory is located at the southern tip of James Bay, with a large population relative to the region and connected to southern communities by rail. Peawanuck is a remote, fly-in community on the southern coast of Hudson Bay, with a small population and more reliant on the land for subsistence. Each community observes and harvests Canada geese and snow geese as an important component of their culture and traditional diet (Berkes 2008).

The thesis begins with a literature review, containing a physical description of the Hudson Bay Lowland, background on the geese and the communities of the study, overview of previous harvest studies, a critical review of the interface between Traditional Ecological Knowledge (TEK) or Indigenous Knowledge (IK) and science as presented in the literature, and a brief overview of the current understanding of the impacts of a changing climate on geese. Next is a methods chapter, describing the mixed methods approach to the study. There are two results chapters presenting information gathered through both the interviews and technical data searches: one describing the changes in climate, goose habitat and goose populations, and the second describing changes or impacts to the access and harvest of geese by local First Nations communities. The discussion chapter offers confirmation in instances of convergence of information between data sources, as well as potential explanations and speculation for instances of divergence, or where data sets disagree. The thesis concludes with recommendations on using a mixed methods design to study human-ecological relationships in northern regions.

2.0 LITERATURE REVIEW

A background description of the study area, communities, and mixed methods rationale is helpful in understanding the context for the study. The review contains a physical description of the Hudson Bay Lowland, followed by a description of both the geese and the communities in the study, an overview of previous harvest studies, a critical review of the interface between Traditional Ecological Knowledge (TEK) or Indigenous Knowledge (IK) and science as presented in the literature, and a brief overview of the current understanding of the impacts of a changing climate on geese.

2.1 PHYSICAL DESCRIPTION OF THE HUDSON BAY LOWLAND

Geology/Geomorphology

The Hudson Bay and James Bay lowlands stretch from Churchill, Manitoba to the Eastmain River in Quebec, covering 325 000 km^2 along approximately 1900 km of saltwater coastline (Riley and McKay 1980, Abraham and Keddy 2005). Over 80% of the Lowland is in Ontario, which covers a quarter of the province (Riley 2003, Abraham and Keddy 2005). The Lowland was covered by ice during the Wisconsin glaciations, and the retreating glacier formed the basin that became Hudson and James Bay (Abraham and Keddy 2005). The land of the Lowland has been emerging over the last 7000 to 8000 years through the process of isostatic rebound (Riley and McKay 1980). The land emergence is more rapid than sea level rise along the western James Bay and Hudson Bay coasts, with the Hudson Bay shoreline moving northward 1 m per year (Riley and McKay 1980). The Lowland extends 200 to 300 km inland, on bedrock of the Pre-Cambrian shield and low lying rocks of old inland basins (Martini et al. 2009). The bedrock is riddled with limestone, and overlain with marine clays (Martini 1981). Beach ridges trap some of these marine sediments and stabilize the substrate for the growth of vegetation (Glooschenko 1978).

Structure and vegetation

The Lowland is one of the largest wetlands in the world (Riley 2003), and is characterized by a series of intertidal and supratidal regions transitioning from saltwater to freshwater marshes (Martini et al. 2009). Wetlands make up 76% to 100% of the region (National Wetlands Working Group (NWWG) 1997), with over 90% as saturated peatland plain (Riley 2003). Beach ridges parallel the coasts, and separate the region's different marsh types (Riley and McKay 1980). Beyond the reaches of the intertidal and supratidal zones are freshwater meadow marshes, interspersed by older beach ridges (Riley and McKay 1980).

The vegetation of the James and Hudson Bay coasts is classified into ecological regions based on climate, landforms, species composition and ecological processes (Ecological Stratification Working Group (ESWG) 1995). These are the Coastal Hudson Bay Lowland, the Hudson Bay Lowland, and the James Bay Lowland (Figure 2.1). The locations of the present study are in two of these regions, with Peawanuck in the most northern Coastal Hudson Bay Lowland, and Moose Factory in the most southern James Bay Lowland.

The most common vascular species to colonize the shoreline is *Puccinellia phryganodes*, a prostrate alkali and salt tolerant grass, which covers 5% to 90% of the intertidal areas (Riley and McKay 1980, Martini et al. 2009). The beach ridges form a distinct barrier between the tidal zones, and on the inland side supratidal freshwater meadow marshes are dominated by *Festuca rubra* (Riley and McKay 1980). *Carex subspathacea* is also common, a species less tolerant of full salinity, and establishes itself in the mud or on shallow river bottoms (Martini et al. 2009). The inland, non-tidal vegetation ranges from boreal forest in the southern region, to maritime arctic tundra in the northern region (Riley and McKay 1980).

Climate

Each ecoregion is classified further into wetland regions (NWWG 1997). The Coastal Hudson Bay Lowland is classified into humid high subarctic and low subarctic regions. The humid high subarctic region contains treed and open bogs, open fens, and is based on continuous permafrost (Figures 2.2, 2.3; NWWG 1997, in Abraham and Keddy 2005, Brown 1973). The low subarctic region is composed of meadow marshes, peat plateau bogs, and discontinuous permafrost (Figure 2.3; Brown 1973, Martini et al. 2009). The most southern region, including Moose Factory, is identified as humid mid-boreal and is characterized by swamps, bogs and fens, and is also based on discontinuous permafrost (Abraham and Keddy 2005, Martini et al. 2009).

The climate of the Lowland is cold relative to other regions at similar latitudes, due to the seasonally varying ice cover of James and Hudson Bays and the associated permafrost (Rouse 1991). Freshwater rivers flowing into James and Hudson Bays dilute the water to a third of the surrounding ocean salinity, allowing them to freeze (Rouse 1991, Riley 2003). This influence, combined with the frozen ground, contributes to the short, cool summers and long cold winters of the Lowland (Rouse 1991, Abraham and Keddy 2005). There is also some temperature variation across the region, with the southern James Bay Lowland being warmer and wetter, and the Coastal Hudson Bay Lowland cooler and drier (Abraham and Keddy 2005).

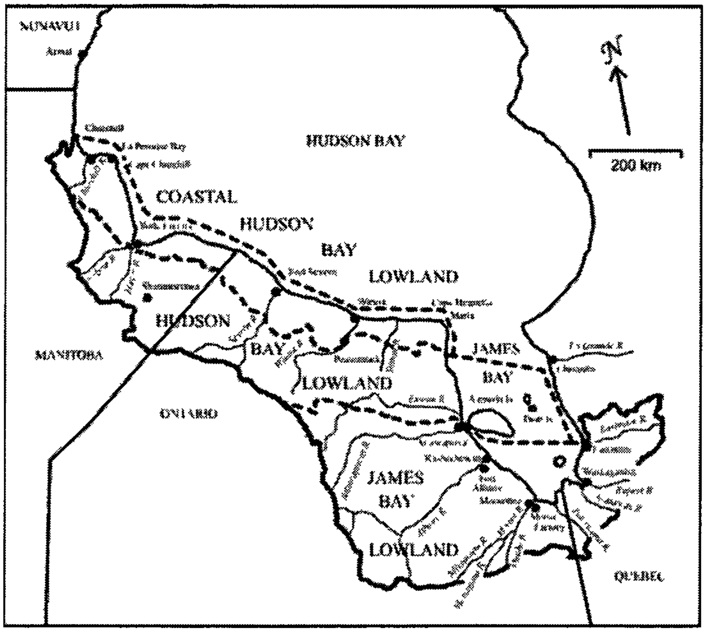


Figure 2.1. Ecological regions of the Hudson Bay Lowland (Ecological Stratification Working Group (ESWG) 1995).

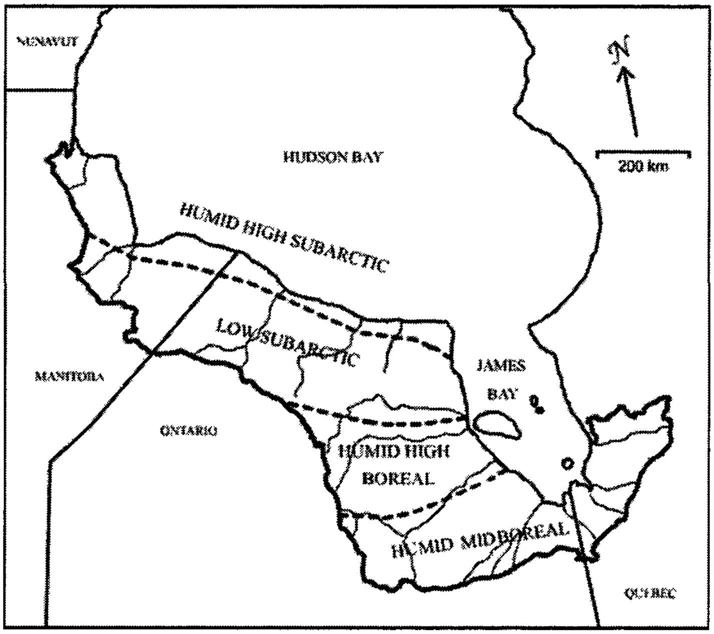


Figure 2.2. Wetland regions of the Hudson Bay Lowland (National Wetlands Working Group (NWWG) 1997).

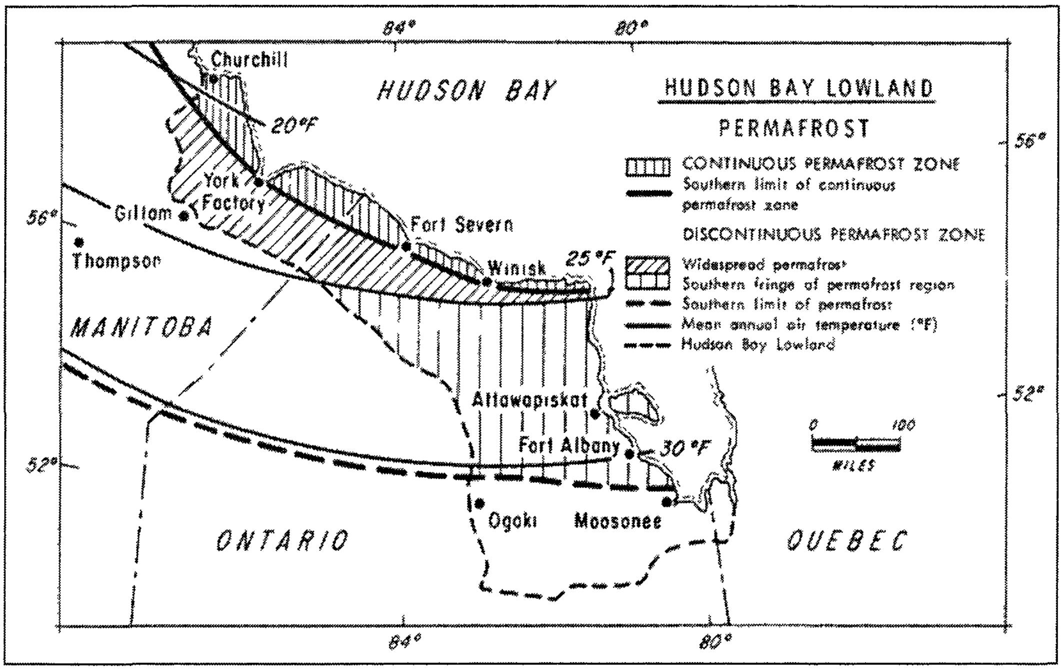


Figure 2.3. Permafrost regions of the Hudson Bay Lowland (Brown 1973).

Other fauna

Avian species comprise the majority of the vertebrate fauna found in the coastal wetlands of the Lowland (Martini et al. 2009). Most are water associated species including ducks, geese, swans (*Cygnus* spp), loons, gulls (*Larus* spp), terns (*Sterna* spp), and shorebirds, but there are also many birds of prey including owls and raptors (OMNR 1985, Martini et al. 2009). More recently, bald eagles (*Haliaeetus leucocephalus*) have become abundant in the coastal areas (OMNR unpublished).

Many mammals also inhabit the Lowland, including the polar bear (*Ursus maritimus*), woodland caribou (*Rangifer tarandus caribou*), wolverine (*Gulo gulo*), mink (*Neovison*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*) and fox (*Vulpes spp*) (OMNR 1985, Abraham and Keddy 2005). There are also ringed seals (*Pusa hispida*) and beluga whales (*Delphinapterus leucas*) in the river estuaries and in areas of the bays near shore (Abraham and Keddy 2005).

Development in the Lowland

There are seven coastal communities in the Ontario portion of the Hudson Bay Lowland, extending from the southern tip of James Bay all the way to the Manitoba border. These are Moosonee, and the First Nation communities of Moose Factory, Kashechewan, Fort Albany, Attawapiskat, Peawanuck (formerly Winisk), and Fort Severn (Figure 2.4).

There are few roads in the Lowland. There is a winter road that connects Moosonee with Fort Albany, Kashechewan, and Attawapiskat, and another winter road from Peawanuck extending to Fort Severn and then to Shamattawa and Gillam, Manitoba (Corston and McComb 2008). The Ontario Northland Railway (ONR) has connected Moosonee to Cochrane since 1932 (George et al. 1993), but the other coastal communities are only accessible by plane or boat. Other developments in the region include several hydroelectric dams on the Moose, Abitibi and Mattagami rivers, beginning in the early 1900s (George et al. 1993), and the Victor diamond mine west of Attawapiskat, operational since 2008.

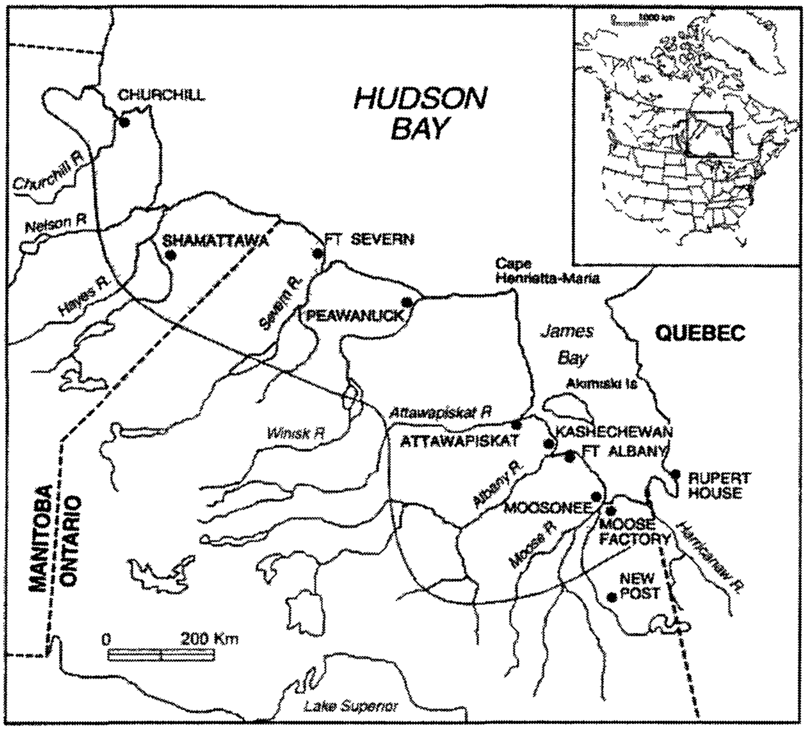


Figure 2.4. Traditional territory of the West Main Cree (adapted from Honigmann 1981, in Ohmagari and Berkes 1997).

2.2 THE GEESE OF THE HUDSON BAY LOWLAND

The wetlands of the Hudson Bay Lowland are both breeding and staging grounds for several goose species, as individuals acquire critical reproductive fat reserves before reaching their arctic breeding grounds (Thomas and Prevett 1982). These include Canada goose (*Branta canadensis interior*), lesser snow goose (*Anser caerulescens caerulescens)*, giant Canada goose (*Branta canadensis maxima*), Cackling goose (formerly lesser or small Canada goose) (*Branta hutchinsii),* Atlantic brant (*Branta bernicla*) and Ross's goose (*Anser rossii*) populations. This study focused solely on Canada /Cackling geese and lesser snow geese.

Avian migration routes connecting southern wintering grounds with Arctic breeding areas are known as flyways. Most of the Canada geese which use the study area portion of the Hudson Bay Lowland are part of the Mississippi Flyway. Canada geese of this flyway that breed in the Ontario portion of the Hudson Bay Lowland are divided into two populations: the Mississippi Valley Population (MVP) and the Southern James Bay Population (SJBP) (hereafter referred to as MVP and SJBP). Cackling geese and giant Canada geese are also found within the Mississippi Flyway (Figure 2.5). Lesser snow geese migrating through and breeding in the Lowland are part of the mid-continent population and winter in the Mississippi and Central Flyways (Figure 2.6). Each of these populations is described in turn.

Mississippi Valley Population (MVP) of Canada geese (*Branta canadensis interior*)

The range of the MVP extends from the wintering grounds in northern and central Illinois, and occasionally southern Wisconsin and Michigan, to the breeding grounds throughout the Hudson Bay Lowland south of Hudson Bay and west of James Bay north of the Attawapiskat River (Brook and Luukkonen 2010). The geese migrate north beginning in mid-February and arrive in the Lowland by mid to late April (Thomas and Prevett 1982, Tacha et al. 1991). Historically MVP geese wintered on sandbars of the Mississippi River in Louisiana and Mississippi (Brook and Luukkonen 2010), however, they have since shifted northward. The shift is attributed to a managerial move in the 1930s to 1950s where refuges in key locations were established to influence the southward migration of geese to provide equal opportunity hunting (Leafloor et al. 2003). These protected areas, combined with a growth in food availability from shifting agricultural practices in the northern United Sates and southern Canada during the same time period, led to a northward shift in the wintering distribution of the geese (Leafloor et al. 2003), as well as an increase in population (Abraham and Jefferies 1997).

The population is currently stable (Brook and Luukkonen 2010). According to spring breeding ground aerial transect surveys, the estimated breeding population has fluctuated around 360 000, ranging between 255 000 and 518 000 birds over the last 20 years (Brook and Luukkonen 2010). Breeding ground aerial surveys in 2011 indicated a total population of breeding birds at 269 800 (±48 200)(US Fish and Wildlife Service 2011).

Southern James Bay Population (SJBP) of Canada Geese (*Branta Canadensis interior*)

The SJBP, formerly known as the Tennessee Valley Population (TVP), is the smallest breeding population of Canada geese in the Hudson Bay Lowland (Abraham and Warr 2003). The SJBP geese winter in southern Ontario and Michigan, to Mississippi, Alabama, and Georgia (US Fish and Wildlife Service 2011). About 15% of the population is part of the Atlantic Flyway and this portion winters in northwest Pennsylvania, Virginia, and South Carolina (Leafloor et al. 1996). The exact breeding range of the SJBP is less well-defined than that of the MVP, as the population has shifted in definition over the years. Presently, the range extends from Akimiski Island to the west and south of James Bay, including the interior muskeg of the Lowland (Abraham and Warr 2003). SJBP Canada geese arrive in the James Bay portion of the Lowland in mid April, leaving in August and early September, although a few will remain until James Bay freezes over in November (Thomas and Prevett 1982).

The SJBP declined in the late 1980s and early 1990s, but had stabilized by 2000 (Abraham and Warr 2003). The population appears to be relatively stable following good reproduction on the western James Bay mainland in the mid-2000s (Arctic Goose Joint Venture (AGJV) 2008). In spring 2011, the estimated number of breeding SJBP Canada geese was 86 900 (±17 500) (US Fish and Wildlife Service 2011). The population is jointly managed by the Mississippi and Atlantic Flyway Councils.

Small Canada geese (also known as Cackling geese) (*Branta hutchinsii*)
Recently renamed (Banks et al. 2004), the Cackling goose migrates from the breeding areas of the Tall Grass Prairie Population at Southampton and Baffin Islands and the McConnell River area of western Hudson Bay (Prevett et al. 1983). Large numbers are harvested along with snow geese along the southern Hudson Bay coast by hunters of the Weenusk First Nation, and other communities such as Fort Severn (Thomas and Prevett 1982).

Giant Canada geese (*Branta canadensis maxima*)
Giant Canada geese were not a focus of this study but are discussed as they have added complexity to studying Canada goose populations in this region. Temperate breeding giant Canada goose populations increased in the 1970s and 1980s and have increased further since 1998 (Brook and Luukkonen 2010). They now represent a large proportion of all Canada geese in the Mississippi Flyway, with the most recent population estimate

at just over 1.6 million birds in 2011 (US Fish and Wildlife Service 2011). They occur in the Lowland as molt migrants, use the same habitats as *interior* subspecies breeding Canada geese, and cannot be differentiated during an aerial survey (Abraham et al. 1999). This conflict complicated aerial surveys using the mid winter index (Leafloor et al. 1996), however this has been mediated by the shift to more accurate counts during breeding ground surveys (Abraham and Warr 2003). Most Canada goose nests in the Lowland are initiated before mid-May and breeding pairs can be counted before the giants arrive from late May to early June (Abraham et al. 1999, Leafloor et al. 2003).

Mid-continent lesser snow geese (*Anser caerulescens caerulescens*)

Lesser snow geese wintering in the mid-continent region including the Mississippi Flyway and eastern Central Flyway belong to the mid-continent population (US Fish and Wildlife Service 2007). The largest Ontario colony is located at Cape Henrietta Maria. The mid-continent population winters from the coast of Louisiana and Texas northward into the Mississippi alluvial valley as far as Iowa (US Fish and Wildlife Service 2011). Spring migration northward begins as early as February, and geese arrive on the southernmost breeding grounds of the Lowland by early May, via the prairies (Thomas and Prevett 1982), reaching northern Hudson Bay breeding areas by mid to late May (Jefferies et al. 2003). They start their southward migration at the end of August or early September, although formerly some remained in the Lowland until late October (Jefferies et al. 2003).

Mid winter surveys are an index (US Fish and Wildlife Service 2007) which in 2011 estimated a population of 3.2 million light geese (US Fish and Wildlife Service 2011). The term "light geese" refers to the light coloured greater snow geese, Ross's geese, and lesser snow geese (US Fish and Wildlife Service 2007). Populations of mid-continent lesser snow geese have been increasing 5% to 7% annually from the 1960s and into the mid 1990s (Abraham and Keddy 2005) and have continued to increase into the 2000s, although at a reduced rate (Alisauskas 2011). Several factors have contributed to this increase, including the establishment of refuges from hunting on migration routes through the United States from the 1930s to 1970s; agricultural food subsidies and the harvest of geese not rising in proportion to the population growth (Jefferies et al. 2003).

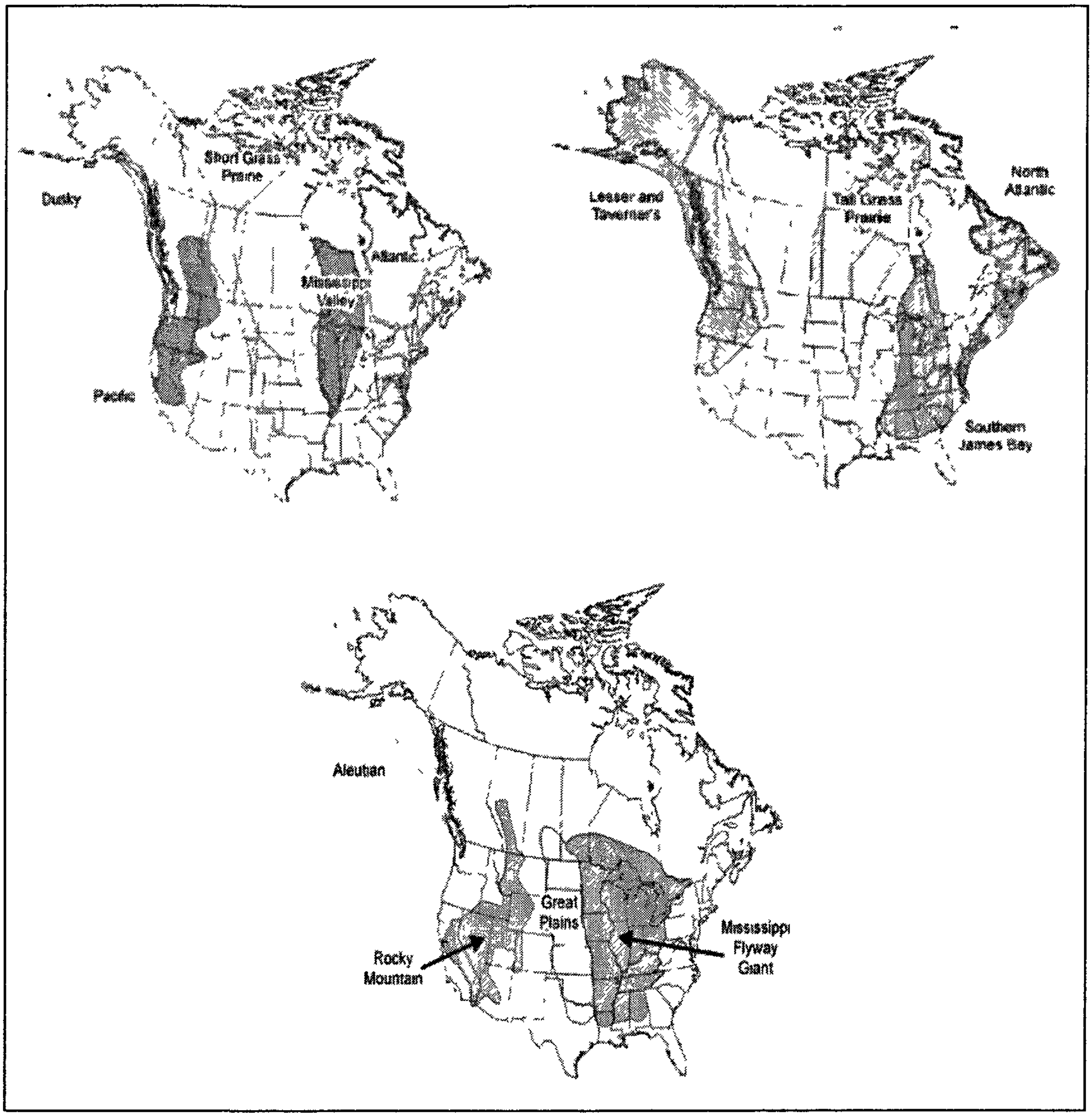


Figure 2.5. Approximate ranges of Canada geese in North America (US Fish and Wildlife Service 2011).

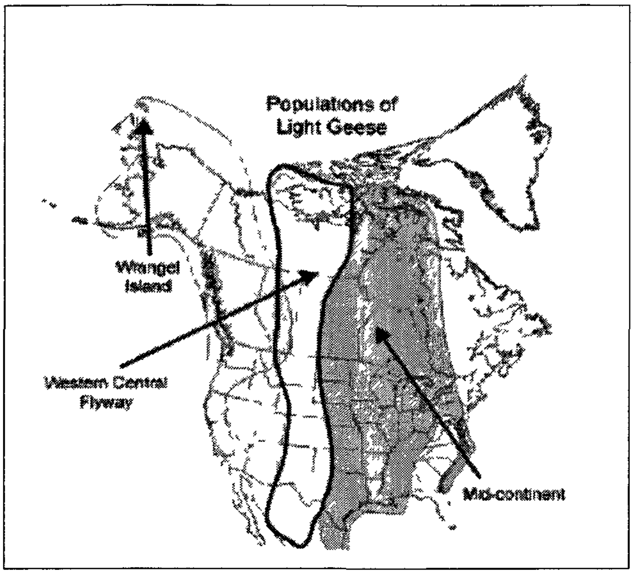


Figure 2.6. Approximate ranges of light geese in North America (US Fish and Wildlife Service 2011).

Canada geese and snow geese of the Mississippi Flyway are jointly managed by states and provinces of the Mississippi Flyway Council, including both U.S. (Fish and Wildlife Service, FWS) and Canadian (Canadian Wildlife Service, CWS) federal governments, as well as in cooperation with First Nations (Brook and Luukkonen 2010). Management of population numbers largely means managing hunting harvest, which is mostly focussed in the United States. In Canada most of the harvest is by First Nations, which is governed by federal treaties, and remains unrestricted (Brook and Luukkonen 2010).

Suitable goose habitat

In the spring, Canada geese arrive on the Lowland before the onset of the main spring thaw and use staging areas that have open water and where the snow has melted (Ogilvie 1978, Gates 1989). While foraging habits between Canada geese and snow geese differ, grasses (*Puccinellia phryganodes),* sedges (*Carex aquatilis* and *Carex subspathacea)*, and horsetails (*Equisetum spp*) are all important diet sources for both (Table 2.1; Prevett et al. 1985, Gates 1989). In the spring, Canada geese predominantly graze sedges, and snow geese predominantly grub grasses (Prevett et al. 1985). Canada geese feed in intertidal salt marshes, supratidal marshes, freshwater sedge fens, and nest on islands in ponds and streams, and on beach ridges (Thomas and Prevett 1982, Bruggink et al. 1994, Jefferies et al. 2003). Geese nesting in forested interior areas feed in freshwater fens and swamps and choose nest sites where there are raised peat palsas, spruce islands in fens, and higher beach ridges (Raveling and Lumsden 1977, Prevett et al. 1985). Snow geese both nest and feed on the coast (Prevett et al. 1985).

Habitat changes have occurred on the wintering grounds and along migration corridors which also impact goose habitat selection. Changes in land use and loss of coastal habitat have caused geese to shift from foraging in natural habitats and wetlands to agricultural cultivated fields (Abraham et al. 2005, Ward et al. 2005).

Habitat changes have also occurred on the breeding grounds. The foraging behaviour of an increased lesser snow goose population over the last 30 years has been destructive to large areas of coastal grass and sedge habitats (Kerbes et al. 1990, Abraham and Jefferies 1997). The more extensive damage to vegetation by grubbing or grazing has been concentrated in certain important breeding or staging sites areas near Churchill, Cape Henrietta Maria, and Akimiski Island (Abraham and Jefferies 1997). The reduction of plants means a reduction in food resource availability but also contributes to secondary abiotic processes such as erosion, excessive drying and salinization, all which affect the recovery of plant community succession (Jefferies et al. 2003).

Table 2.1. Spring activity and diet of Canada geese and snow geese in the Hudson Bay Lowland.

Species	**Primary type of activity in Lowland**	**Important vegetation**	**Primary type of foraging behaviour**
Canada Geese ***Branta canadensis interior***	Reproduction, molt	Sedges most important (*Carex* spp), horsetails (*Equisetum* spp), and grass (*Puccinellia phyrganodes*)	Grazing
Snow Geese ***Anser caerulescens***	Staging, reproduction	Grasses most important (*Puccinellia phyrganodes, Festuca rubra*)	Grubbing and shoot pulling

Adapted from (Thomas and Prevett 1982, Prevett et al. 1985, Jefferies et al. 2003)

Estimating populations of geese

The way in which Canada goose populations are estimated has changed in the last 20 years. The total number of geese used to be estimated using a mid-winter index (MWI) on the wintering grounds and birds were assigned to different populations based on proportions of band recoveries or band observations (Abraham and Jefferies 1997). However, there was a discrepancy between those estimates and birds counted in the spring on the breeding grounds (Abraham and Jefferies 1997), due to the growing numbers of temperate breeding Canada geese and the overlapping winter ranges which prohibited discrimination of these stocks (Abraham and Warr 2003). The substantial overestimation of some populations of birds (SJBP, for example) using the MWI was due to the winter survey counting aggregations of geese from different colonies, populations and flyways (Abraham and Jefferies 1997). More accurate population-specific estimates could be obtained through surveys conducted on the breeding grounds (Leafloor et al. 2003). Beginning in 1990, winter surveys have been replaced by breeding ground surveys for the MVP and SJBP (Abraham and Jefferies 1997).

A similar dilemma exists for estimating lesser snow goose populations. Mid-continent lesser snow goose populations have been indexed in mid-winter since the 1950s (Abraham and Jefferies 1997), although these likely underestimate actual populations by about half (Kerbes 1975). The Lincoln method of using band recoveries in August is likely a more accurate means of estimating snow goose populations (Alisauskas et al. 2011).

2.3 THE PEOPLE OF THE HUDSON BAY LOWLAND AND THEIR RELATIONSHIP WITH GEESE

The people

The Swampy Cree of the Hudson Bay Lowland historically lived in scattered bands, but moved into village settlements starting in the late 1600s with the arrival of Europeans (Lytwyn 2002). There are now seven coastal communities in the Ontario Hudson Bay Lowland, including Moose Factory and Peawanuck, which are the focus of this study.

Moose Factory is located at the southern tip of James Bay, along the Moose River on Moose Factory Island (51°N 80°W). It falls within the southern James Bay Lowland ecoregion. It was established in 1673, as a fur trading post for the Hudson's Bay Company (HBC), and became the commercial trading centre of the James Bay region (OMNR 1985). It remained a trading post until the Indian Act of 1880, when the federal government began subsidizing education and providing financial assistance in response to a decline in the fur trade (Stephenson 1991). Treaty 9 was signed in 1905, followed by the construction of a school and hospital in 1951 (OMNR 1985). Employment has increased since the 1960s with small scale commercial developments and federal funding; however, unemployment remains a concern (Stephenson 1991).

Moose Factory Island has a population of approximately 2700, with Moose Cree membership comprising approximately 1600 (Moose Cree First Nation 2010). Most people in the MCFN speak English as their first language, but many also speak Cree (Stephenson 1991). Demographically, it is the older generation (60 and over) which predominantly speaks Cree (L Dialect) as a primary language and few under the age of 30 speak it at all (Stephenson 1991).

The current community of Peawanuck is inhabited by residents of the former village of Winisk, which was located at the mouth of the Winisk River as a traditional summer meeting spot for the Weenusk Cree. The HBC established an outpost trader there in the early 1880s, followed by a trading post in 1901 and by 1924 there was also a permanent Roman Catholic Mission (Liewbow and Trudeau 1964, Graham 1988). Treaty 9 was signed in 1930 (Liewbow and Trudeau 1964). Prior to 1955, the Winisk site was only occupied for a few weeks each summer when hunters and their families converged in the area, as most families lived the majority of the year hunting and trapping dispersed throughout the inland area (Graham 1988). A mid-Canada Line Radar Base was built across the river from Winisk starting in 1955, and during the construction years most of the trappers and hunters chose to spend their time in wage employment at the Base (Liewbow and Trudeau 1964). This was also a large turning point for the community in terms of wage labour, and interaction with non-native culture (Lytwyn 2002).

In May of 1986, spring flooding swept away the original settled community at the river mouth and the Cree of the Weenusk First Nation (WFN) relocated to the new village of Peawanuck (Graham 1988). Peawanuck (meaning a place where flint is found) is located about 32 km inland from the Winisk River mouth (54°N 80°W), and is on the border of the Coastal Hudson Bay Lowland and more inland Hudson Bay Lowland ecoregions. The population of Peawanuck as of the 2006 Census was 221 (StatsCan 2006). The mother tongue is predominantly Swampy Cree (N Dialect), however the language most spoken at home is English (StatsCan 2006).

The communities in the Hudson Bay region are supported by a mixed economic base. This includes a combination of transfer payments and special government grants, a wage employment sector, and a traditional sector of hunting, fishing and other harvesting activities (Berkes et al. 1994). Wildlife harvesting effort, participation rates, magnitude of the harvest, frequency of bush food consumption, the degree of sharing, the replacement value of the harvest, and contribution to the overall regional economy are all key factors which contribute to the importance of hunting as a sector (Berkes et al. 1994). Participation in the hunt is greater in the more northern communities, such as Peawanuck (Thompson and Hutchison 1987), as people are more reliant on country foods (Berkes et al. 1992). The MCFN is less reliant on subsistence activities than other communities of the Lowland, and has the greatest association with communities to the south (George and Preston 1987). There has also been a large socioeconomic shift in hunting in the James Bay region in the last 30 years, attributable to the growth of industrial developments and resource exploitation in the region as well as increased time spent on waged labour (Peloquin and Berkes 2009). However, hunting traditions remain an important part of Cree culture (Berkes et al. 1992).

Hunters and their families have traditionally gone to family hunting camps, in the same locations, for many years. The number of people going to the camps had remained relatively proportional to the population, at 80% of the community (Berkes et al. 1994). Both communities have a "goose hunting break" in April to allow students a week off school to join their families at the camps. In Moose Factory, it falls in the second week in

April, and in Peawanuck it varies with the year but falls within the end of April or beginning of May.

The relationship between the Cree and geese of the Lowland

Geese are an important component of the Cree culture, in terms of connection with the land, reciprocity, sharing, and community (Berkes 2008). Historically, the arrival of Canada geese brought an end to the long winter and months of dependence on land mammals, fish and dried or salted geese from the previous season (Hanson and Currie 1957). The first Canada goose killed of the season is still celebrated at most hunt camps (D. Isaac, pers. comm.), symbolizing this relationship. A young hunter's first goose killed is also celebrated (D. Isaac, pers. comm.). Some hunters also hang the trachea of the geese they kill on trees or camp posts as a sign of respect (Berkes 2008).

The cooking and use of geese also holds important cultural significance (Berkes 2008). Geese are traditionally smoked via hanging over a fire (called s*agabon* in Cree), roasted, boiled, or salted and packed in wooden casks (Ohmagari and Berkes 1997, Lytwyn 2002). Goose feet, necks, and the head are eaten, and goose fat is boiled down for later use (Berkes 2008). The trachea is also used for pipes, and the feathers for pillows, blankets and clothing (Lytwyn 2002).

In Cree, Canada geese (*B. c. interior*) are known as *niskas*, and snow geese are known as *waveys*. Cackling geese (*B. hutchinsii*) are sometimes referred to as such, but are more commonly known as small Canada geese or smallheads. The harvest of geese is equally as important as the harvest of moose or caribou (Berkes et al. 1992). Canada geese are hunted in April, followed by snow geese mixed with Cackling geese in a second hunt in May (Prevett et al. 1983). During the summer, very few geese are taken by either community, as the breeding grounds are relatively inaccessible to hunters and the geese are thin after their breeding effort and before fattening for their fall migration (Hanson and Currie 1957). In the fall, the hunt is focused on the snow goose, although Canada geese have also been harvested (Hanson and Currie 1957). The total harvest of the Cree in the last 50 years has increased due to an increase in the number of hunters, but it has not exceeded the rate of biological productivity of the geese (Hanson and Currie 1957, Berkes et al. 1992).

2.4 PREVIOUS WATERFOWL HARVEST STUDIES IN THE HUDSON AND JAMES BAY LOWLANDS

There have been four major published quantitative wildlife harvest studies and reports over the last 50 years, one occurring about every 10 to 20 years. All of these studies at least partially involved waterfowl harvest surveys as a component and spanned multiple communities in the Hudson Bay Lowland. These studies were conducted from 1954 to 1956 (Hanson and Currie 1957), 1974 to 1977 (Prevett et al. 1983), 1981 to 1983 (Thompson and Hutchison 1987), 1989 to 1991 (Berkes et al. 1992, Berkes et al. 1994) and an unpublished study in 2003 and 2004 (Hughes and Walton 2005). There was also a climate change element to the project in 2005, intended to expand on the ones in 2003 and 2004 (OMNR unpublished). Only the Thompson and Hutchison (1987) and Berkes et al. (1992) studies included detailed land use surveys in addition to harvest and wildlife other than waterfowl. There was also a community-led project from 1993 to 1995 which documented Traditional Ecological Knowledge (TEK) and environmental changes in the region (McDonald et al. 1997).

All the studies except for Berkes et al. (1992) and McDonald et al. (1997) were conducted by the Ontario Ministry of Natural Resources (formerly the Department of Lands and Forests). The studies in 2003 to 2005 were led by OMNR and the Canadian Wildlife Service (CWS). The objectives of the OMNR studies were conservation and management through determining harvest totals for various species and traditional land use activities of the northern communities. The Berkes et al. (1992) study was conducted through the TASO (Technology Assessment in Subarctic Ontario) program of McMaster University, the Mushkegowuk Council, the local First Nations, and the Omushkegowuk Harvesters Association. They had a similar objective of documenting land use activities in the Hudson Bay Lowland to assist in developing a strategy for natural resource co-management. The research by McDonald et al. (1997) was led by the Environmental Committee of Sanikiluaq, as part of the Hudson Bay Programme. Officially called the Hudson Bay Traditional Ecological Knowledge Management Systems (TEKMS) study, the project emphasized the importance of including TEK in a cumulative impact assessment to assist in the sustainable development of their homeland.

The communities involved in these studies included a combination of the coastal villages of Fort Severn, York Factory, Peawanuck (including when it was formerly Winisk), Attawapiskat, Kashechewan, Fort Albany, Moose Factory, Moosonee, and Moose River Crossing, as well as a variety of inland villages. In the case of the Hudson Bay Programme project, it involved all communities in the James and Hudson Bay basin. No two studies encompassed the same group of communities, however, for the purpose of my study a sufficient overlap still exists for a spatial and temporal comparison.

While all the studies looked at total harvest in the region and involved some type of interview or survey/questionnaire, the specific methods and objectives varied greatly between them. The first study in the mid 1950s (Hanson and Currie 1957) was a collection of field observations rather than a series of interviews with discussed results. Although it focused on "wild geese", it did not consistently compare and contrast goose species. Their research was primarily concerned with goose conservation and wanted to determine whether the harvest was too large for the goose populations to handle. They did not record specific numbers of geese killed, or the number of days spent hunting. The authors determined that the goose harvest did not increase in proportion to the population increase, mostly due to the time limits of the hunting season.

Prevett et al. (1983) compared goose species and seasons, and conducted systematic interviews across communities in the region with the objective to estimate total numbers of hunters and harvest. They also recorded the number of kills per hunter and the number of days spent hunting. The results of Prevett et al. (1983) were similar to Hanson and Currie (1957) with respect to a low proportion of the goose population being killed by First Nations hunters. They also observed that weather was the most important factor affecting migration patterns, timing and number of geese available to hunters. The study revealed, with the use of band recovery data, differences in harvest by season, species and populations within a species (for example, Canada geese) specific to each community. They found seasonal differences with more Canada geese being harvested during the spring hunt and more snow geese being harvested during the summer and fall hunts.

The first comprehensive harvest study beyond waterfowl was conducted in the early 1980s and was essentially an inventory of wildlife harvest and land use in the region (Thompson and Hutchison 1987). It included both native and non-native residents within the OMNR Moosonee District which was geographically almost identical to Ontario's portion of the Hudson Bay Lowland. Only native data from that study is included in this analysis. Their methods involved two surveys, collecting data on "how much" (harvest) and "where" (harvest location), which were collected and analysed independently. One minor downfall is consistency, with Moose Factory only participating in the second year of the study and slightly skewing the overall results due to it being one of the larger communities. The authors documented hunting days, kill per hunter by species and season, and were also the first to map hunting locations.

The study in 1989 (Berkes et al. 1992) was just as comprehensive, documenting traditional activities and determining the actual harvest of wildlife in the Mushkegowuk communities. Interviews were conducted using similar questions as the OMNR study from 1981 to 1983, and covered all seven coastal communities. Questions gathered quantitative data on harvest, as well as qualitative data on hunting practices. The authors documented many of the same variables as the previous two studies, including number of hunting days, harvest counts by species and season, and hunting locations. There was also a heavy emphasis on the economic replacement value of bush foods. The results of the study indicate that the traditional economy remains an important element in the economy of the region.

The study completed by McDonald et al. (1997) aimed to document TEK of environmental change in the entire Hudson Bay bioregion. Almost thirty communities participated in the study, which included a series of regional workshops on an array of research topics spanning environmental change, contamination, hydroelectric development, and natural foods. Digital text and map databases were also developed. This study provided information on nine elements of change, including coastal shoreline changes, migratory travel routes, sea ice changes, wind direction, and human activities.

The last study was performed by the OMNR and CWS in 2003 and 2004. The goal was to determine the magnitude, timing and distribution of waterfowl harvesting in the Hudson

Bay Lowland (Hughes and Walton 2005). The authors collected harvest data in the form of a questionnaire from five coastal communities, not including Peawanuck. They looked at the number of hunting days, the number of geese killed per hunter by species as well as by season, and documented hunting locations. In 2005 their study was augmented with a pilot project to collect information through local observations on climatic changes. The sample size was small, however, and not conclusive. Although, it did develop base questions and establish benchmarks for future work.

Although these previous studies looked at wildlife harvest in the region, there are several gaps which I aimed to address. First, they had varying objectives, methods of data collection, analysis, and sample sizes, all making them difficult to compare (Table 2.2). Second, none of the previous studies (other than the pilot project in 2005) looked specifically at the aspect of climate change and the subsequent impacts on harvesting trends, if any. These studies collected quantitative harvest and harvest effort related information. They did not directly collect information on potential indicators of change beyond general climate statements. They provide a good snapshot of harvest activities in a region in a given year, and in some cases established benchmarks for climate changes. My study aimed to fill some of the gaps between those studies by using their data as a baseline, and building on the pilot study in 2005, to better understand overall trends of an impact of climate change on geese in the Lowland at a greater temporal scale.

Table 2.2. Characteristics of previous studies involving geese and the Hudson Bay Lowland.

Source	Subject	Method of data collection	Quantitative/ Qualitative	Sample Size	
				WFN*	MCFN**
Hanson and Currie (1957)	Goose harvest	Directed interviews by researchers	Quantitative	unknown	unknown
Prevett et al. (1983)	Goose harvest	Directed interviews by researchers	Quantitative	46	unknown
Thompson and Hutchison (1987)	Comprehensive harvest survey	Directed interviews by aboriginal interviewers (including mapping)	Quantitative and Qualitative	23	91
Berkes et al. (1992, 1994)	Comprehensive harvest survey	Directed interviews by aboriginal interviewers (including mapping)	Quantitative and Qualitative	44	235
McDonald et al. (1997)	Environmental observations	Semi-directed interviews by aboriginal interviewers (including mapping)	Qualitative	unknown	unknown
Hughes and Walton (2005)	Goose harvest	Directed interviews by aboriginal interviewers (self administered questionnaires in Moose Factory)	Quantitative	n/a	41

*WFN: Weenusk First Nation
**MCFN: Moose Cree First Nation

2.5 BRIDGING INDIGENOUS KNOWLEDGE/TRADITIONAL ECOLOGICAL KNOWLEDGE AND SCIENCE

Introduction

Science or IK/TEK alone cannot answer all questions relating to human impacts of climate change in Indigenous communities (Furgal et al. 2006). Employing a mixed methods approach to draw on the strengths of both qualitative and quantitative approaches increases insight into complex research questions (Creswell 2009). The approach, however, needs to take into consideration the fundamental differences as well as similarities between the two knowledge systems.

A review and discussion of foundations, philosophies and development of knowledge systems is useful for understanding the context within which my research study and its methodology is framed. In this review I present how knowledge is constructed, how knowledge is based in the context of a philosophy and worldview, and how knowledge is applied or utilized. While this description is not complete, it offers a critique on the ways IK/TEK and science are currently presented in the literature, as well as setting the basis for a discussion on the utility, feasibility and application of linking IK/TEK and science to study and understand ecological processes such as climate change and waterfowl ecology in northern regions. Lastly, I give an overview and critique of the use of IK/TEK and science in the Hudson Bay Lowland.

Terminology

A comprehensive review of terminology on this topic is beyond the scope of this thesis, however, a brief review and commentary on terminology is important to understand the context of this study. There are many terms used in the literature to describe the type of knowledge that people who are connected to their environment possess: Traditional Ecological Knowledge (TEK), Traditional Knowledge (TK), Indigenous Knowledge (IK), Indigenous Environmental Knowledge (IEK), Aboriginal Knowledge (AK), Local Knowledge (LK), Local Ecological Knowledge (LEK), and others. There is no universally accepted definition of the concept, and many authors describe the difficulties with inconsistent use of the definitions (Usher 2000, Laidler 2006, Berkes 2008). There is also an insufficient understanding in the literature of what each of these terms means (Stevenson 1996, Nadasty 1999, Usher 2000). It is argued that this is because they are terms used by academics and hold different meanings depending on the context and culture involved (Laidler 2006).

For the purpose of this review I use the terms Indigenous Knowledge (IK) and Traditional Ecological Knowledge (TEK). IK and TEK seek to understand local knowledge of the land (Dudgeon and Berkes 2003), and are the most commonly used terms in the literature in Canada (Furgal et al. 2006, Berkes 2008). Here, IK is defined as "the local knowledge held by Indigenous peoples or local knowledge unique to particular cultural groups" (Warren et al. 1995). I use IK in this review because it encompasses the knowledge-practice-belief complex as described by Berkes (2008), in a broad sense, and includes other elements, such as ethnoscience, which go beyond a definition solely restricted to ecological relationships (Berkes 2008). There are critiques of this term that appear in the literature, such as the implication that this knowledge is restricted to Indigenous people or that there is a category of knowledge that can be clearly labelled as Indigenous (Berkes 2008). However, it remains reflective of the knowledge-complex-belief complex and is still commonly used in the literature, and so it is used in this review.

Berkes et al. (2000: 1252) define TEK as an ecologically-related subset of IK, and as a "cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment". There are critiques of this term as well that include concerns of the word "traditional" implying that this form of knowledge is "simple, static, and savage" (Warren et al. 1995). Also, not all knowledge evolved by Indigenous people is traditional, ecological or environmental (Warren et al. 1995, Stevenson 1996). This second critique is addressed by TEK being included in the broader concept of IK.

While these terms are appropriate in a literature review on the topic, for the purposes of my thesis I do not use either of the terms IK or TEK when referring to my results. My study did focus on ethnoscience and ecological relationships between hunters and geese, and it is reasonable to expect that the knowledge being shared could extend beyond those parameters. However, I collected local observations which were limited to very specific scales, and they did not include philosophical or spiritual components. Also, several community members I interacted with were uncomfortable with any term, and the labelling of what they know and how they know it. For these reasons, I respect and understand the arguments presented in the current literature on IK and TEK, and do not want to mislead in presenting the findings of my thesis. In my results and discussion I present my findings as local observations, reported by local hunters or community members. This is a more direct and appropriate description of my findings, although the local observations that I am presenting may be considered by many academics, other Indigenous peoples and researchers as TEK, as well as being embedded within the broader concept of IK as a system of knowledge.

Similarly, while I use the term "science" in my literature review and discussion on it as a knowledge system, I do not identify my primarily quantitative, technical data sets or findings as science. Science is a process, and the sources that I used are gathered and analyzed using a scientific method (e.g. aerial surveys and weather station data), however are more accurately described as technical data sources. I also used a scientific (albeit social scientific) method of gathering and analyzing my qualitative data from interviews. Therefore, to be consistent, I use the term science when speaking of the way of knowing, but am more specific in my sources when referring to my results and discussion.

The idealistic dichotomy

In the literature on this topic there has been a tendency to over-simplify the characteristics of both IK and science. For example, that IK is qualitative, holistic and intuitive, and science is quantitative, reductionist and analytical (Nadasty 1999). Yet there are practical and philosophical differences which make such a dichotomous and standardized comparison inadequate (Agrawal 1995, Wenzel 1999). One can argue that where the literature falls short is in the discussion surrounding the instances where there is convergence or divergence of these simplistic views. I argue that while simplistic views of both IK and science can be helpful, it is also important to recognize that these views are indeed simplistic and divergences and idiosyncrasies need to be recognized in efforts of collaboration.

Knowledge Construction

It is important to understand how knowledge is constructed to understand the feasibility of collaborations between different types of knowledge systems. When discussing knowledge construction and the relationship between IK/TEK and science, it is important to differentiate between knowledge as content and knowledge as a way of knowing. Content is static, whereas a way of knowing is dynamic and includes the processes by which this knowledge is acquired (Peloquin and Berkes 2009).

The Indigenous knowledge system is based on a culturally-based cosmology, whereby "information derived from observation, experience, and instruction is organized to provide explanation and guidance" (Usher 2000). Similarly, native science is defined as "knowledge gained from interaction of body, mind, soul and spirit with all aspects of nature" (Cajete 2004). Adapted from Usher (2000), there are four categories overlaying this cosmology, classifying TEK, including: 1) factual knowledge about the environment, 2) factual knowledge about its use, 3) culturally-based value statements, and 4) the cultural framework by which this knowledge is constructed.

Factual or rational knowledge within TEK includes statements about topics such as ice, weather, animal behaviour, or coastal conditions, and is based on both empirical and generalized observations from personal and shared experience(s) over time (Usher 2000). Repeated local observations and understanding place-specific characteristics are important; for example for harvesting success, personal safety, reliability of information and confidence in passing along information (Laidler 2006). From experiences and observations, as well as cultural beliefs, inferences are made and connections are drawn between them to understand why things are the way they are (Usher 2000).

Factual knowledge among Indigenous peoples about the past and current use of the environment relates to patterns of land use, particularly traditional land use and harvest over generations (Usher 2000). It is both knowledge as content and knowledge as process (way of knowing). It relies heavily on oral histories as well as personal experiences, and contributes to the overall factual knowledge of the environment held by that group. These uses are not understood in quantitative terms, but rather often in detailed qualitative forms based on trends and diachronic data (long time series of data on one locality) (Johnson 1992, Laidler 2006).

Culturally based value statements are related to the moral, spiritual and ethical responsibility for proper behaviour with respect to animals and the environment (Johnson 1992, Usher 2000). These statements are strongly linked to the philosophy and worldviews of a particular group that are the foundations of TEK and IK systems, include aspects of spirituality and cosmology, and are often reported in narrative with metaphor, analogy and as myth (Ellis 2005).

Scientists also acquire knowledge through a process, although in different way. Science knowledge is founded on theoretical propositions and empirical laws which are designed to provide literal explanations for what the world is like (Knorr-Cetina 1981). This knowledge is acquired through a systematic means of observing, theorizing, hypothesizing, predicting, experimenting, evaluating and revising. Mainly, it relies on practical reasoning, evidence and explanation. This does not exclusively mean direct evidence, but evidence which supports facts that fit into the (current) Newtonian belief system (Dewitt 2004). Although the naked eye is used in behaviour observation studies, evidence is largely obtained through mechanical and electronic measuring tools which allow for objectivity beyond the variations between individual human abilities (Shapin 1996). Science knowledge is also dynamic, and can evolve over time (Shapin 1996). As an example, Aristotelian beliefs and facts which turned out to be incorrect do not mean they were not science, but rather that they were true science when all such evidence appeared to be supportive of those facts (Dewitt 2004).

Indigenous ways of knowing are different than scientific ways of acquiring knowledge (Peloquin and Berkes 2009), and this distinction is critical in understanding when trying to learn from both in an attempt to enrich our understanding of natural or physical phenomena.

Foundation and philosophy of IK

Worldview is an interrelated and interconnected system of beliefs, held by people and evolving over time (Dewitt 2004). IK and science are founded in worldview, with differences in specific beliefs which make up the interlocking pieces of each worldview.

IK, or TEK, is presented in the literature as based on a philosophy and worldview of interconnectedness and a sense of place within the natural world. Indigenous cultures hold the belief that all living things are related and that all things are connected, including the non-human (Pierotti and Wildcat 2000, Turner et al. 2000), or non-human persons (Fienup-Riordan 1999). They see ecosystems as "constantly reforming multi dimensional interacting cycles…where all factors are influences impacting other elements of the system as a whole" (Freeman 1992).

It is some authors' position that Indigenous cultures understand the demand and pressure they place on the resources upon which they depend (Pierotti and Wildcat 2000), and therefore treat nature with respect. This understanding includes a role in maintaining the delicate balance of life. Berkes et al. (1994) and Berkes (2008) argue that through the morality of hunting, young Cree hunters are taught on the land about the ethics and values of sharing and reciprocity. They are taught to hunt only as many birds or animals as they need, or will share, and the hunt is not an act of violence but rather an act of sustenance, for both the hunter and the animals he kills (Fienup-Riordan 1999, Berkes 2008). The descriptions of these teachings are ideals, however, and are not always reflected in reality. There are studies which show that some traditional societies often overharvest their prey (Diamond et al. 1987, FitzGibbon 1998). Increases in human population density and habitat loss are also contributing to overharvesting (FitzGibbon 1998). That is not to say that all Indigenous people overharvest their resources or that all Indigenous people treat nature with respect, it is only to say that generalizations, either way, should not be made.

Foundation and philosophy of science

The scientific worldview has undergone several revolutions. Modern science evolved as a fundamental reordering of the way scientists think about the natural world (Shapin 1996). The latest revolution was in response to newfound evidence from the invention of the telescope, that the Aristotelian belief of the earth being stationary was wrong (Dewitt 2004). In turn that meant the entire worldview was wrong, as all pieces and beliefs were reliant and related to one another (Dewitt 2004). Out of this and other evidence (due largely to new ways of measuring nature) came the Newtonian worldview, which has remained the foundation of modern science (Dewitt 2004).

Scientific theory is grounded on its objective foundation which allows for verifying or falsifying truth (Mshvéniéradzé 1968). One approach is rooted in analytical and systematic principles of reasoning based on observation and experimentation, repetition, and a belief in a cause and effect relational model (Freeman 1992). It is also often portrayed as separating people from nature (Johnson 1992, Ellis 2005), with the intention of reducing human involvement and thus human subjectivity and error in observation and understanding.

As with the principles behind TEK/IK, these perceptions of science as presented in the literature are also simplistic and not always reflected in reality. Science can be subjective as well, as it is not possible to truly separate a scientist's subjective perspective from a study (Kuhn 1996, Shapin 1996). Also, it is not the science that separates nature from people, it is the people who conduct the science that choose to make that distinction, for the sake of maintaining objectivity. There are, however, branches of science that are holistic, one example being ecology. These differences are not negative, per se, but need to be recognized.

Both IK and science contribute to understanding the natural environment. A realist approach, as presented by (Bielawski 1996: 219) accepts that the "objects of nature exist in and of themselves, were here before science, and will remain regardless of the activities of inquiry directed toward them". This acceptance applies to both IK and science, and allows both knowledge systems to contribute to understanding the world (Bielawski 1996). However, acknowledgement is needed to recognize where similarities and differences in philosophy exist between each system, and how each can work with the other in collaborative research.

The utility of linking IK with science

The value of utilizing IK or TEK information has been recognized since the mid 1960s (Wenzel 1999). It was identified around the same time political pressure was increasing to recognize Indigenous rights and a growing environmental movement was searching for alternative approaches to science and technology (Johnson 1992). These pressures resulted in scientists wanting to confer with Indigenous peoples on "ecological principles" to better manage resources (Johnson 1992). Yet, the value of TEK was largely based on the benefit of "value added" to science studies as it reinforced existing conclusions by adding information to support claims (Nadasty 1999, Mallory et al. 2006). The concept of linking, combining, or integrating IK and science information is the current debate in the literature. While there is discussion advocating the use of TEK and its integration with science, there is little discussion or description of methods used to obtain that goal (Nadasty 1999).

Linking information from different knowledge systems, especially including qualitative and quantitative components, can be helpful in addressing complexity in a research question. The use of quantitative or qualitative approaches by themselves is not adequate in addressing complex issues and research questions (Creswell 2009). The inclusion of information from community informants can contribute to gaps in science, as well as address local concerns and interests. Also, the use of multiple methods of observation can increase the confidence of individual observations, broaden the scope of information on changes, and contribute a variety of insights into an issue (Huntington et al. 2004). This is because local knowledge generally covers longer periods of time, has continuous data sets when scientists are not present, and has detailed information at different spatial scales (Usher 2000). This advantage is particularly true in studying climate change impacts, where there are high levels of uncertainty in climate models, and data sets are often incomplete (Huntington 2000).

There are, however, differing views on the utility of combining knowledge systems to study ecological interactions. Some authors argue that there remains an over-reliance on scientific knowledge to answer questions related to the natural world (Gilligan et al. 2006). The scientific community has a tendency to view traditional knowledge as being explicitly subjective and therefore biased (Usher 2000, Mallory et al. 2006), solely anecdotal and as a result non-objective (Hobson 1992). Several authors critique this view stating that traditional knowledge holders are scientists as well (Agrawal 1995). Berkes et al. (2000) also argue that bias in TEK is quite limited. Even though there is considerable variation between individual knowledge holders, this information is gathered in a collective knowledge-base of TEK from many individuals and refined through observation and practice over time, thus reducing variability and increasing confidence and certainty in the knowledge (Berkes et al. 2000).

Other authors advocate the utility of TEK in understanding natural and environmental issues by suggesting that both approaches are based on similar underlying principles (Freeman 1992, Wenzel 1999, Roué and Nakashima 2002). Huntington (2000) and Bonny and Berkes (2008) suggest that TEK, like science, generates its understanding from empirical evidence. More specifically, Bielawski (1996) describes both TEK and science as "consensual, replicable, generalizable, incorporating, and...experimental and predictive". So although some authors argue that not all science or TEK is empirical, replicable, generalizable, or predictive, it is important to establish specific points of potential convergence before drawing any hard lines of comparison.

Another example is an analogy given by Freeman (1992) of TEK as a supercomputer. Supercomputers are programmed to collect and systematize knowledge, to recognize and work with incomplete datasets, to intuitively filter out background noise, discern chaos, and draw conclusions from various disparate data sets (Freeman 1992). TEK functions very similarly under these parameters. TEK is able to understand complexity by taking into account a multifaceted and dynamic web of interactions (Peloquin and Berkes 2009).

It can be argued that, based on and considering where these similarities or convergences exist, TEK and science together can provide more and sometimes better information to understand and predict environmental events than one way of seeing the natural world on its own (Huntington 2000). The next section describes some additional considerations for the feasibility and application of using science and TEK information in a collaborative study.

The importance of communication, scale, and context

According to the literature, there are two important components to consider for a meaningful and successful collaboration in a TEK study. First, effective communication and relationship building is essential (Bonny and Berkes 2008). Initial community visits, discussions of proposals and project objectives, and continuous dialogue between researchers and the appropriate community members or groups is paramount (Gagnon and Berteaux 2006, Laidler 2006). Open and clear communication can help ensure that the project objectives are aimed at the common goals of both the researcher and the community (Furgal et al. 2006). Second, it is critical to the utility of TEK that scale and context be adequately considered (Duerden and Kuhn 1998). In terms of scale, the science and the local observations being compared need to be referring to the same time period and the same geographical space (Gagnon and Berteaux 2009). The methods of gathering and analyzing information for a project are also important. Specific methods depend on the community, the type of information the researcher is looking for, the logistics of time and resources available, as well as the desired deliverables (Huntington 2000). These components of communication, scale and context, as well as information gathering and analysis are essential but can also be challenges in the collaborative process and are addressed further in the Discussion.

TEK and Science in the Hudson and James Bay Lowland

There are few examples of true collaborations between scientists and community members in the Ontario portion of the Hudson Bay Lowland (Table 2.3). In addition to the previously mentioned harvest surveys, there has been a TEK study on the transmission of bush skills by women in the James Bay region (Ohmagari and Berkes 1997); a TEK study on interpretations of climate change in western James Bay (Ho 2003); a science project involving eider ducks in the Belcher Islands (Gilchrist et al. 2006); a TEK study on climate change, well being and resilience in Peawanuck (Lemelin et al. 2010); and a TEK study on climate change and food security in western James Bay (Hori 2010).

Ohmagari and Berkes (1997) interviewed women identified by the community as experts, in both Moose Factory and Peawanuck, on traditionally important skills. Initial interviews with these informants generated questions for a structured interview guide and for the collection of quantitative data. The authors also used open-ended interviews and participant observation. This study is a good example of effective qualitative research; however, it did not include a science component. Ho (2003) conducted semi-directed interviews in Fort Albany, Moose Factory and Attawapiskat, gathering interpretations of climate and environmental conditions in the James Bay region. This study did not contain a science component, although the topics related to ecosystem function and interaction.

Gilchrist et al. (2006) based their study on initial concerns and questions of the community of Sanikiluaq, and included a local monitoring component to their project. It was community initiated, but scientist-led. Lemelin et al. (2010) also conducted a qualitative study using interviews. The study was guided by an approach termed CREE (capacity building, respect, equity, and empowerment), and sought to include community members and participants in every stage of the research process. It was successful in that regard; however, there was mixed interest and participation in the project on the part of the community members. Hori's (2010) study focused on climate change and food security in western James Bay, with a focus on climate impacts to fish species. It also included a climate modelling component. The TEK and science were collected and analyzed independently and then presented together.

Table 2.3. Projects involving TEK and Science in the Hudson and James Bay Lowland

Subject	**TEK contribution**	**Science contribution**	**Source**
Transmission of bush skills	Knowledge transfer from elders to youth	n/a	Ohmagari and Berkes (1997)
Climate and environmental conditions	Interpretations of change in the region	n/a	Ho (2003)
Conservation of eider ducks	Initial observations, ongoing monitoring	Monitoring equipment	Gilchrist et al. (2006)
Climate change, well being and resilience	Observations of environmental changes	n/a	Lemelin et al. (2010)
Climate change and food security	Observations on changes in fish	Climate modelling	Hori (2010)

Summary

TEK/IK and science are two distinct ways of knowing, overlapping in some epistemological areas and remaining distinctly different in others. They differ in worldview, methodology, and temporal and spatial scales. Comparisons and collaborations are valuable, but only when these differences and conditional bases are recognized and incorporated into the process. The purpose of using a mixed methods approach in this project was to acknowledge these differences, and draw on strengths of each way of knowing to provide a more comprehensive examination of a complex research question.

2.6 CURRENT UNDERSTANDING OF CLIMATE CHANGE IMPACTS ON GEESE OF THE HUDSON BAY LOWLAND

Climate change in Hudson and James Bays

The climate is warming at an accelerated pace in Arctic regions, including the sub-arctic Hudson Bay Lowland (ACIA 2005). Polar regions are more susceptible to an earlier advancement of warming compared to the global average because of their strong relationship with cryospheric processes, specifically sea ice and snow cover (Walsh et al. 2005).

The extent and duration of the sea ice cover in Hudson Bay has decreased, lengthening the ice free season, at a rate of 3 days per decade since 1970 (Etkin 1991, Smith 1998, Gough et al. 2004). Sea ice depletion leads to warming as a decreased surface albedo from less ice means an increase in the amount of solar energy absorbed by the water (Gagnon and Gough 2005). Sea ice depletion and a warmer climate have projected secondary effects on hydrology, vegetation, and wildlife of the region (Rouse 1991, Walsh et al. 2005). Reduced sea ice is projected to lead to a significant increase in the annual mean discharge of freshwater to Hudson Bay, as well as the Arctic Ocean (Walsh et al. 2005). Studies comparing climate models in the region also show an earlier spring peak flow in rivers entering southern Hudson Bay (Gagnon and Gough 2002). Changes in spring runoff, as well as precipitation, will affect water levels, salinity, and nutrient fluxes in the wetlands, altering their biological production (Hughes 2004, Abraham and

Keddy 2005, Walsh et al. 2005). For example, increased runoff and precipitation leads to reduced soil salinity, and affects saltwater marsh productivity (Hughes 2004).

The warming temperatures also affect plant distributions and characteristics through changes to processes such as photosynthesis, transpiration, decomposition, and nutrient cycling (Ayres 1993, Hughes 2004). This will lead to changes in secondary succession and productivity (Ayres 1993). It will also lead to shifts in range and distribution of species, both plant and wildlife, with consequences in terms of availablity, acessibility and quality of resources (Prowse et al. 2009).

Impact of a changing climate on geese

The specific effects of a changing climate on migratory birds such as geese are speculative due to a lack of detailed studies, yet trends of change are still likely (Ayres 1993, Bairlein et al. 2004). Few studies have documented these effects in the Hudson Bay Lowland; however, studies on climate-herbivore interactions have been done in similar regions (McCarty 2001, Ward et al. 2005, Kery et al. 2006, Hedenström et al. 2007).

An important impact of a changing climate on migratory birds involves the interaction between the geese and their food resources. Salt marshes (especially with *Carex spp.* and *Puccinellia spp.*) are important feeding and nesting grounds for geese, and have an indirect effect on geese through their role as habitat and food supply (McCarty 2001, Kery et al. 2006). Marshes are sensitive to both temperature and precipitation fluctuations, and the abundance and availability of marsh plant resources have an indirect effect on growth and recruitment of goslings (Ward et al. 2005). If the range or species composition of the marshes shifts, so does the food resource for the geese.

Related to vegetation, there is a limited window of favourable conditions which would be considered optimal for a species, especially during migration, and it is important to know if that period is shifting (Visser and Both 2005). For example, if the main selection pressure on phenology is food abundance, then the timing and speed of goose migration needs to coincide with the availability of vegetation at the nesting and feeding sites

(Visser and Both 2005). If it does not, then a mismatch is created, affecting the fitness of the species (Visser and Both 2005, Hedenström et al. 2007).

There have been several studies documenting the phenology of species occurring earlier in northern areas due to a changing climate (Visser and Both 2005, Hedenström et al. 2007, Prowse et al. 2009). The timing of the arrival of geese in Manitoba, for example, has been used as a phenological indicator of climate change, where geese are arriving earlier (Ball 1983, Murphy-Klassen et al. 2009). Also, snow goose and Canada goose populations in the Canadian Arctic have advanced breeding by 30 days between the 1950s and 1980s (MacInnes et al. 1990). These shifts are not fully understood; however, they are likely climate driven and are important in terms of understanding species abundance and distribution (MacInnes et al. 1990, Visser and Both 2005, Hedenström et al. 2007). Further studies are needed to better understand these shifts and the impacts to both the goose populations and in turn the human populations which rely on them.

3.0 METHODS

3.1 RESEARCH QUESTIONS

The research question was how a changing climate impacts goose ecology and in turn the goose harvest by First Nations of the Hudson Bay Lowland. To address this research question, I had two objectives. First, I sought to examine how climate and goose habitat may be changing in the Hudson Bay Lowland, and how these changes may be impacting Canada goose and lesser snow goose populations in terms of abundance and distribution. A second objective was to examine how these changes affect coastal Cree communities in terms of access to and harvest of geese. Each objective used data from qualitative and quantitative sources.

3.2 PROJECT DESIGN

This project used a mixed methods approach to strengthen my examination of the issue because of the limitations and bias inherent in either a solely quantitative or qualitative approach to such a complicated research question (Creswell 2009). Limitations of a strictly quantitative approach include the researcher's theories not reflecting local understandings, or missing out on phenomenon because of the focus of the theory or hypothesis (Johnson and Onwuegbuzie 2004). There are also limitations of a strictly qualitative approach, such as the knowledge produced may not generalize to other settings, as well as the collection and data analysis stages are often very time consuming (Johnson and Onwuegbuzie 2004). There are however, strengths in both approaches, and when combined in a mixed methods design can broaden the understanding of each (Creswell 2009).

There are several types of mixed methods designs. The two major strategies include concurrent and sequential approaches. A concurrent approach is when qualitative and quantitative data are collected simultaneously (Creswell 2009). An example is the study by Hori (2010) where information from climate models and interviews with hunters were conducted simultaneously, analyzed independently, and presented together. A sequential approach involves one form of data collection sequentially building on the other

(Creswell 2009). For example, a qualitative phase of data collection that builds on a previous quantitative phase.

The type of mixed methods approach I used was a sequential transformative strategy (Figure 3.1; Creswell 2009). This process involved using a "theoretical lens to shape a directional research question aimed at exploring a problem" (Creswell 2009: 212), in this case human-ecological relationships. I chose a sequential transformative design as it gives equal weight to both qualitative and quantitative data and analyses and uses multiple phases of data collection (Creswell 2009).

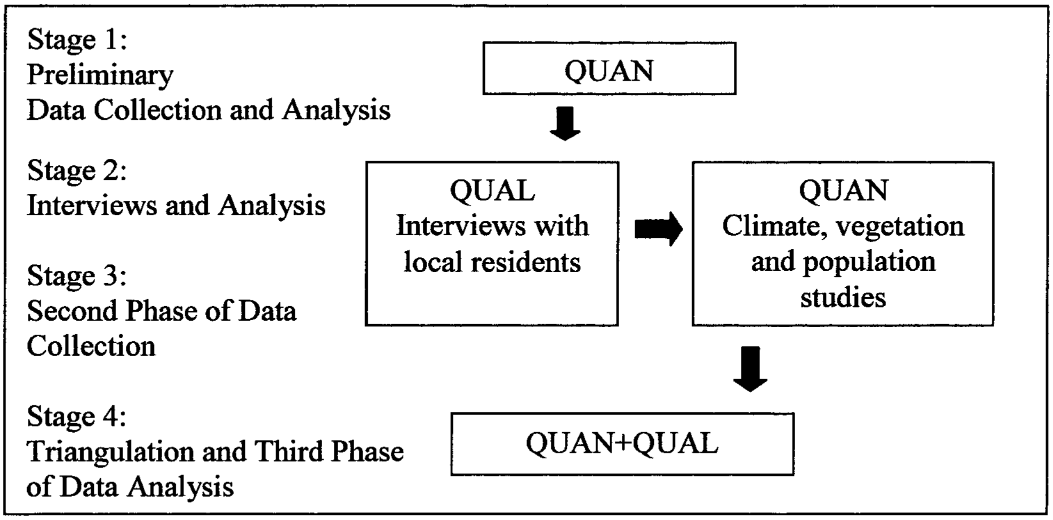


Figure 3.1. Sequential Transformative Design using qualitative (QUAL) and quantitative (QUAN) data sources (Creswell 2009).

The initial stage was to collect and analyze historical harvest surveys for trends and identify gaps in understanding. These gaps were sequentially used as the basis for my interview guide and questions to ask hunters in each of the communities. I used a qualitative analysis software (NVivo) to code the interview transcripts within common themes. From the results of the coding analysis came a list of questions, which could sequentially be asked of an additional quantitative data analysis using climate, vegetation and goose population data. I triangulated between information gathered by the local observations with these data sets, seeking to converge and corroborate findings (Johnson and Onwuegbuzie 2004, Creswell 2009). The next section outlines these stages in more detail.

3.3 DATA COLLECTION METHODS

First Stage: Historical Harvest Studies

In approaching the overall objectives, the first stage was to review the existing quantitative data on the topic. I collected and analyzed available quantitative goose harvest surveys to identify trends, gaps and key questions with respect to First Nations use of geese in the James Bay and Hudson Bay Lowland.

Within the harvest surveys, I calculated and analyzed trends in changes to the catch per unit effort of geese over time. I calculated the number of geese killed per hunter per day to compare across studies in a standardized manner. I used the number of hunters who participated in interviews instead of the number of potential hunters, as this reflected reported and not projected values. Berkes et al. (1992) was the only report that included solely projected numbers for days spent hunting and kill per hunter, so the mean was calculated from the projected number of days and potential number of hunters (Table 3.1). My analysis differentiated between hunting season as well as goose species hunted.

Most of the harvest studies included general comments or observations on climate, vegetation, or other wildlife. McDonald et al. (1997) and the pilot MNR project in 2005 were the only ones that included direct questions on those variables. There are, however, other studies which cover these topics indirectly and have been included in the discussion as points of comparison.

This analysis of past harvest surveys generated a list of themes for questions to be posed in interviews with northern residents, who have acquired an intimate knowledge of the land through years of direct experience and observation (Table 3.2).

Table 3.1. Availability of raw data collected for all harvest studies, noting extrapolation, for Moose Factory and Peawanuck (using reported numbers, except where noted).

Study	**Variable**			
	Number of participants interviewed/completed surveys	**Mean number of days spent hunting**	**Mean number of geese killed per hunter**	**Total harvest estimate**
Hanson and Currie (1957)	Unknown	No data available	Seasons combined, only snow geese in MF, only Canada geese in P	Yes
Prevett *et al.* (1983)	Yes	Yes	Yes	Yes
Thompson and Hutchison (1987)	Yes. MF did not participate in second year	Yes	Yes	Yes
Berkes *et al.* (1992)†	Yes	Extrapolated from total number of days, both MF and P	Extrapolated for both P and MF	Yes
Hughes and Walton (2005)*	Yes, but small sample size, MF only	Yes	Yes	Yes

P-Peawanuck, MF-Moose Factory

† Berkes et al (1992) used projected, not reported numbers

*Hughes and Walton (2005) did not conduct their study in Peawanuck

Table 3.2. Themes for the semi-directed interviews, informed by the first quantitative analysis.

Hunter Demographics	Harvest	Number of Geese Seen	Timing of Migration	Habitat Changes
Age	Canada geese in Spring	Canada geese in Spring	Canada geese in Spring	Climate
Coastal or Inland	Snow geese in Spring	Snow geese in Spring	Snow geese in Spring	Vegetation
Number of Years Hunting	Canada geese in Fall	Canada geese in Fall	Canada geese in Fall	Wildlife
	Snow geese in Fall	Snow geese in Fall	Snow geese in Fall	

Second Stage: Interviews with Northern Residents

Rationale for methods used for gathering and interpreting local observations

Early studies involving TEK or IK were conducted by anthropologists, ethno-botanists and natural scientists, mostly to document terminologies and knowledge among different cultures for describing plants and animals and animal behaviour (Johnson 1992). The role of Aboriginal people in these studies has since grown, and now there are several ways in which TEK is typically gathered and interpreted.

Methods for documenting TEK span the social sciences, and ideally, today, operate under strict ethical principles for the consideration of cultural context and intellectual property rights. The most common contemporary approaches to gathering TEK that appear in the academic literature include interviews, questionnaires, facilitated analytical workshops, and collaborative field work (Huntington 1998, 2000). Interviews and workshops were used in this study and therefore are discussed in detail.

Interviews can be an effective method of gathering large amounts of qualitative data in a short period of time (Huntington 2000). They can answer "why" questions about quantitative data or help explain quantitative datasets as well as being used to identify new questions for quantitative inquiry in a sequential process (Kamberelis and Dimitriadis 2005). In interviews with TEK holders, semi-directed interviews are common and can be done individually or in a focus group setting (Huntington 1998).

Semi-directed interviews are loosely guided by the researcher to cover certain topics while letting the participant(s) determine the conversational direction (Huntington 1998). With this format there are no set questions, but rather a list of topics for discussion, and some prompt questions to keep the conversation going (Huntington 1998).

Props can also be useful, for example using maps as a common reference point can help stimulate discussion (Huntington 1998). The concept of letting the conversation proceed naturally can be extremely beneficial in covering both anticipated topics as well as unexpected ones which can in turn provide valuable insight into the initial topic (Huntington 1998).

Another interview technique is to document TEK/IK using biographical maps and timelines, essentially documenting the life history of an informant (Ferguson and Messier 1997). Studies have shown that the recollection of events by informants is indeed quite accurate, especially if the events were personal or historically significant for the community (Ferguson and Messier 1997). Significant events to an individual or group such as deaths, marriages, floods, and overt government interventions are all examples of events which can be cross-referenced with other records and corroborate a personal history timeline. This line of questioning can be useful for studying changes over time, in both social and ecological systems (Ferguson and Messier 1997).

In some situations, workshops can help to develop new ideas and a better understanding of the perspectives of both scientists and TEK holders on the given topic (Huntington 2000). This can be especially useful in interpreting existing data where there is divergence of information (Huntington 2000). It is not always logistically possible, but it can be greatly beneficial to have the researcher and the participants in the same room, talking through and clarifying issues.

Interviews and Analysis

The project received approval by the Trent University Research Ethics Board in January 2009 (Protocol #21039, in Appendix). Community visits and correspondence with the Lands and Resources director of the Moose Cree First Nation (MCFN) began in December 2008, and in July 2009 with the Chief of the Weenusk First Nation (WFN).

Semi-directed interviews with northern residents and hunters were conducted to build on gaps and explain trends and patterns in the first quantitative analysis, and to identify key factors influencing trends in the goose harvest from a First Nation perspective.

Semi-directed interviews were conducted in the MCFN in July and August 2009, and in September 2009 in the WFN. The participants were selected using a purposeful sampling method, meaning that participants were chosen based on their experience on the land and not randomly (Creswell 2009). They were chosen based on their geographic distribution, to get a sample of inland and coastal locations, and throughout the community's homeland territory. The interviewees also had to have at least 10 years hunting experience. An attempt was also made to get a demographic range including youth (aged 30 or younger, with less than 20 years hunting experience), experienced hunters (20 to 40 years hunting experience), and elders (more than 40 years hunting experience). This selection process was aided by hiring a community liaison. I obtained written consent from all participants prior to the interviews, and the interview was audio recorded when permitted. The interviews were conducted in English, or translated into Cree for those elders who did not speak English. The community liaisons also acted as translators, in two interviews in Moose Cree and 4 interviews in Weenusk.

The topics in Table 3.2 were not necessarily addressed in order, but rather as the discussion most naturally progressed. The types of questions included a mix of descriptive questions, structural questions, and opinion questions (Dunn 2000). Questions were related to changes in the number of geese killed, the number of days spent hunting, observations on the number of geese seen in the area, the timing and pattern of migration, and environmental factors (Interview guide in Appendix). The questions also focused on where changes were taking place and perceived reasons why. The interview included a mapping component where participants were encouraged to visually explain their observations and experiences on a map of their homeland.

The total number of people interviewed in each community was determined by reaching the point of saturation (where the information being gathered became repetitive and nothing new was being shared) (Creswell 2009). I conducted 21 interviews in the MCFN, and 13 in the WFN.

Each interview was transcribed verbatim using the notes and audio tapes from the sessions into separate word documents. I coded the transcripts using a margin coding scheme (Cameron 2000, Creswell 2009). Using NVivo software, I coded appropriate text within the transcripts to four parent nodes, or main themes. These included: Hunting practices, Migration, (number of) Geese, and Environmental Factors. From these I could create node diagrams, to show a conceptual organization of the qualitative data gathered. Each node is a hierarchical diagram of the organization of common responses to an interview topic or question. The first level of nodes is comprised of overarching common responses, and each subsequent level of nodes contains more specific elements of the response. Under each of my parent nodes, I then coded to categorize information on species, season, and specific observations (Figures 3.2 to 3.5). All hunter attributes were also categorized and recorded. The qualitative responses were quantified, so that I could standardize the terms used when writing the qualitative results. For example, in instances where more than 50% of respondents had a given observation, I could say "the majority". A list of these terms is in the Glossary. I did not perform any statistical analysis on the interview responses.

The maps from the interview sessions in the MCFN were scanned and digitized. I used ArcGIS to map the hunting locations between goose species (Canada geese and snow geese), seasons (spring and fall), and time periods (past and present). "Past" locations were defined as being used at least 20 years ago, and "present" was defined as current hunting locations or those attended within the last 20 years. These data points were compared against mapping done by Thompson and Hutchison (1987).

Validity and Verification

To ensure validity in my construction and application of codes to the qualitative data, I conducted a peer coding comparison or process to check for inter-coder variability and ensure repeatability (Creswell 2009). I verified and validated data with participants through a process of repeated trips to the communities to distribute and discuss the transcripts, present my preliminary findings, as well as gain consent for use of quotes from individuals (Creswell 2009). All of these measures were to ensure accurate capture and correct interpretation of the information, and account for any outliers in the data.

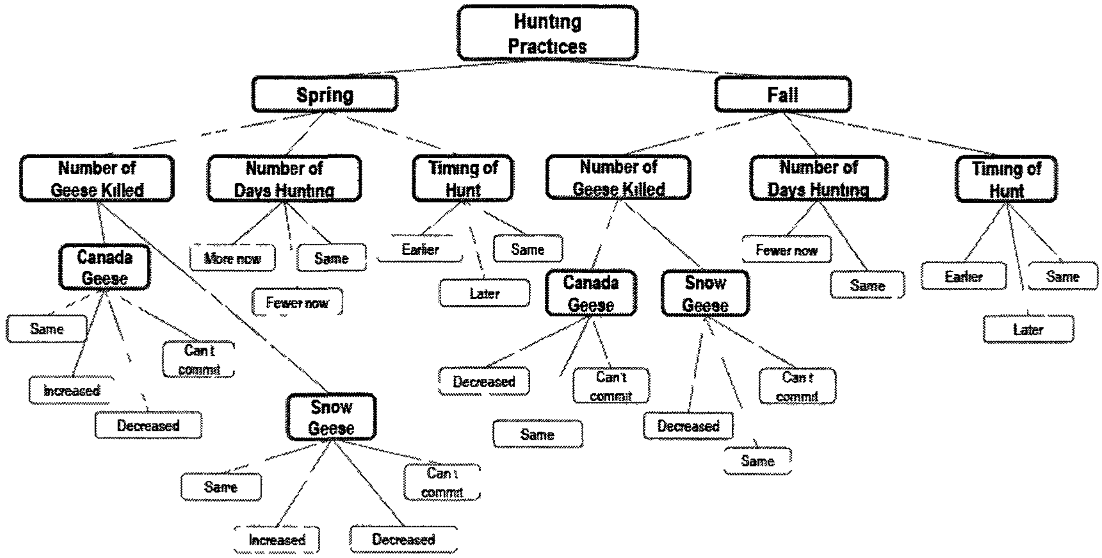


Figure 3.2. Qualitative observations on goose hunting practices.

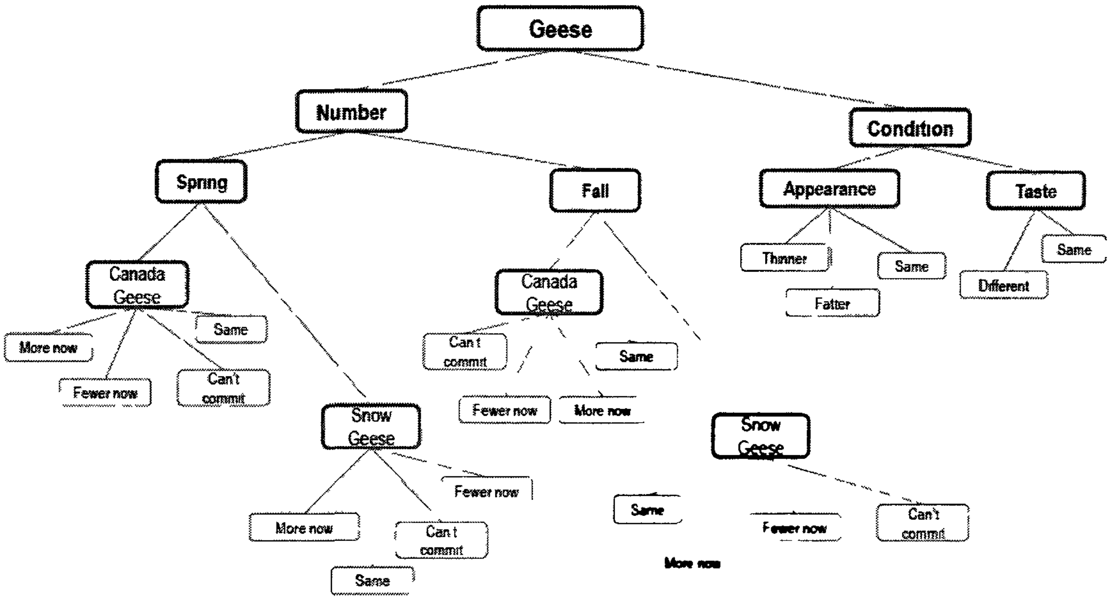


Figure 3.3. Qualitative observations on goose abundance and condition.

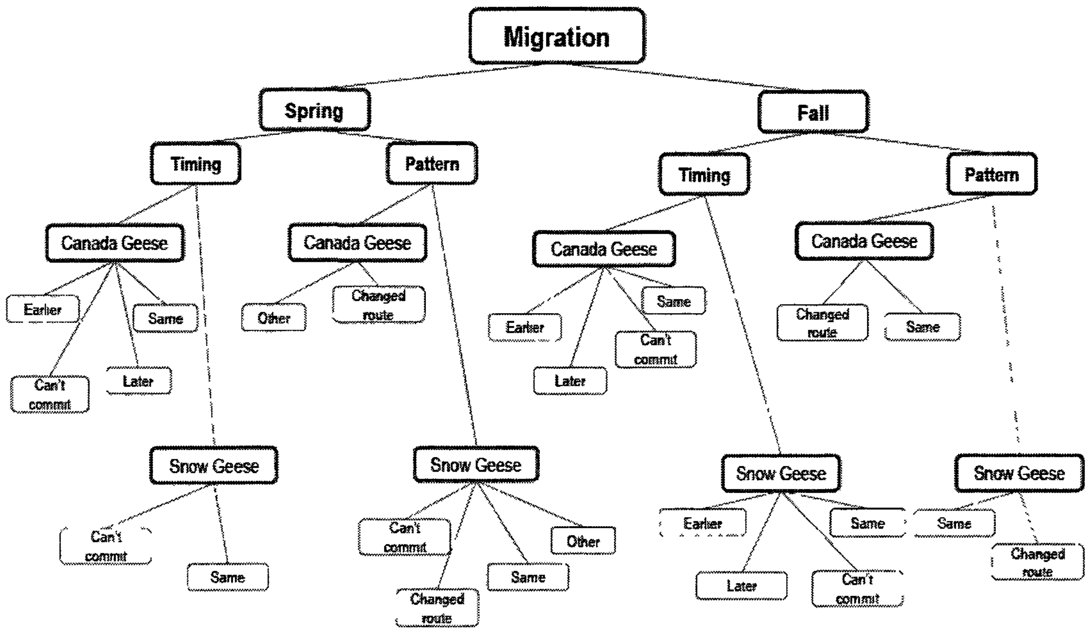


Figure 3.4. Qualitative observations on goose migration.

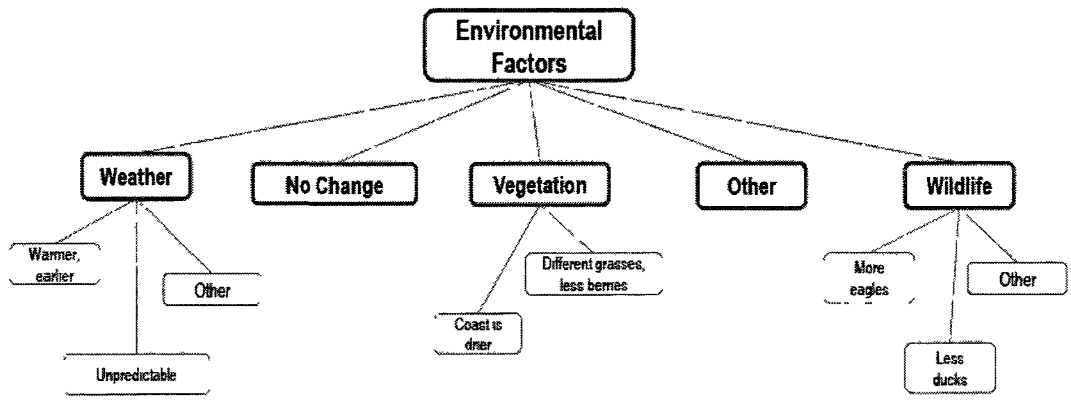


Figure 3.5. Qualitative observations on environmental factors.

Third Stage: Triangulation

The qualitative analysis presented patterns and overall key factors influencing trends in the individual First Nation's harvest of geese. These factors were used as the basis for a third stage of data collection and analysis of additional quantitative sources, including technical data from federal and provincial databases and reports. Major sources include weather station data, vegetation studies, and aerial breeding ground surveys (Table 3.3). Species and annual reports were also consulted. The sources and scale of data examined were informed by the qualitative analysis, and the scale of the local observations.

The fourth stage used the process of triangulation between the different data sets (Johnson and Onwuegbuzie 2004, Creswell 2009) to determine where local observations and technical data sources were corroboratory, complementary, or contradictory. Critical to this step in triangulation was that the datasets could only be linked if they were at the same scale.

In ecology, scale refers to the spatial and temporal dimensions of a pattern or process (Cumming et al. 2006). Duerden and Kuhn (1998) identify the importance of scale in maintaining context, and Gagnon and Berteaux (2009) identify time and space as important scales. However, it is also relevant and important to ensure that the phenomenon being examined is also at the same scale. Comparisons involving strictly temporal and spatial scales can be misleading if the subject matter being discussed is different. Phenomenon is defined for this purpose as ecological process or structure (Dungan et al. 2002). For example, the number of geese seen by hunters is likely the same phenomenon as the number of geese counted in an aerial survey. For my triangulation I searched for technical data sets that were at the same temporal, spatial, and phenomenological scales as identified in the interviews. In instances where data sets matched scales, I could determine if they were corroborating, complementary, or contradictory, as well as with what level of confidence (Table 3.4). In the discussion, I confirmed where the datasets were corroborating or complementary (in agreement), or assessed and speculated as to why they were contradictory (disagreed). In circumstances where information was corroboratory or complementary between data sources, the study helped support understanding of the topic, and where it was contradictory, revealed areas where more information is necessary.

Table 3.3. Qualitative and quantitative data sources for understanding interactions between geese, communities, and the land.

For understanding interactions between geese and the land (i.e. changes in goose habitat, abundance, and distribution)	**For understanding interactions between communities, geese and the land (i.e. hunting patterns, access to the land)**
Hunter interviews*	Hunter interviews*
Climate data**	Harvest studies**
Vegetation studies**	
Aerial surveys**	

*Qualitative source ** Quantitative source

Table 3.4. Rationale for determining whether data sets were corroborating, complementary, or contradictory, and with what level of confidence.

Result	**Confidence**	**Rationale**
Corroborating	High	All 3 scales (Temporal, Spatial, Phenomenological) are aligned
Complementary	High	2 scales are aligned
	Low	1 scale is aligned
Contradictory	High	All 3 scales are aligned
	Med	2 scales are aligned
	Low	1 scale is aligned
Inconclusive		No data available at same scale

Table 3.5. Template for matching local observations to technical data sources, with themes informed by semi-directed interviews and qualitative analysis (complete table in Appendix).

Indicator	Observations gathered through interviews with northern residents	Information gathered through technical data sources	Scale- Temporal/ Spatial/ Phenomenological	Corroborating, Contradictory, or Complementary
Habitat				
Weather				
Goose Abundance				
Timing of Migration				
Pattern of Migration				
Hunting Practices				
Wildlife				

3.4 COMMUNITY PROJECT DELIVERABLES

I produced several community deliverables throughout the project, including progress fact sheets and presentations delivered in community meetings. In Moose Factory, I presented preliminary findings in a community research presentation in March 2010 and final results with the Lands and Resources Director in March 2011. In Peawanuck, I presented preliminary results to community members in February 2010 and final results in March 2011.

An additional community deliverable for this project involves future harvest surveys. It is planned to develop comprehensive community run harvest surveys to be carried out collaboratively with each of the communities. These surveys will include more than just geese and will use information from the interviews to base questions on critical environmental observations not usually collected through a standard harvest survey. These surveys will build community capacity, as well as continue to document local observations on changes in wildlife populations and landscapes in the Hudson Bay Lowland.

4.0 CHANGES IN CLIMATE AND HABITAT, AND IMPACTS TO THE ABUNDANCE AND DISTRIBUTION OF GEESE

The first study objective was to examine if the climate is changing, and if there have been changes in goose habitat. It was also to examine if there have been changes in the number of geese, the timing and distribution of goose migration and if these changes can be linked to a changing climate.

Sources for Local Observations

Of the 21 people interviewed in the Moose Cree First Nation (MCFN), 7 were youth, 7 were experienced hunters, and 7 were elders. In the Weenusk First Nation (WFN) there were 7 experienced hunters and 6 elders. There were no youth identified or available to be interviewed at that time.

Although it was not intended, not all participants had more than 10 years hunting experience. Because of this, in the MCFN, only 20 people of the 21 were able to make comparisons between current observations and those for the past. In the WFN, 12 of the 13 were able to discuss both present and past observations. So the total sample size for questions pertaining to change is actually 20 for the MCFN and 12 for the WFN. Also, the number of responses for each question varied (Table 4.1 and 4.2). The only information used from the remaining interviewees was with respect to current harvest numbers. Also, when discussing the past compared to the present, the time frame discussed varied depending on the age and experience of the hunter (Tables 4.3 and 4.4).

The number of people who had a given response was quantified, under the themes of Environmental Factors, Geese, Migration, and Hunting Practices (Figures 4.1 to 4.4). A statistical analysis was not performed on the qualitative results.

Table 4.1. Number of responses for each question asked on goose abundance, timing and pattern of migration.

Indicator	Moose Cree First Nation				Weenusk First Nation			
	Spring		Fall		Spring		Fall	
	Canada Geese	Snow Geese	Canada Geese	Snow Geese	Canada Geese	Snow Geese	Canada Geese	Snow Geese
Abundance (number seen)	20	11	8	17	12	11	10	9
Timing of Migration	20	10	8	11	6	11	/	10
Pattern of Migration	14	/	/	2	7	/	4	7

Table 4.2. Number of responses for each question asked on environmental indicators.

Indicator	Moose Cree First Nation	Weenusk First Nation
Climate	9	10
Vegetation	14	8
Wildlife	13	8

Table 4.3. Interviewee characteristics in the Moose Cree First Nation.

Demographic	Number Interviewed (n=21)	Age Range	Years discussed
Elders	7	Over 60	1940-2009
Experienced hunters	7	30-50	1970-2009
Youth	7	25-30	1990-2009

Table 4.4. Interviewee characteristics in the Weenusk First Nation.

Demographic	Number Interviewed (n=13)	Age Range	Years discussed
Elders	7	Over 60	1940-2009
Experienced hunters	6	30-50	1970-2009
Youth	0	25-30	n/a

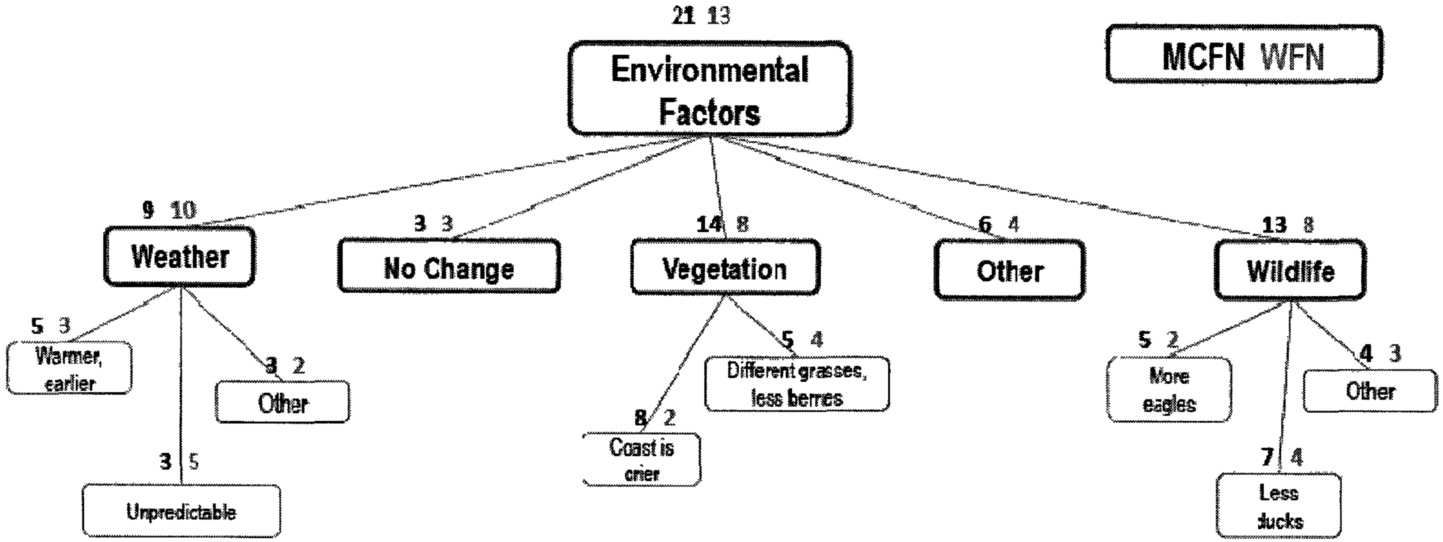


Figure 4.1. Observations on environmental factors, as identified in semi-directed interviews with northern residents of the Moose Cree First Nation (MCFN) and Weenusk First Nation (WFN). The number of people with a given observation or response is in black (MCFN) or grey (WFN).

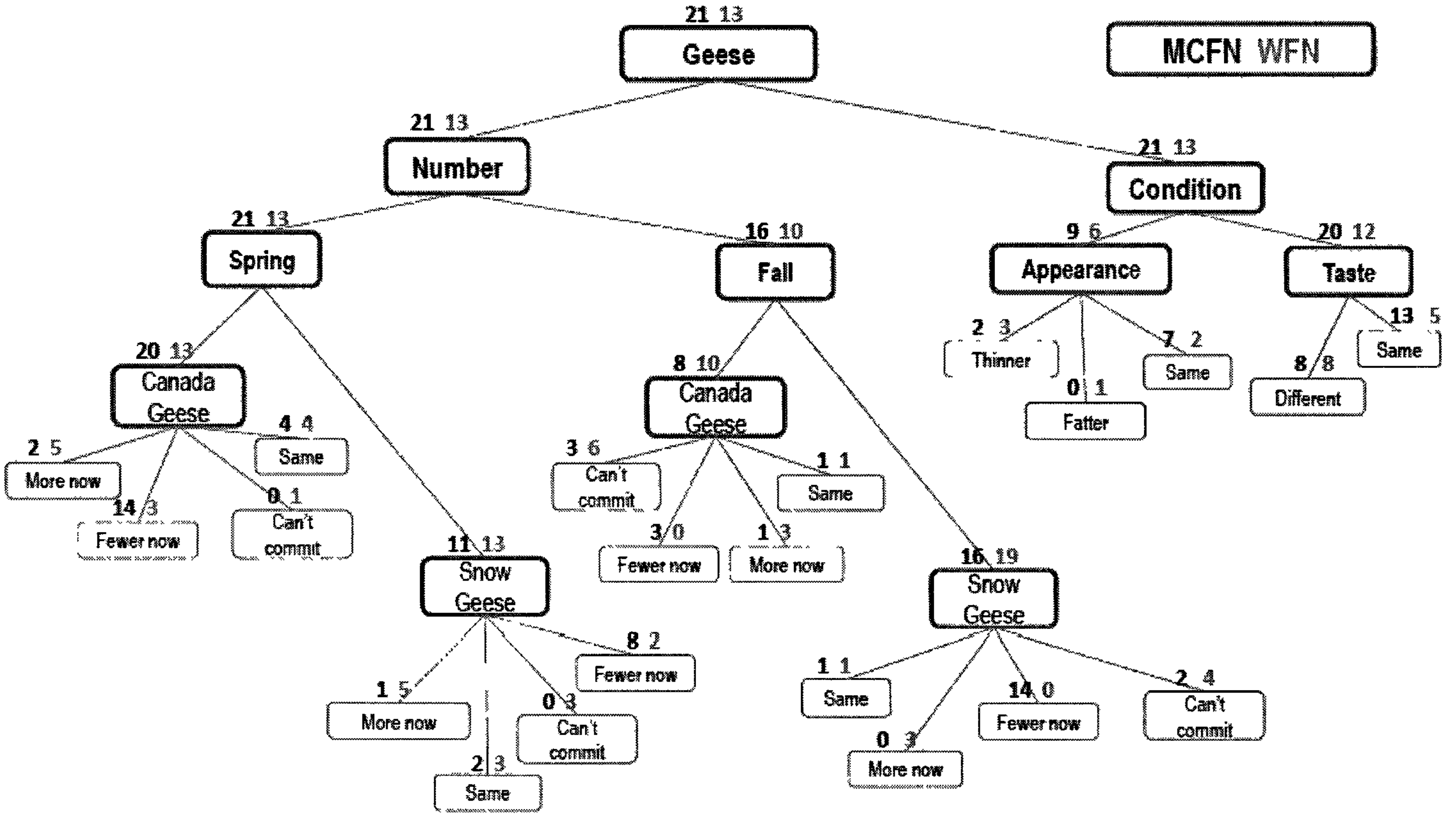


Figure 4.2. Observations on abundance of Canada geese and snow geese, as identified in semi-directed interviews with northern residents of the Moose Cree First Nation (MCFN) and Weenusk First Nation (WFN). The number of people with a given observation or response is in black (MCFN) or grey (WFN).

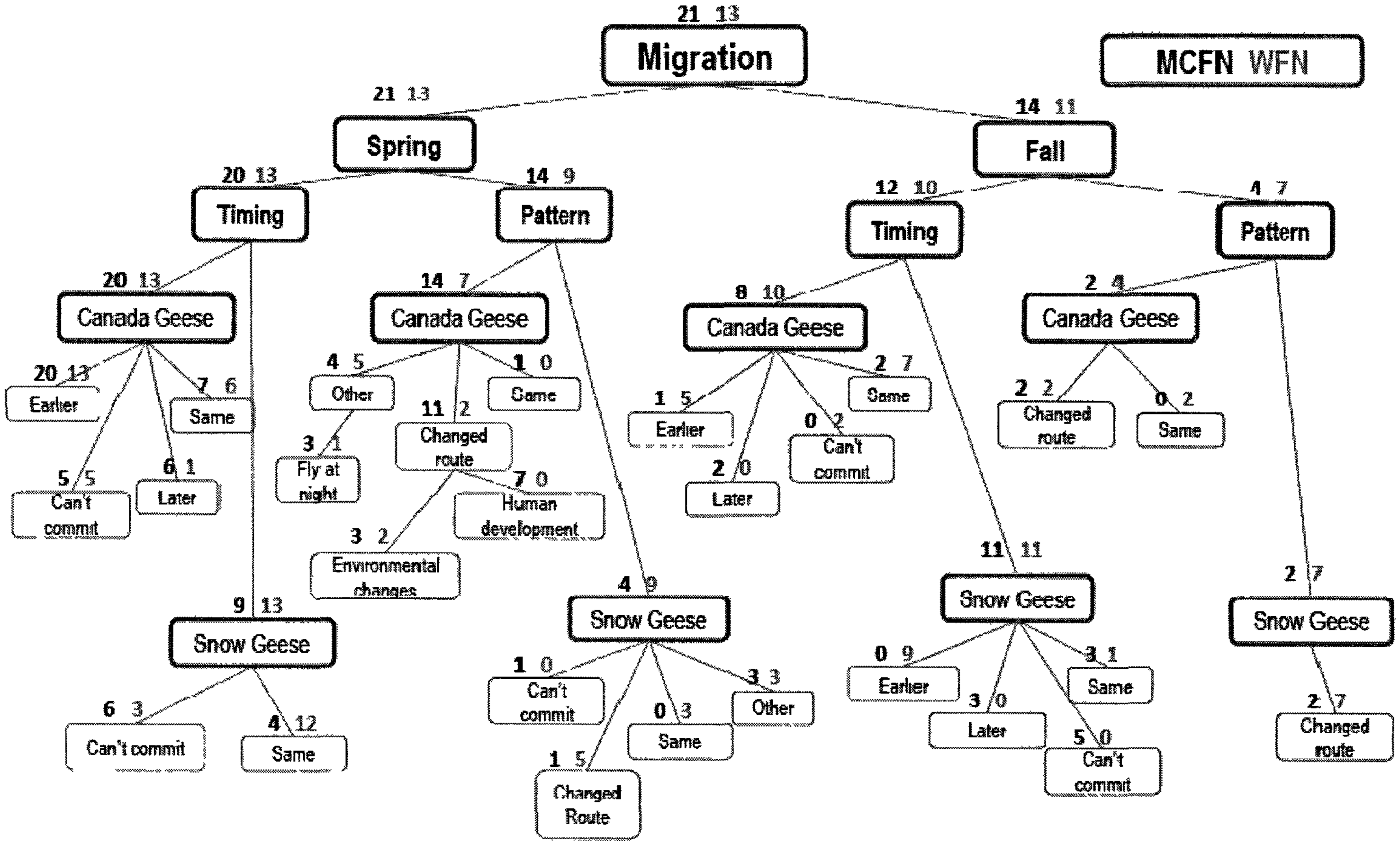


Figure 4.3. Observations on migration patterns of Canada geese and snow geese, as identified in semi-directed interviews with northern residents of the Moose Cree First Nation (MCFN) and Weenusk First Nation (WFN). The number of people with a given observation or response is in black (MCFN) or grey (WFN).

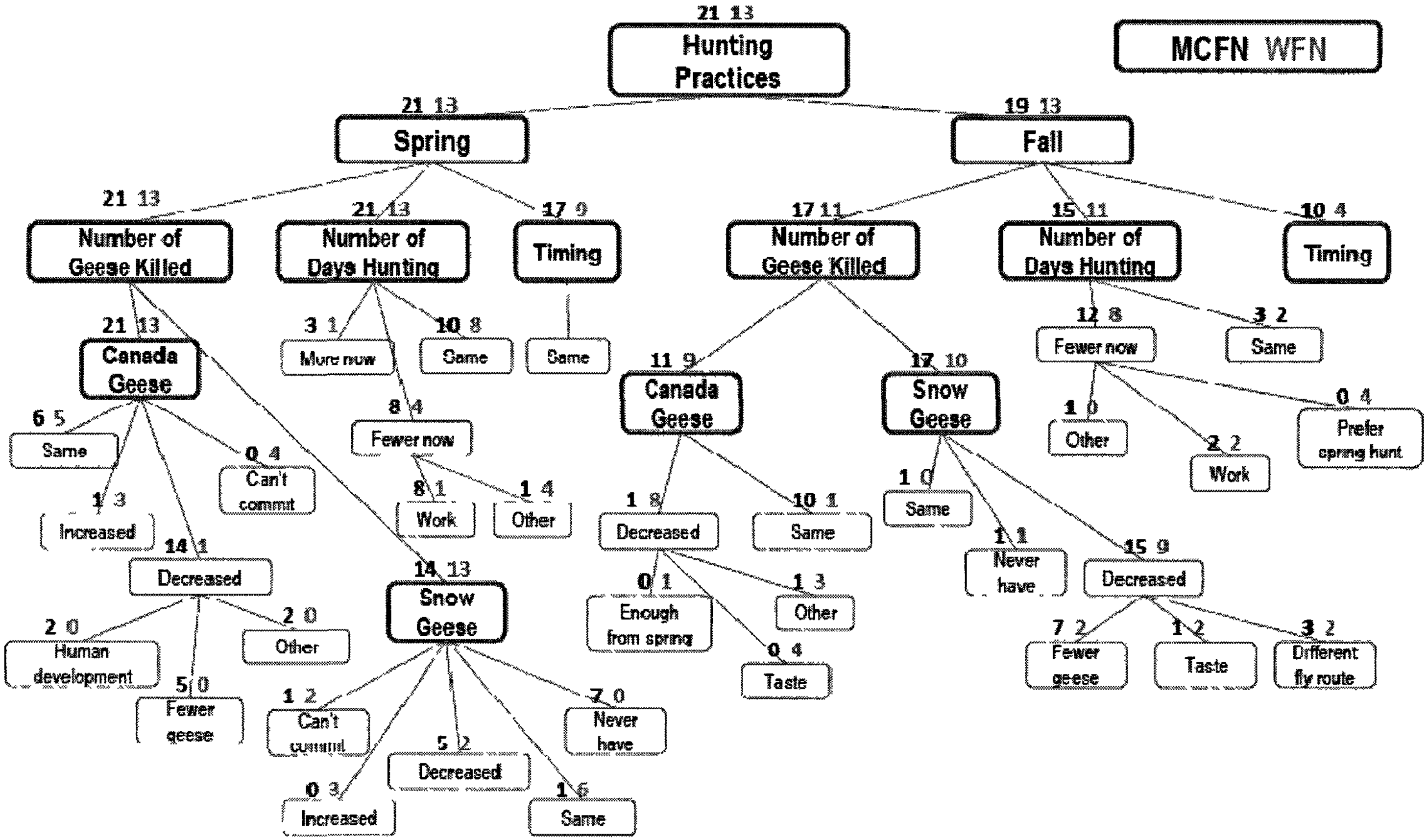


Figure 4.4. Hunting Practices of the Moose Cree First Nation (MCFN) and Weenusk First Nation (WFN), as identified in semi-directed interviews with northern residents. The number of people with a given observation or response is in black (MCFN) or grey (WFN).

Sources for Technical Data

For comparative data sets to the local observations I used a variety of technical sources, including provincial and federal data sets, as well as technical reports, surveys and studies. For comparative information on climate and weather, I used data from both the digital elevation model climate database from the Canadian Forest Service (McKenney et al. 2006), and from the Environment Canada weather station (6075425) in Moosonee (Environment Canada 2009). The database models climate variables based on the Environment Canada weather stations in Moosonee and Peawanuck. The model divides regions into 10 by 10 km^2 squares, the same as the Ontario Breeding Bird Atlas (Cadman et al 2007). For analyses related to temperature, I chose 8 squares around each community and took the average monthly temperature between them, to get a single data point for each community. The squares were chosen to encompass the same regions as the homeland territories of the communities, including both inland and coastal areas. I graphed mean monthly data for the years 1961 to 2008, inclusive, to cover the same years as those discussed by hunters. I focused on March to May as the late winter and early spring months, as those were the months described in the interviews. I also plotted daily minimum and maximum temperatures for the months of April and May, looking for differences in inter-annual variation (Environment Canada 2009). I used temperatures of 20°C and -30°C as arbitrary "extremes" to compare over decades. These parameters were only available from the Moosonee weather station. I also plotted break up dates for the Moose River from 1950 to 2010 (K. Corston unpublished) to compare to local observations of an earlier spring. Published reports on river and lake ice in boreal regions of northern Ontario were also consulted, and linked to local observations.

For data sets to compare to local observations on vegetation, recorded data were available for Shegogau, on the southern James Bay coast, for 1973 to 1975 and 2003 to 2005 (K. Middel unpublished). The study site was located within the hunting grounds of the MCFN. There have been no comparable studies in the Peawanuck area. Growing Degree Days (GDD) were also used as a variable for spring vegetation growth. Degree days for a given day represent the number of Celsius degrees that the mean temperature is above or below a given base (Environment Canada 2011). In this case, the base temperature used was 5°C, as this was the base in previous vegetation analyses in the region (K

Middel unpublished). Accumulated growing degree days (AGDD) are the sum total of (positive) degree days in a given month (Environment Canada 2011). I calculated AGDD for April and May, as those were the months discussed in the interviews.

For comparative data sets on the abundance of Canada geese, I used spring breeding population data for the years 1989 to 2010 (US Fish and Wildlife Service 2010), as spring breeding surveys are at the same temporal scale as local observations. Coastal fall aerial surveys were also used for years between 1975 and 1984 in both regions as well as 2009 in southern James Bay (OMNR unpublished). Fall surveys were not conducted in the remaining years. I used data from the coastal segments between the Albany River and the Quebec border for southern James Bay and coastal segments from Severn River to Cape Henrietta Maria for southern Hudson Bay, as those were at the same spatial scale as the observations from the local hunters.

For comparative data sets on the abundance of snow geese, the local observations are from the fall, and therefore the fall coastal surveys are at the same temporal and spatial scales. There were also additional surveys and data from 1998 and 2009 in southern James Bay (OMNR unpublished). Breeding ground surveys were also available from 1970 to 2010 (US Fish and Wildlife Service 2010).

For observations on changes in wildlife, species counts of birds have been done in the region (Ontario Partners in Flight 2010) and are at a comparable temporal, spatial, and phenomenological scale to local observations. Aerial duck surveys were conducted throughout Ontario between 1955 and 2009 (Zimpfer et al. 2009). However, data for the coastal segments of James and Hudson Bay (strata #51, 57, and 59) were not included in the report.

4.1 CHANGES IN CLIMATE AND HABITAT

Specific questions related to climate and habitat were not asked during the interviews; however the interviewees were asked to describe what they thought was occurring in terms of environmental change on the coast and around their hunting grounds. The main topics that arose from this question were changes in the weather or climate, changes in the vegetation, and changes in the species composition of wildlife. Some of these changes included variation in temperature norms, unpredictability of weather, and changes in the composition of vegetation on the coast. Eighteen of the 20 hunters in the Moose Cree First Nation (MCFN) sample and 10 of the 12 hunters in the Weenusk First Nation (WFN) sample commented on environmental changes.

Climate

Shifts in temperature averages and extremes over a certain period of time are indicators of a changing climate. Also relevant to climate and change are observations on the unpredictable nature of the weather. Each of these observations was raised through the interviews, with nine hunters in the MCFN and 10 in the WFN commenting on changes in the weather.

Temperature

Local observations on changes in temperature norms included: spring becoming warmer and occurring earlier (with an associated earlier river break up); freeze up of lakes and rivers occurring later in the fall; and an increase in temperature variability within the same year as well as between years (Table 4.5).

In southern James Bay, 5 of the 9 MCFN hunters who commented on the weather said that it was warmer, or that spring was earlier. One hunter commented that he has noticed the "heat and the sun, you can feel it changing. The sun's getting hotter" (Darrell Isaac, youth, MCFN). Another hunter commented on the spring melt:

"*It's the weather itself doing something to the ice, it melts fast. The way it melts today it melts really fast. It doesn't have that cold in the mornings, warms up and then is freezing again at night, those types of conditions off and on. Now it's just complete meltdown*" (Rick Rickard, MCFN).

There were also local observations on the timing of the breakup being earlier, associated with the increased temperatures and faster thawing.

Weather station data corroborates local observations of generally increasing temperatures. In the southern James Bay region, average temperatures for spring months have increased approximately 3°C in the last 50 years. March, April and May have increased from -13°C, -4°C and 5°C respectively in 1961, to -10°C, -1°C and 8°C in 2008 (Figure 4.5; McKenney et al. 2006).

The observation of an earlier break up is corroborated by data from studies on the Moose River as well as in James Bay (Gagnon and Gough 2005, Ho et al. 2005). The Moose River has gone from breaking up on average on May 3rd (123 Julian days) in 1950 to April 26th (116 Julian days) in 2010 (Figure 4.6; OMNR unpublished). This is a significant increase in the 50 year period ($p=0.036$, Adj. $R^2=0.057$). Studies on lakes in northwestern Ontario also show a shift to an earlier spring break up (Schindler et al. 1990). These data sets are at a different phenomenological scale, as an earlier break up of the river is only one indicator of an earlier spring, so the finding of spring being earlier is only complementary.

There were also local observations about freeze up in the fall. As one youth hunter described:

"*It doesn't freeze as quick as it used to. It's freezing a little later. There's more and more open water, like in between Charles Island and the mainland and Moosonee, it takes a long time for it to freeze*" (Darrell Isaac, youth, MCFN).

There are no formally kept records for the timing of the freeze up for the Moose River. Studies on river and lake freeze up times in northwestern Ontario do not show a significant shift to later freeze up dates (Schindler et al. 1990, Duguay et al. 2006). The thawing and freezing of rivers is also influenced by factors additional to temperature, including water levels, ocean circulation, wind and snow cover (Etkin 1991, Magnuson et al. 2000, Gagnon and Gough 2005). The local observation of a later freeze up time is contradictory to these studies but with low confidence, based on these additional influences (Table 4.5).

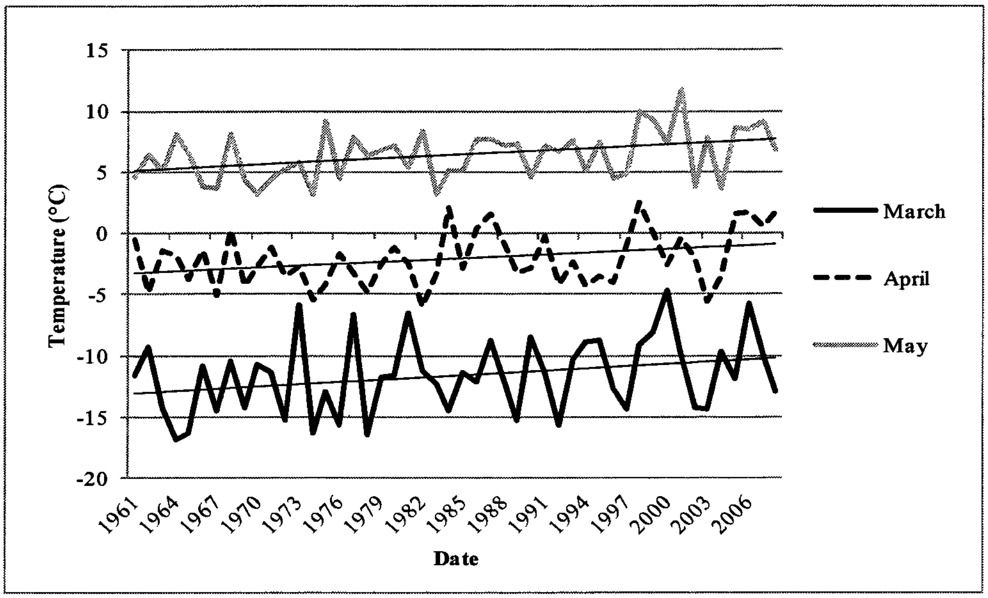


Figure 4.5. Mean monthly temperatures for late winter and early spring months in Moosonee from 1961 to 2008 (McKenney et al. 2006). (March p=0.048, adj. R^2=0.062; April p=0.029, adj. R^2= 0.08; May p=0.008, adj. R^2=0.123).

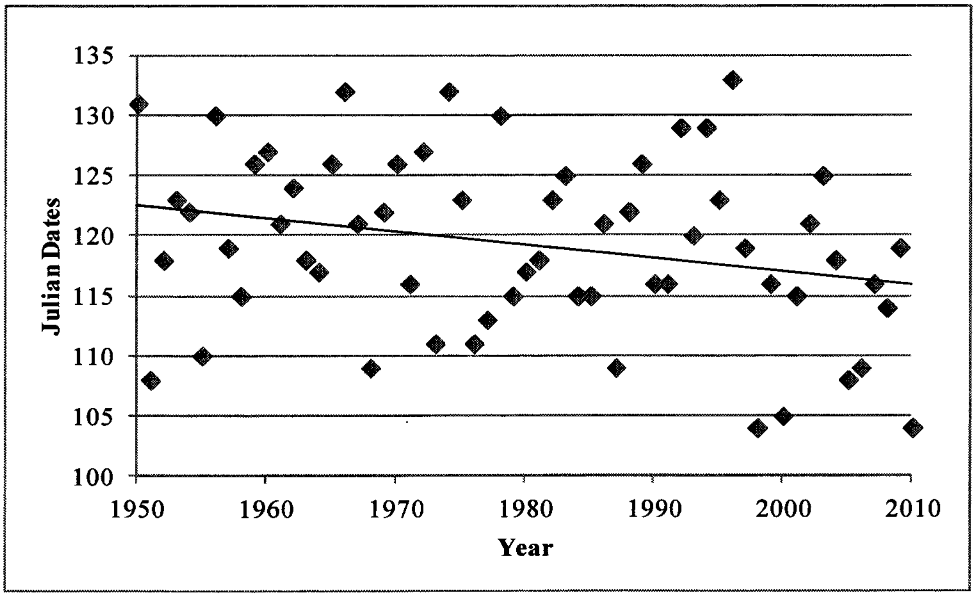


Figure 4.6. Ice break up dates on the Moose River, from 1950 to 2010 (adapted from OMNR unpublished data, courtesy of Ken Corston). (p=0.036, adj. R^2=0.057).

In the Hudson Bay region, observations from the WFN were that spring was warmer and had an earlier onset. Five of the 10 hunters commented on spring arriving earlier. One elder commented on how the average winter temperature 20 years ago was -35°C, but that now it is warmer; the temperature still goes down to -30°C at night, but it rises to 15°C to 19°C during the day. Another elder commented on how the Winisk River has been breaking up earlier in the last 10 years, limiting his use of the ice later in the spring.

In Peawanuck, weather station data corroborates the observation that late winter and spring temperatures have increased. March, April and May monthly means have all increased on average 3°C in the last 50 years (Figure 4.7; McKenney et al. 2006). March has increased on average from -18°C to -15°C, April from -7°C to -4°C, and May from 1°C to 4°C. There are no official records of the timing of the break up for the Winisk River.

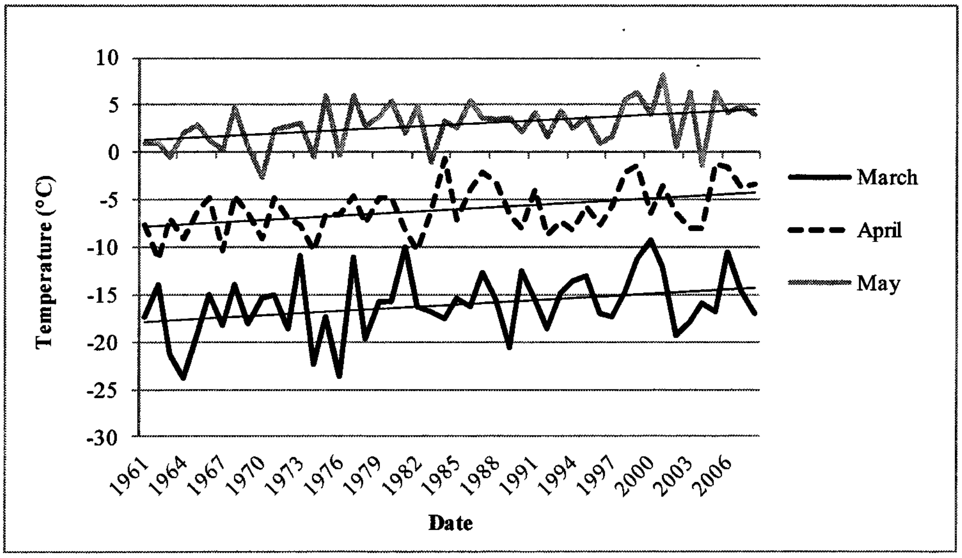


Figure 4.7. Mean monthly temperatures for late winter and early spring months in Peawanuck from 1961 to 2008 (March $p=0.027$, Adj. $R^2=0.081$; April $p=0.002$, Adj. $R^2=0.166$; May $p=0.004$, Adj. $R^2=0.149$; McKenney et al. 2006).

Table 4.5. Local observations and technical data sources on aspects of climate.

Observations gathered through interviews with northern residents	Information gathered through technical data sources	Scale: Temporal, Spatial, Phenomenological	Corroborating, Contradictory, Complementary
Spring is warmer	Spring temperatures have increased	Same	Corroborating
Spring is earlier	Earlier break up of Moose River	Phen- different	Complementary
Freeze up is later on lakes and rivers	Later freeze up on James and Hudson Bay, not significantly later on inland lakes and rivers	Spatial-different	Contradictory, low confidence

Unpredictability

Hunters in both communities commented on the variable nature of the weather. In addition to spring break up occurring earlier, the temperature within the month of April was reported as becoming increasingly varied, making the ice conditions increasingly unsafe (Table 4.6).

Three of the 9 hunters in the MCFN sample who commented on the weather said that it was more unpredictable, in that it has become more varied or unsafe. Specific observations include:

"*Breakup comes early, not really safe there anymore, not during breakup anyways*" (Billy Isaac, elder, MCFN).

"*What I've noticed anyway over the years I've trapped on the river the conditions are very unpredictable now. It's not safe. It becomes very questionable to be on the river now, late in the season*" (Rick Rickard, MCFN).

Of the 10 hunters in the WFN to comment on the weather, 5 had observations that it was more unpredictable. The hunters were referring to the changing conditions of the ice on the river, and how it was unsafe to navigate it in the spring around break up. One hunter explained that in the last 10 years, the "sudden thaw days alternating with freeze up days" have made the river too dangerous to travel on by mid-April.

Temperature records do not show an increase in the number of extreme temperature days (or peaks) in the months of April or May from the years 1960 to 2009 for the Moosonee area (Figures 4.8 and 4.9). For April, from 1961 to 1970 there were 6 days where the temperature was close to or above 20°C and 6 days where it was almost -30°C. From 1971 to 1980, there were 6 days where the temperature was close to 20°C, but only one day when it dropped to -30°C. From 1981 to 1990 there were 9 days where the temperature was above 20°C, and 2 days where it was -30°C. There are missing years (1994 to 1997 inclusive) in the 1991 to 2000 dataset so a comparative count for that decade is not possible. From 2001 to 2009, there were 5 days where the temperature was close to or above 20°C, and only one day where it was close to -30°C. These results show a trend towards less extreme cold days during the overall 50 year time period, but not a significant change in the number of extremely warm days.

For the month of May, other than the period from 1961 to 1970, there were 13 to 17 days in each decade where the temperature was above 25°C, and either one or no days where the temperature was as low as -15°C (Figure 4.9). These results do not show an increase in the number of peak cold days or peak warm days. The temperature records also do not show an increase in variation of daily temperature range (Figures 4.10 and 4.11).

These comparisons were only available for Moosonee, as daily maximum and minimum temperature measurements were not available from the Peawanuck weather station. The local observation of an increase in daily temperature variation (sudden thaws and refreezing) within the month of April (or May) for the Moose Factory area is at the same temporal and spatial scale, but is contradictory (Table 4.6).

Another local observation was the sudden shift in wind direction within a given day, contributing to hunters' difficulty in predicting weather patterns. This observation is inconclusive for this study, as there are no direct means of comparison. Although, wind direction is known to have an effect on goose migration (Ball 1983), and it could be an influencing factor.

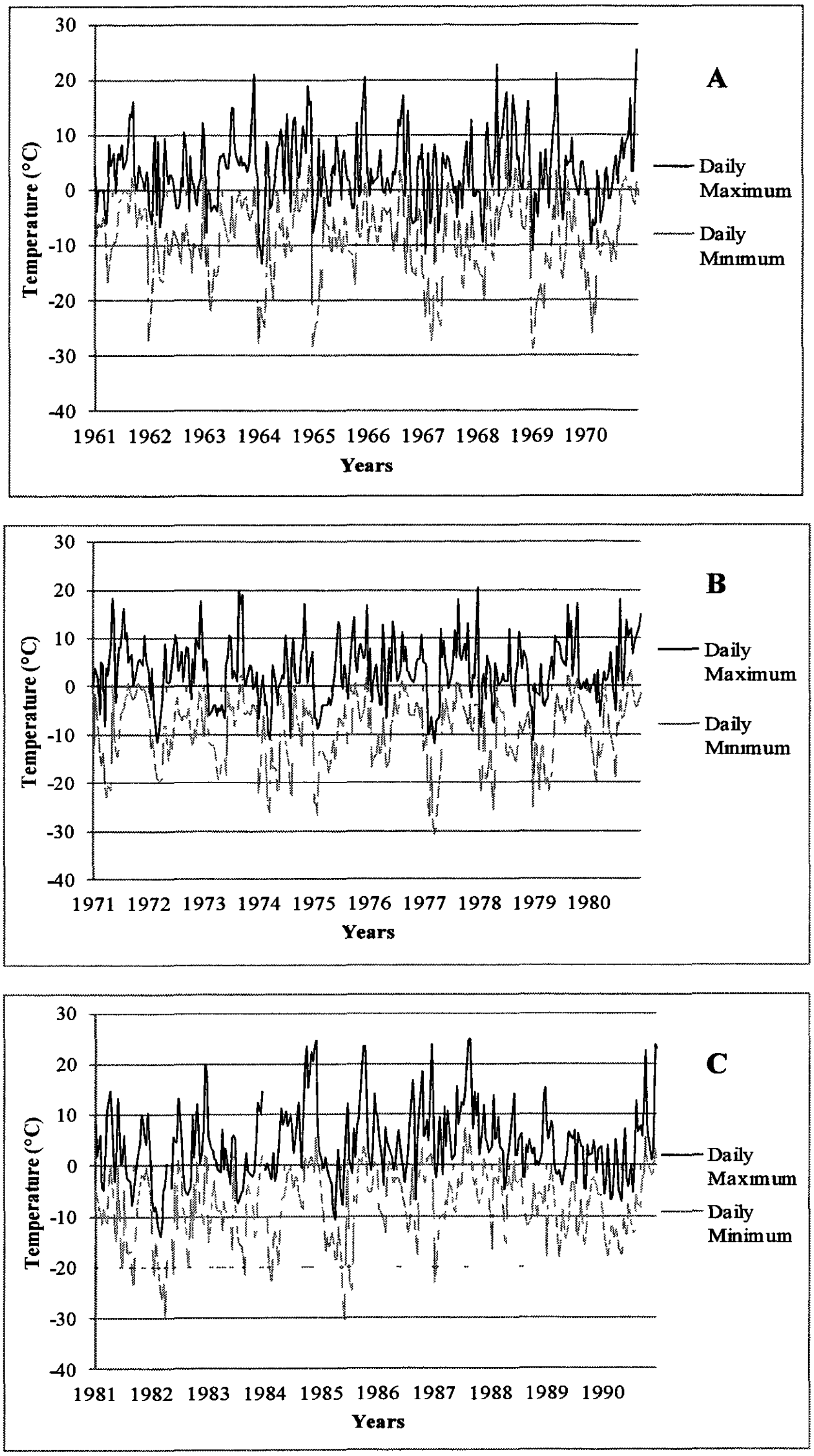


Figure 4.8 (A-C). April minimum and maximum daily temperatures from (A) 1961 to 1970, (B) 1971 to 1980, and (C) from 1981 to 1990 (Moosonee weather station 6075425; Environment Canada 2009).

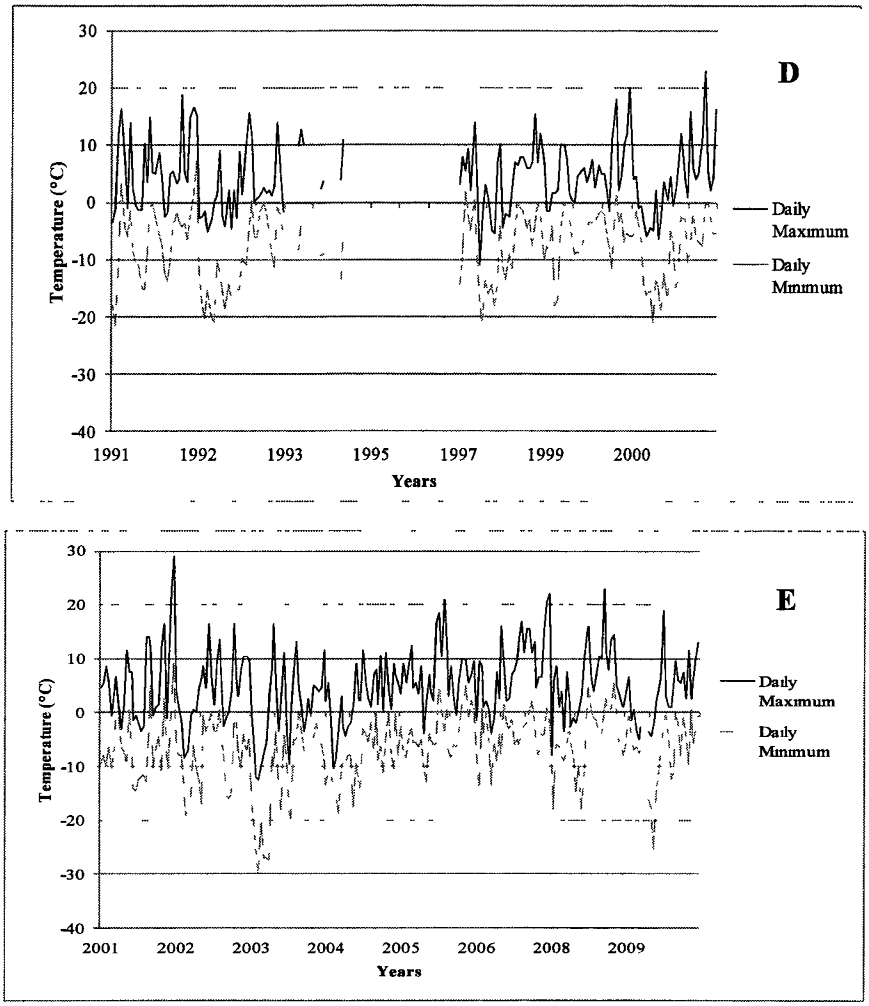


Figure 4.8 (D-E). April minimum and maximum daily temperatures from (D) 1991 to 2000 and (E) from 2001 to 2009 (Moosonee weather station 6075425; Environment Canada 2009).

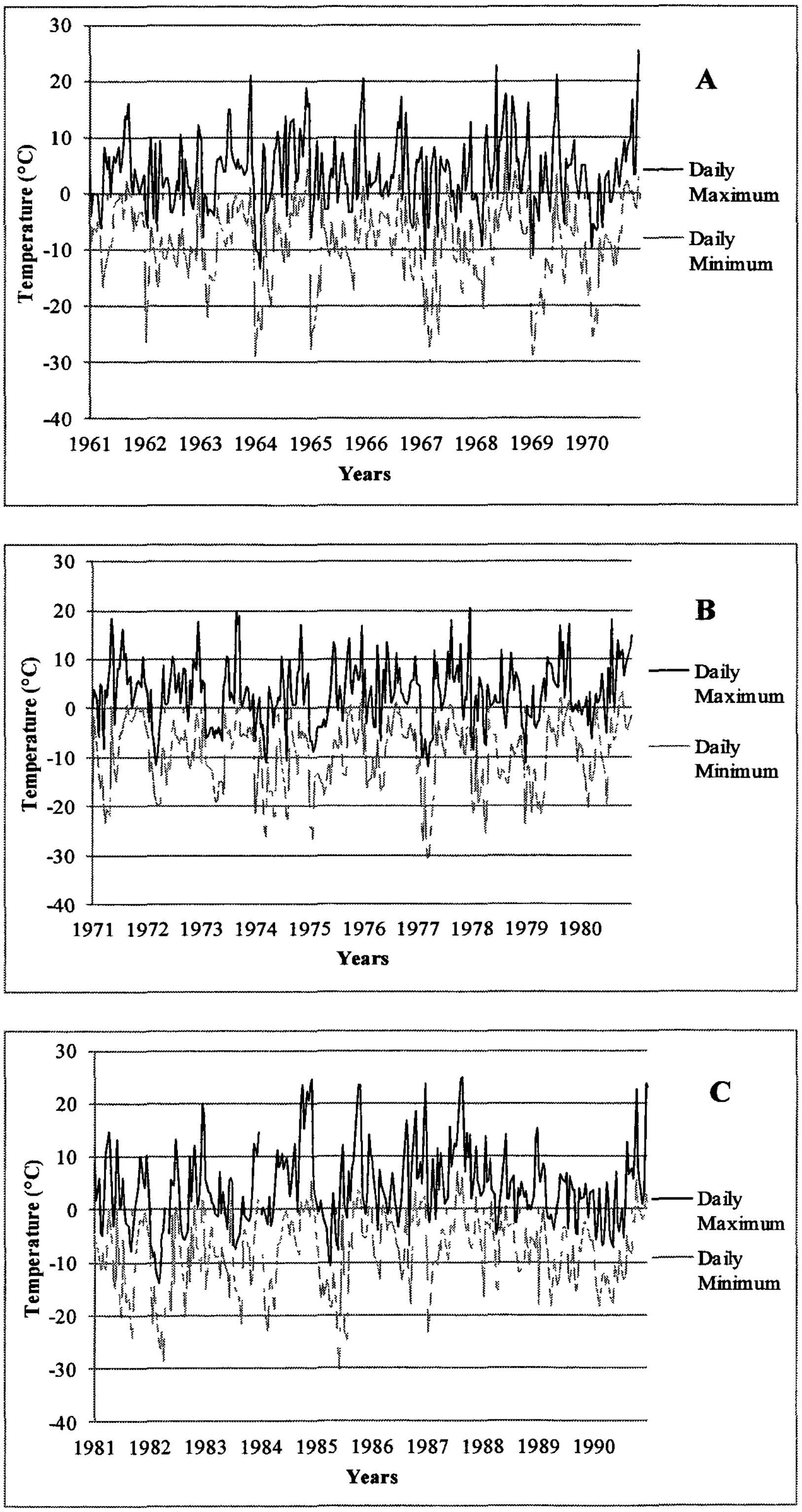
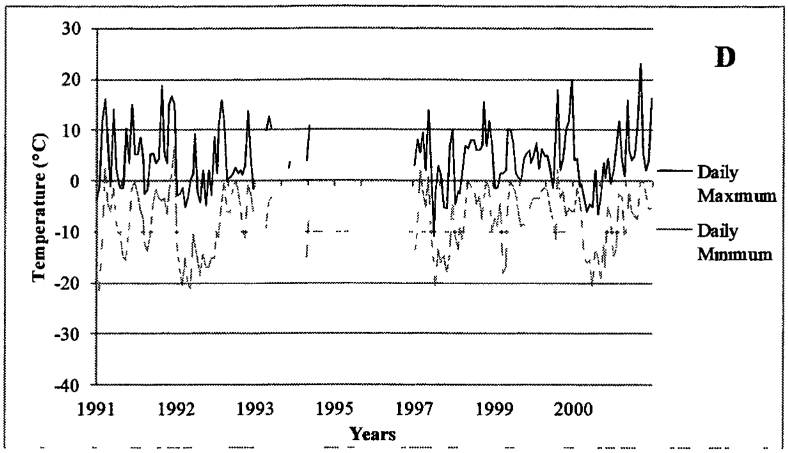


Figure 4.9 (A-C). May minimum and maximum daily temperatures from (A) 1961 to 1970, (B) 1971 to 1980, and (C) 1981 to 1990 (Moosonee weather station 6075425; Environment Canada 2009).



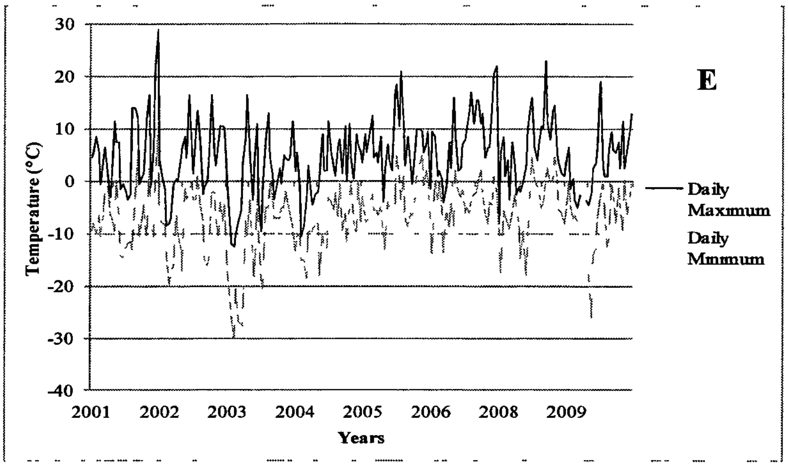


Figure 4.9 (D-E). May minimum and maximum daily temperatures from (D) 1991 to 2000 and (E) 2001 to 2009 (Moosonee weather station 6075425; Environment Canada 2009).

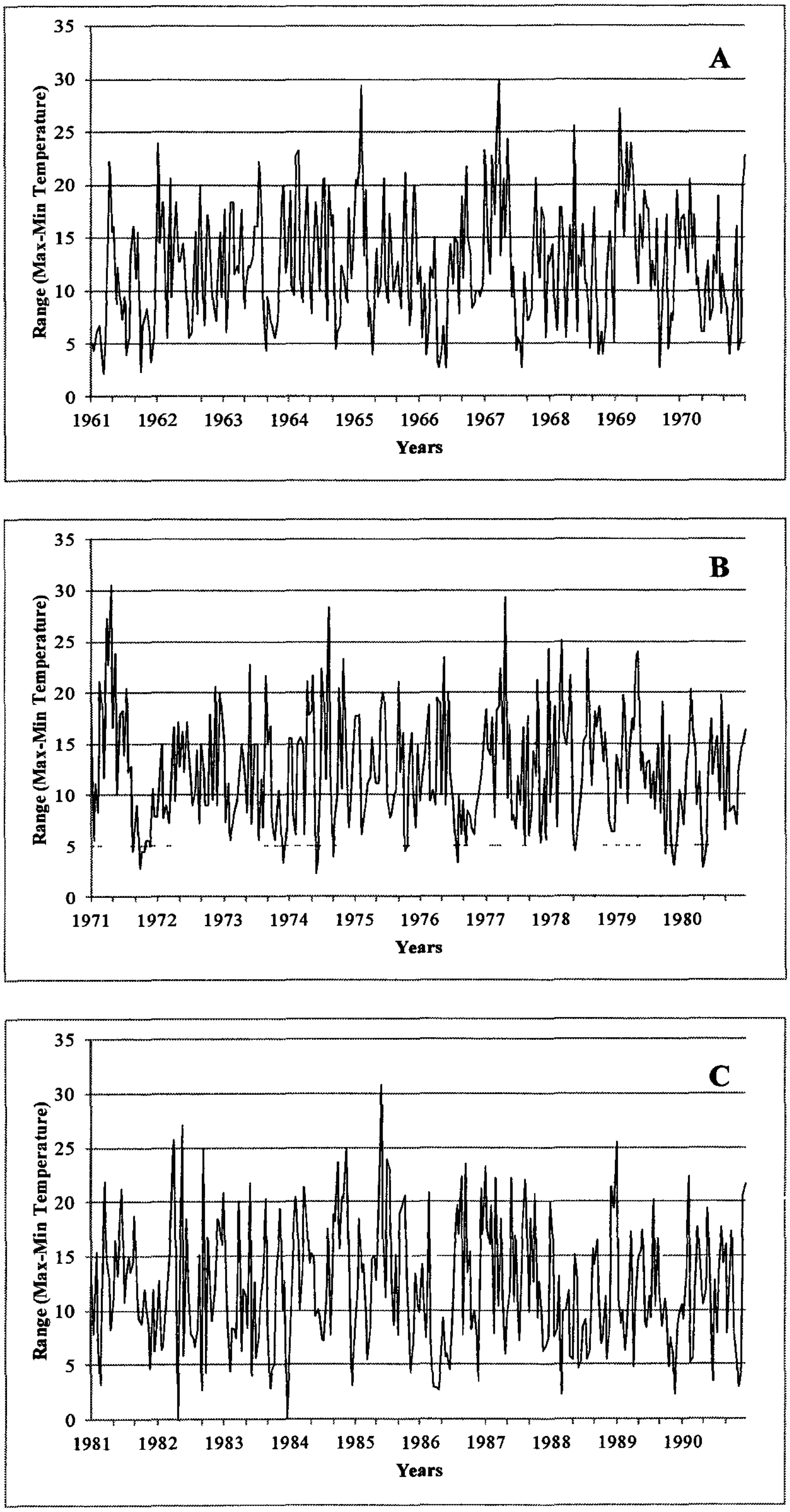


Figure 4.10 (A-C). April daily temperature ranges in °C from (A) 1961 to 1970, (B) 1971 to 1980, and (C) 1981 to 1990 (Moosonee weather station 6075425; Environment Canada 2009).

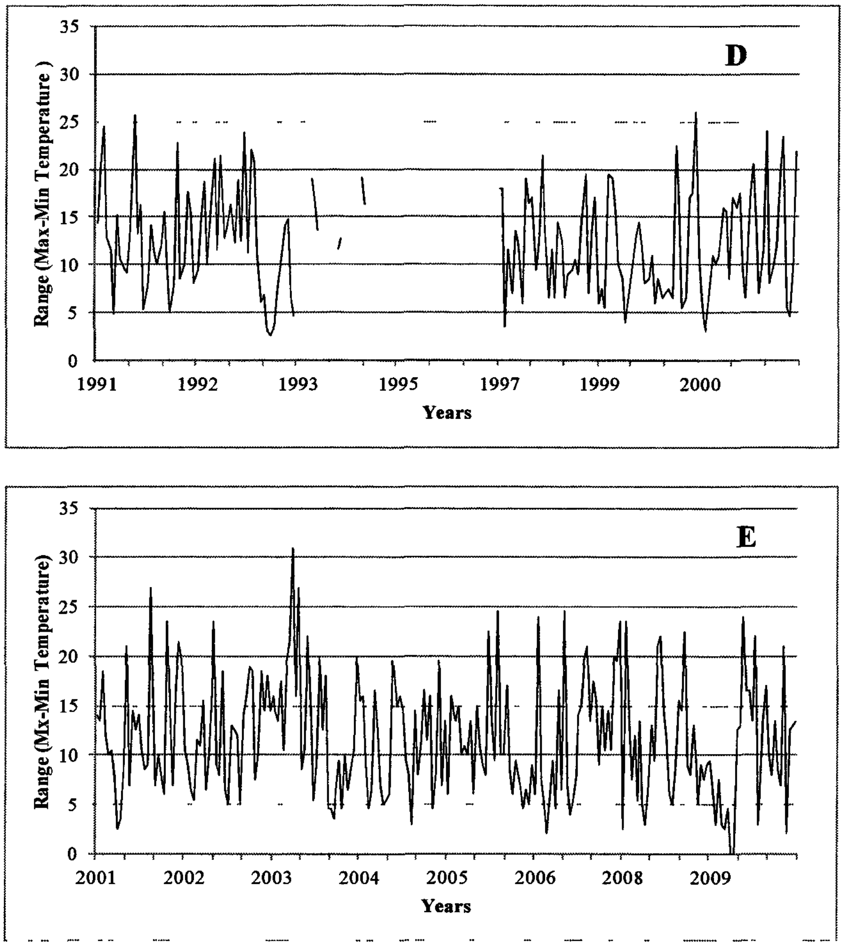


Figure 4.10 (D-E). April daily temperature ranges in °C from (D) 1991 to 2000 and (E) 2001 to 2009 (Moosonee weather station 6075425; Environment Canada 2009).

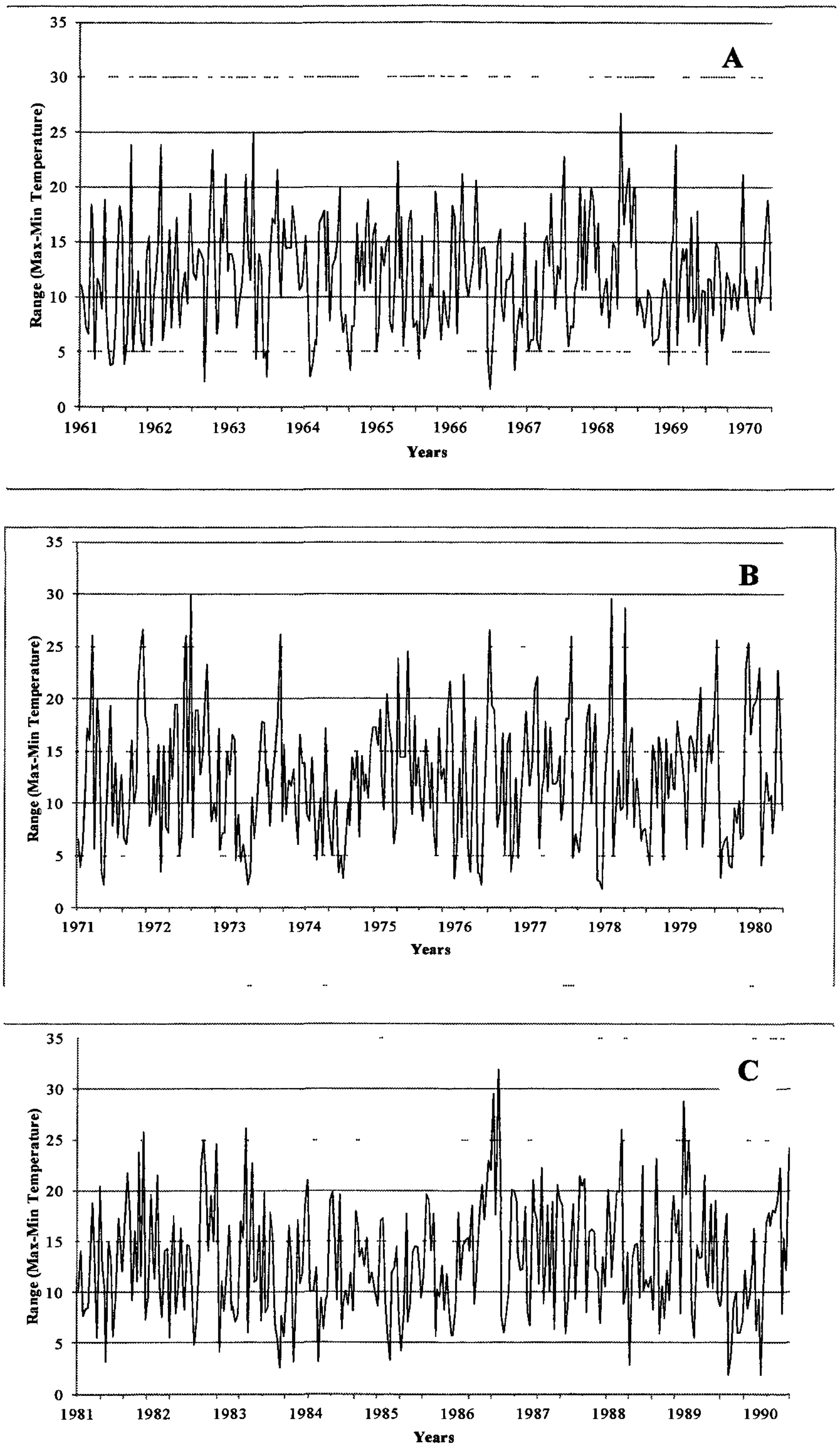


Figure 4.11 (A-C). May daily temperature ranges in °C from (A) 1961 to 1970, (B) 1971 to 1980, and (C) 1981 to 1990 (Moosonee weather station 6075425; Environment Canada 2009).

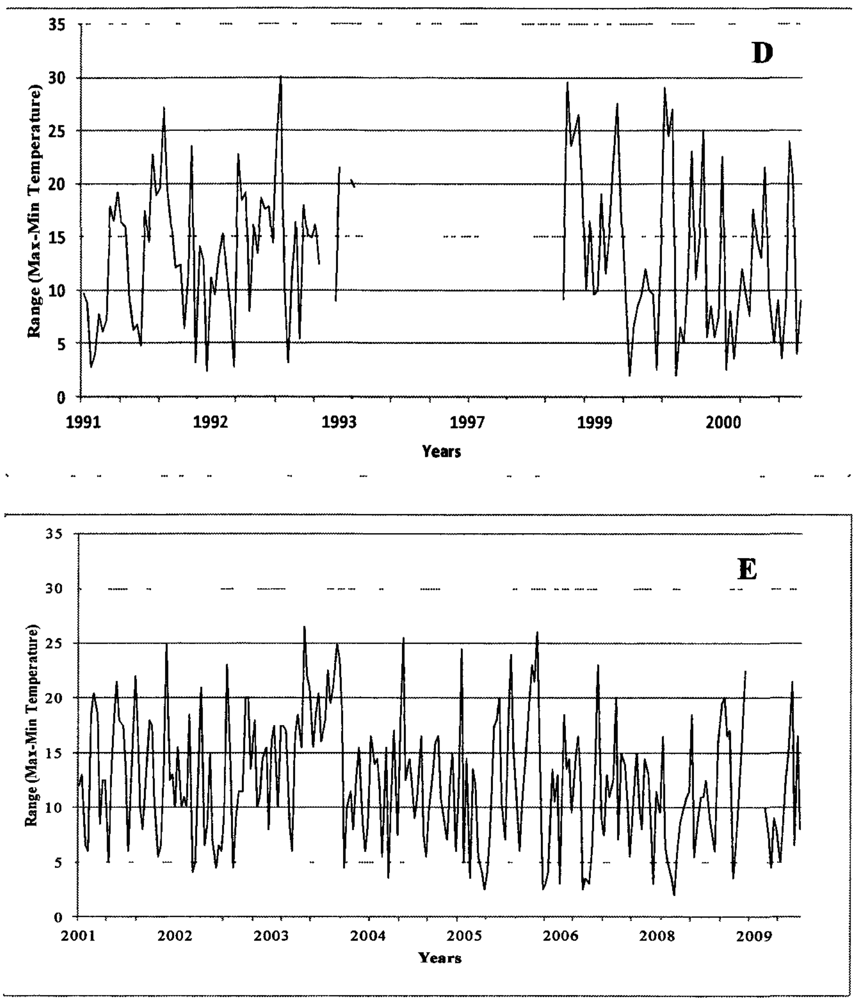


Figure 4.11 (D-E). May daily temperature ranges in °C from (D) 1991 to 2000 and (E) 2001 to 2009 (Moosonee weather station 6075425; Environment Canada 2009).

Table 4.6. Local observations and technical data sources on unpredictable weather.

Observations gathered through interviews with northern residents	**Information gathered through technical data sources**	**Scale: Temporal, Spatial, Phenomenological**	**Corroborating, Contradictory, Complementary**
Increased variation in temperature within the months of April and May	Not a significant increase in number of extreme days or inter-annual range of temperature for April or May	Different Phen.	Contradictory
Sudden shifts in wind direction	n/a	n/a	Inconclusive

Vegetation

In the MCFN, of the 18 people who commented on environmental changes, 14 had comments specific to vegetation. In the WFN, 8 of the 10 who had comments on the environment observed changes to the vegetation. In both communities, these comments were related to either the coast becoming drier, to changes in the grasses or vegetation on the coast, or to a decline in berries (Table 4.7).

Five people in the MCFN and 2 in the WFN observed the coast becoming drier. Precipitation records show that the average monthly precipitation on the James Bay coast in each of the spring months (March, April and May) has not changed significantly (Figure 4.12). Daily average precipitation levels also do not show a significant trend for the months of April or May (Figures 4.13 and 4.14). Previous local studies in James Bay also did not find a significant change in precipitation (K. Middel, OMNR unpublished). Although, a comparable study in Churchill indicated a decrease in water cover for the coastal region over the same time period (Ballantyne 2009). There are also factors in addition to precipitation which influence the moisture levels of the coast, so the phenomenological scales of these data sets are different. Due to differences in spatial and phenomenological scales, the observation in my study of a drier coast is contradictory, although with low confidence (Table 4.7).

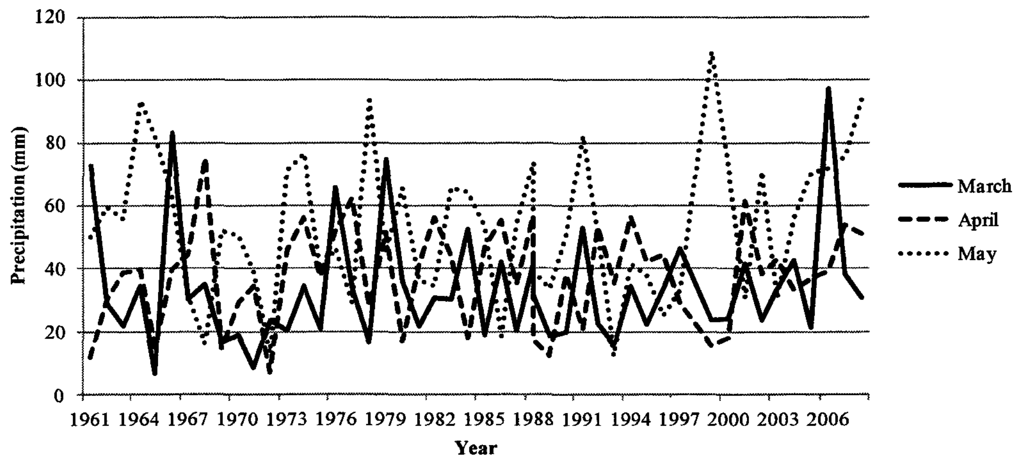


Figure 4.12. Average monthly precipitation for late winter and early spring months in Moosonee (McKenney et al. 2006). (March p=0.333, Adj. R^2=0.0009; April p=0.398, Adj. R^2=0.006; May p=0.485, Adj. R^2=0.01).

In southern Hudson Bay, average monthly precipitation for each of the spring months has not changed significantly (Figure 4.15). April is the only month to show a decline, however, this is likely due to the outlier years of 1963 and 1964 (which were excluded from the analysis). Daily precipitation records are not available for Peawanuck.

A further observation by people in both communities was that the willows are now progressively moving towards the bay and into the grass and sedge habitats. As several hunters commented:

"*The willows are growing out. There's willows growing now where there weren't willows before, where there used to be grass and open*" (Chris Isaac, MCFN).

"*It's all started growing where the geese used to land... it's all willows and stuff, growing. All along the coast. It's a long way to go inland*" (Elder, MCFN).

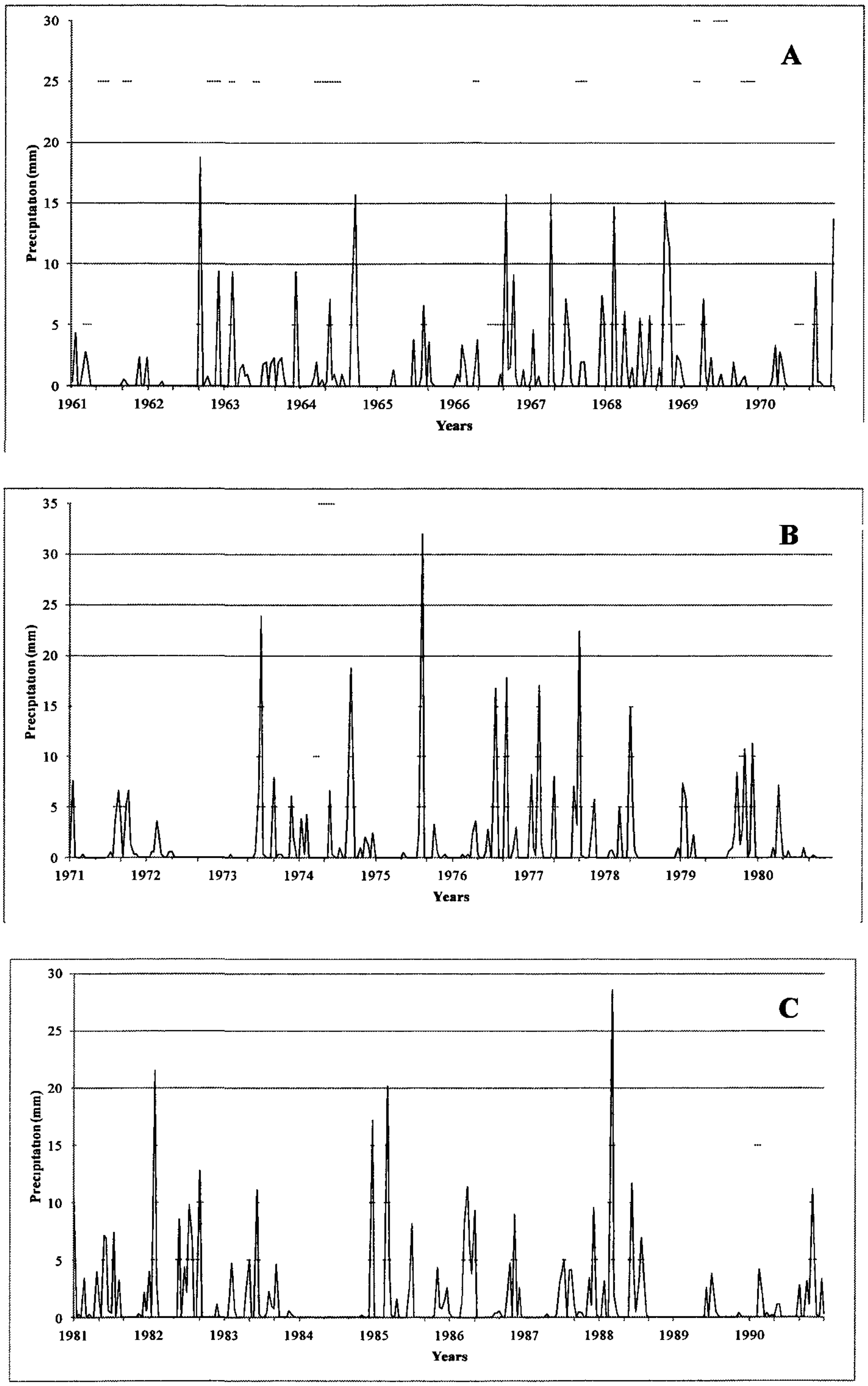
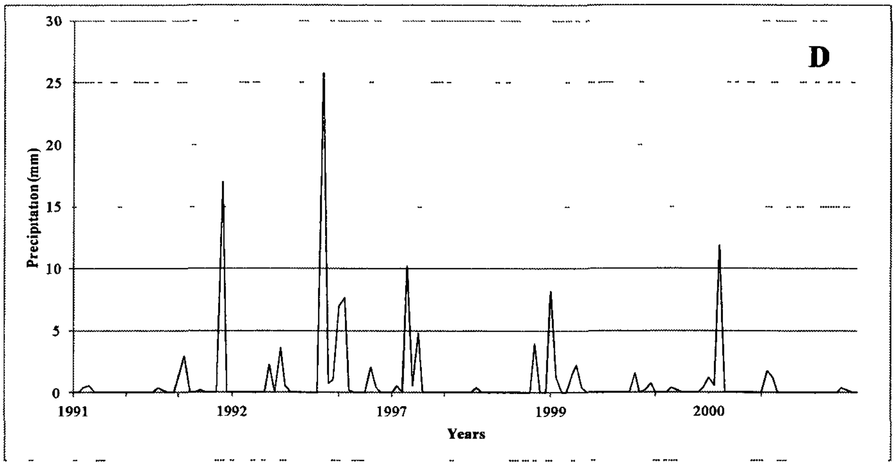


Figure 4.13 (A-C). April daily precipitation in Moosonee from (A) 1961 to 1970, (B) 1971 to 1980, and (C) 1981 to 1990 (Moosonee weather station 6075425; Environment Canada 2009).



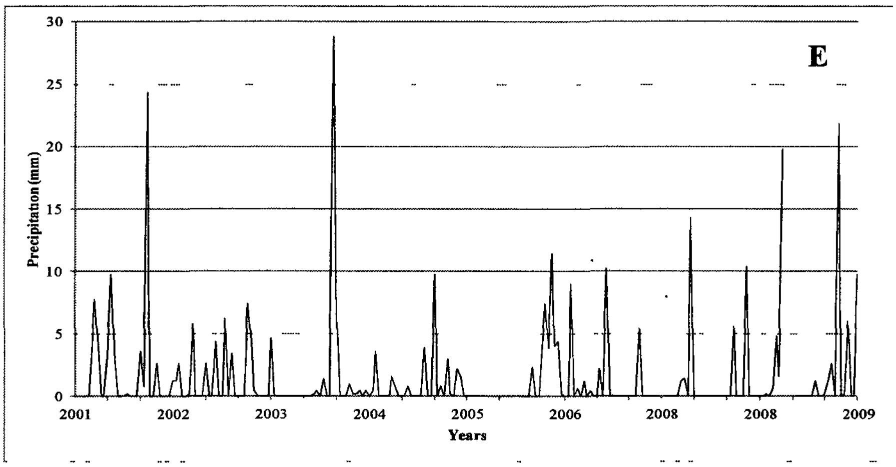


Figure 4.13 (D-E). April daily precipitation in Moosonee from (D) 1991 to 2000 and (E) 2001 to 2009 (Moosonee weather station 6075425; Environment Canada 2009).

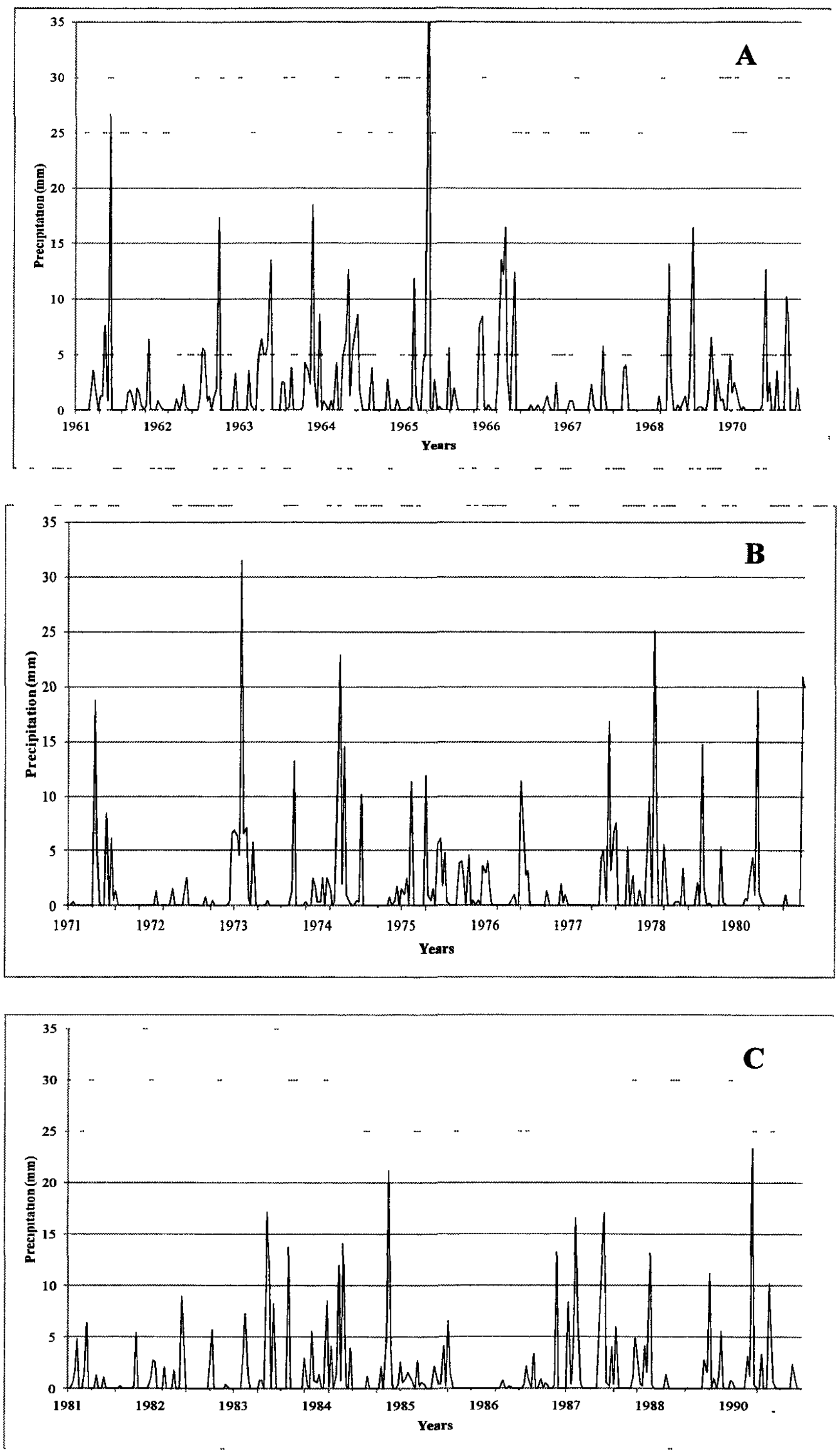


Figure 4.14 (A-C). May daily precipitation in Moosonee from (A) 1961 to 1970, (B) 1971 to 1980, and (C) 1981 to 1990 (Moosonee weather station 6075425; Environment Canada 2009).

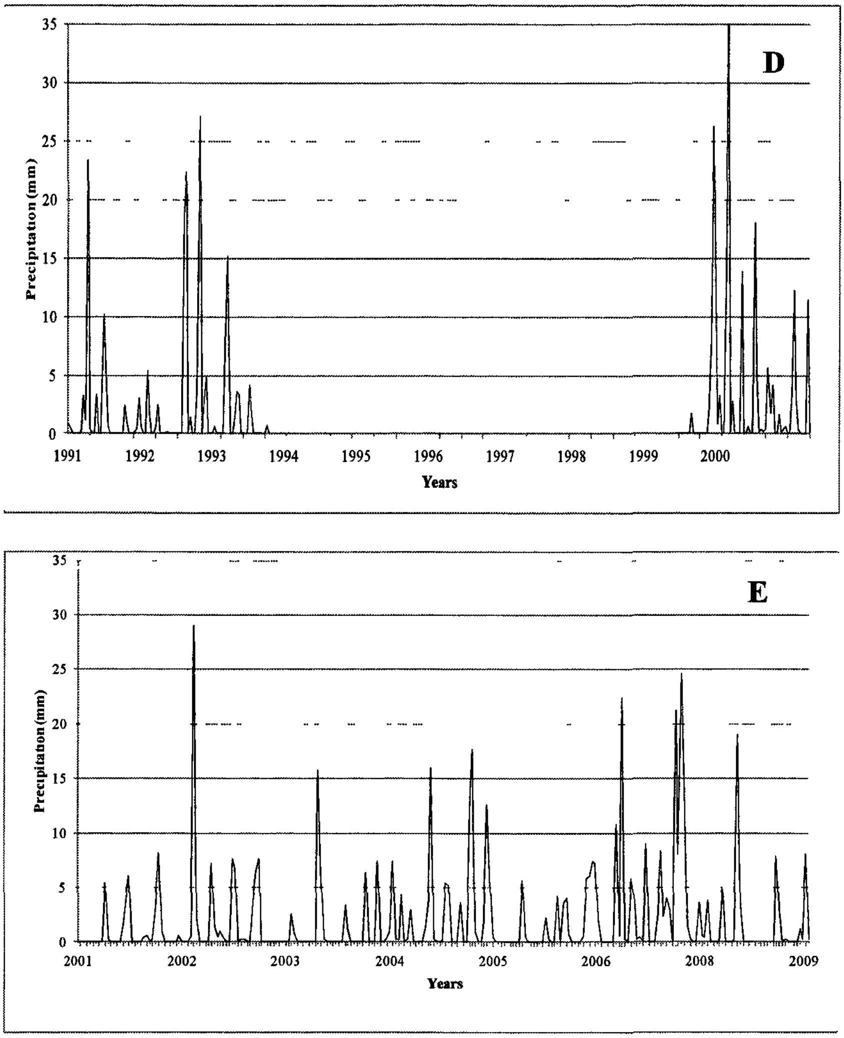


Figure 4.14 (D-E). May daily precipitation in Moosonee from (D) 1991 to 2000 and (E) 2001 to 2009 (Moosonee weather station 6075425; Environment Canada 2009).

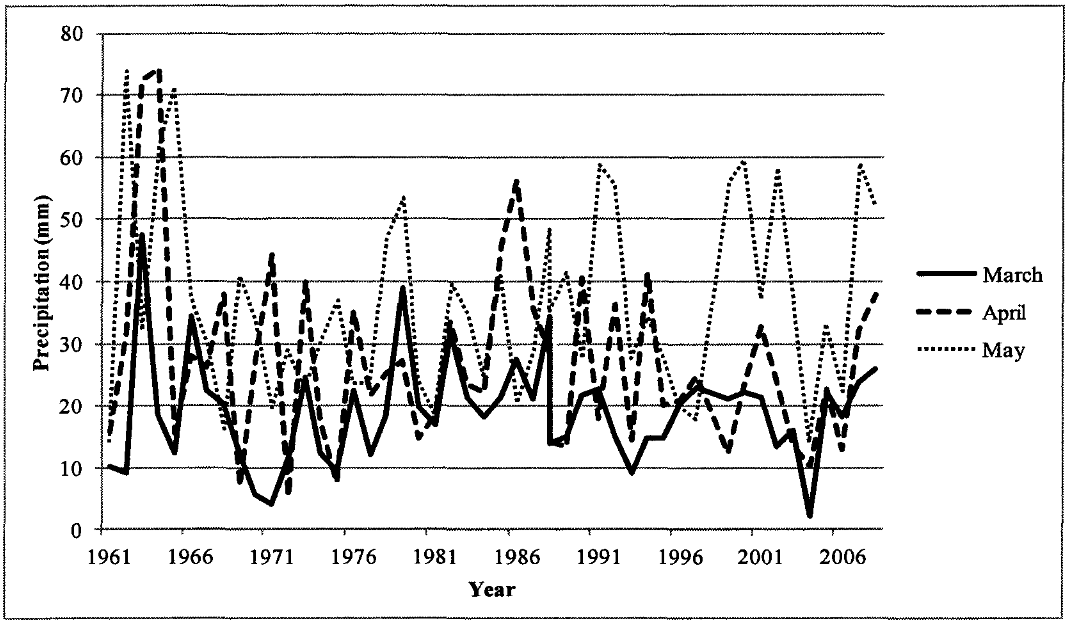


Figure 4.15. Average monthly precipitation for late winter and spring months in Peawanuck (McKenney et al. 2006). (March p=0.94, Adj. R^2=0.022; April p=0.137, Adj. R^2=0.027; May p=0.775, Adj. R^2=0.02).

The observation of changes in the grasses on the coast was also linked to the discussion on geese. Elders in Moose Factory suggestively attributed the decline in snow geese to this change:

"*Actually drying out, the land along the coast. Maybe that's why there's no wavies. It used to be wet all the time. Different kind of grass growing"* (Abel Cheechoo, elder, MCFN).

"*Yeah it's all dry, its dry there's no place for them really to eat*" (Agnes Corston, elder, MCFN).

Elders in the WFN commented on an increased abundance of weeds in the rivers. One elder used the example of Hawley (Sutton) River now being all "choked up" (Elder, WFN). Warmer temperatures and increased summer rain has allowed the grasses to grow to taller heights than they used to, both in the muskeg and on the coast (Elder, WFN). This has contributed to the feeding areas for the geese being replaced by willows (Elder, WFN). One elder commented that both Canada geese and snow geese hardly "hang around" in the feeding grounds, as the ground is dry where the willows meet the grass.

This observation is supported by a study at Shegogau, located on the western James Bay coast near Moose Factory, which showed a significant change in vegetation cover and species composition in the tidal zones (K. Abraham et al., OMNR unpublished). The study documented an overall coastward shift in the type of vegetation cover, including shrubs, and a shift in the species composition of the grasses between 1973 and 2003. It found that vegetation cover for grasses had declined in abundance in the intertidal zone (<300m from the coast line), and increased in abundance in the supratidal zone (300m to 720m from the coast line; Figure 4.16). The species composition of grasses has also shifted, with a decline in *Puccinellia phryganodes* in the intertidal zone in 2003 compared to 1975, and an increase in *Festuca rubra* in the supratidal zone (Figure 4.17). Beyond 750m there was no significant change. Although particular grass species were not described by the hunters, *P. phryganodes* and *F. rubra* are the primary grasses in this region (Riley and McKay 1980), and are also the main plants selected for by both snow geese and Canada geese (Prevett et al. 1985), so there is high confidence that the local observation of a change in these species of grasses on the coast is corroboratory to provincial records (Table 4.7).

Another variable influencing vegetation growth and composition is the number of accumulated growing degree days (AGDD) in the spring months. There has been not been a significant change in the number of AGDD in April and May for Moosonee between 1960 and 2009 (Figure 4.18 and 4.19). These findings are at the same temporal scale as the OMNR vegetation study, although are not at the coastal locations described by hunters. They are, however, specific to the southern James Bay region, and could be a factor in the shift in grass species on the coast.

There are no comparable studies documenting berries on the James Bay or Hudson Bay coasts, and therefore the finding of a decline in berries is inconclusive.

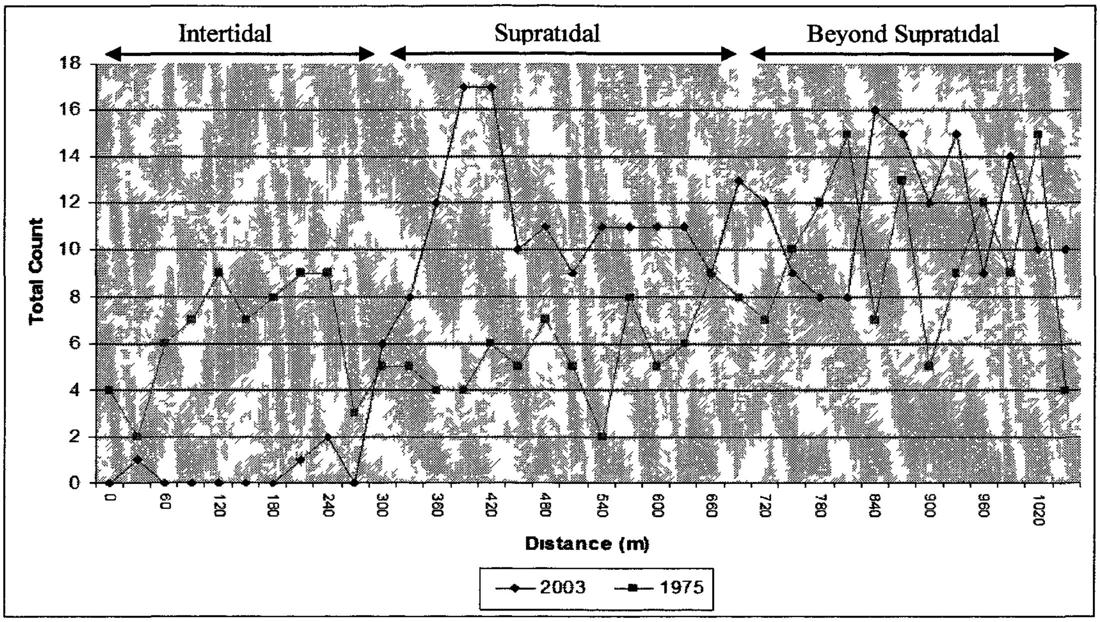


Figure 4.16. Shift in grass composition between tidal zones between 1975 and 2003 (N=36, $p < 0.05$; Abraham et al. OMNR unpublished).

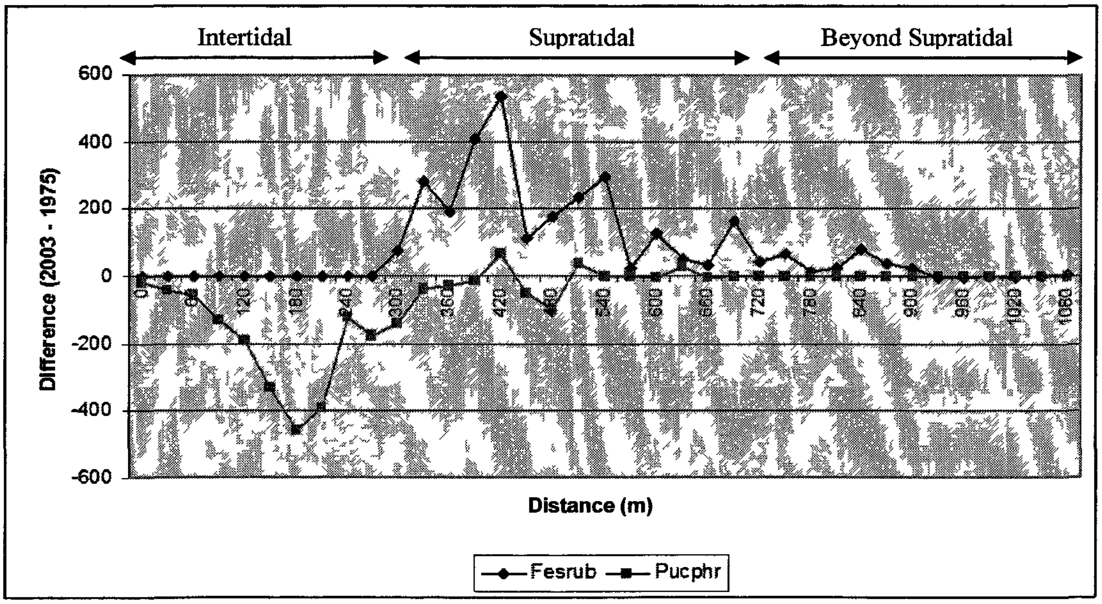


Figure 4.17. Species differences between *Festuca rubra* and *Puccinellia phryganodes* at Shegogau, on the western James Bay coast (Abraham et al. OMNR unpublished).

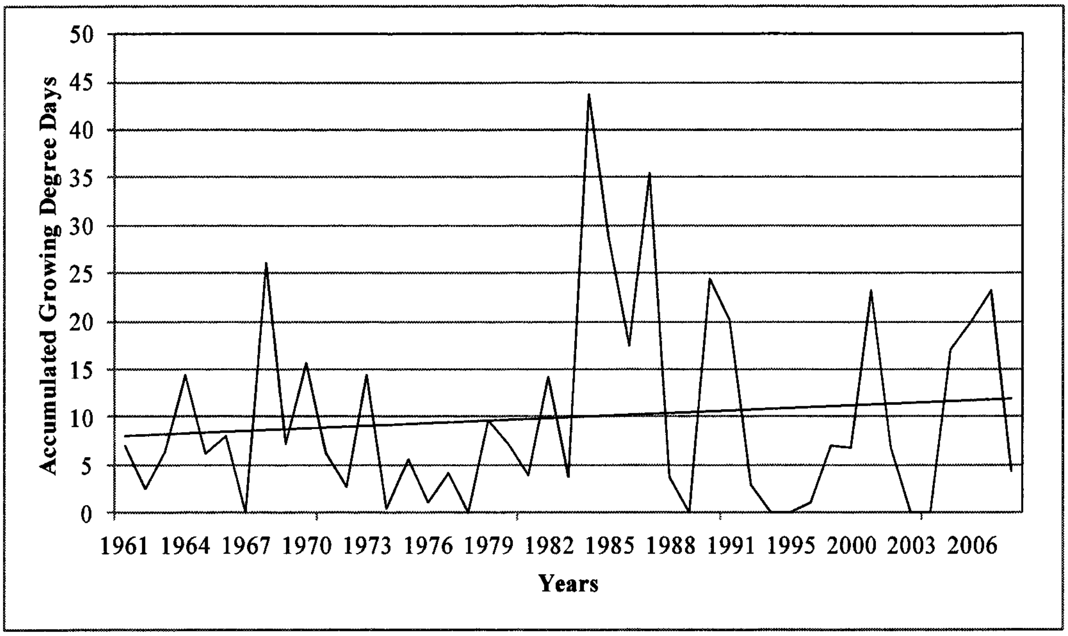


Figure 4.18. Accumulated Growing Degree Days (AGDD) in April (Moosonee weather station 6075425; Environment Canada 2009) (p=0.53, Adj. R^2= -0.01).

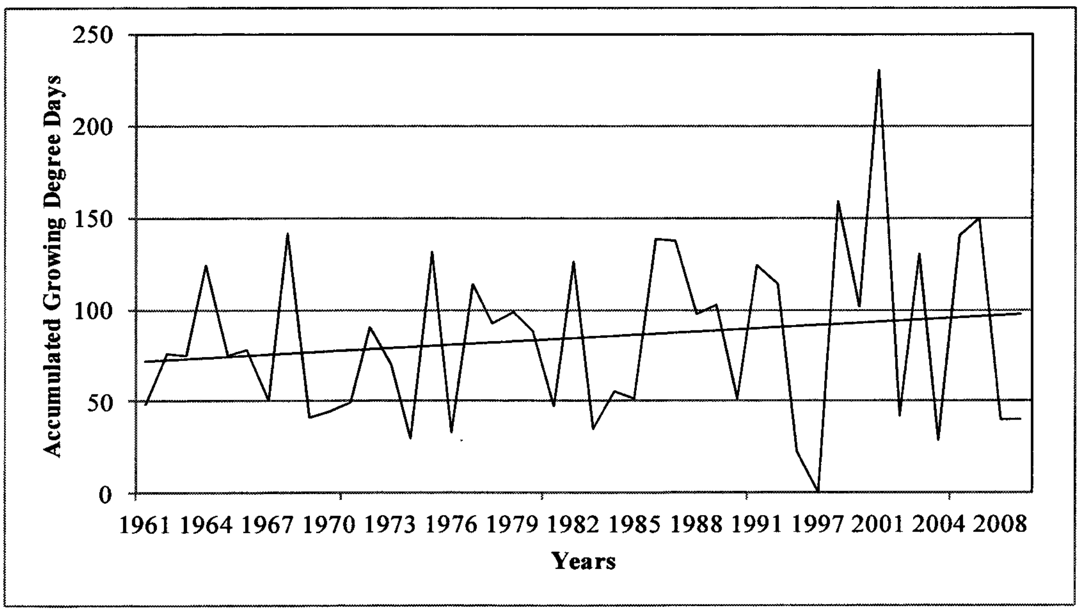


Figure 4.19. Accumulated Growing Degree Days (AGDD) in May (Moosonee weather station 6075425; Environment Canada 2009) (p=0.32, Adj. R^2=0.004).

Table 4.7. Local observations and technical data sources on changes in coastal vegetation.

Observations gathered through interviews with northern residents	**Information gathered through technical data sources**	**Scale: Temporal, Spatial, Phenomenological**	**Corroborating, Contradictory, Complementary**
Coast is drier	No change in precipitation	Different spatial Different phen.	Contradictory, low confidence
Change in the types of grasses on the coast	Shift in the composition of coastal grasses (James Bay only)	Same	Corroborating
Increase in shrubs on the coast	Increase in shrubs on the coast	Different spatial	Complementary
Fewer berries	No local data available	n/a	Inconclusive

4.2 CHANGES IN GOOSE ABUNDANCE AND DISTRIBUTION

Abundance

Most of the Canada geese that migrate through the James Bay region and are observed by the Moose Cree First Nation (MCFN) are part of the Southern James Bay Population (SJBP). Most of the Canada geese that migrate through southern Hudson Bay and are observed by the Weenusk First Nation (WFN) are part of the Mississippi Valley Population (MVP). Snow geese that migrate through both communities are part of the same mid-continent population. There are, however, local differences in terms of abundance. The results are divided by region observed: first are the Canada geese observed in southern James Bay (SJBP), followed by Canada geese observed in Hudson Bay (MVP), snow geese observed by the MCFN, and then the snow geese observed by the WFN (Table 4.8).

Canada geese in James Bay: the Southern James Bay Population (SJBP):

In southern James Bay, of the 20 hunters in the MCFN sample who reported on the abundance of Canada geese in the spring, 14 said that they see fewer geese now than they did previously. Four said the number was the same. Several hunters commented on the decline:

"Previously there were large flocks but now it's very seldom you see huge flocks. You see maybe a flock of I would say about 10 or 20. Some larger flocks" (Doug Rickard, MCFN).

"*How many geese in a flock? The most I think would probably be about 10. And sometimes there are loners. But most of them are only like 4-5. There are no big flocks anymore like there used to be. There would be like 50-60 in a flock a long time (25 years) ago"* (Shannon Trapper, MCFN).

"Yeah from the 80s to now there's a big decrease, out at Halfway Point we used to kill hundreds and see thousands and thousands out there. It used to be like an island out in the bay, just black. I haven't seen that for years" (Derek Moses, MCFN).

Only 8 of the 20 hunters commented on fall abundance of Canada geese, with 3 saying there were fewer and 3 unable to commit either way. Reasons given for hunters seeing fewer geese in James Bay include a difference in the vegetation upon which the geese feed, an increase in the number of eagles on the coast scaring the geese, and a shift in the flying route of the geese.

Spring population estimates on the breeding grounds indicate that SJBP Canada geese have remained stable since 1989 (Figure 4.20; US Fish and Wildlife Service 2010). There are no local spring surveys prior to 1989 for direct comparison.

Fall aerial surveys do not show a change from the mid 1970s (Figure 4.21; OMNR unpublished). However, the temporal scale of observation here differs in that hunters spoke of geese in the spring during migration, while these aerial surveys are flown in the fall. The timing of the survey is also not optimal in terms of matching the peaks in fall migration of SJBP Canada geese. The local observation of a decline in local SJBP Canada geese is contradictory based on the combination of spring and fall surveys, but with low confidence as the temporal and spatial scales are different (Table 4.8).

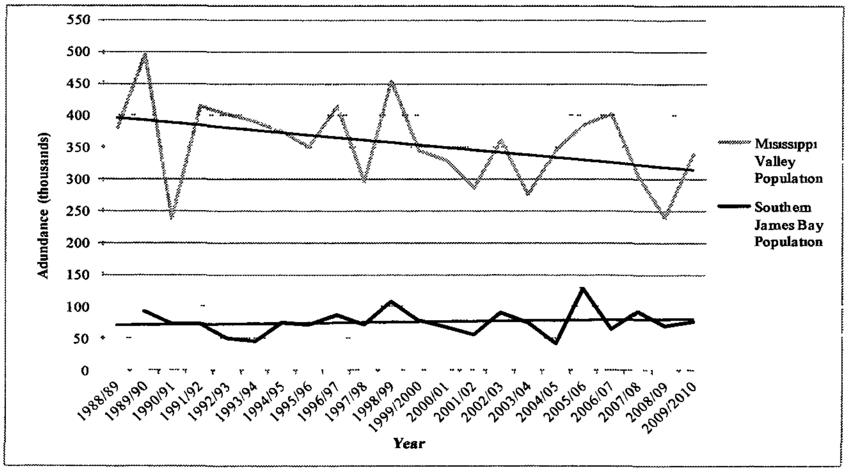


Figure 4.20. Abundance estimates of Canada goose populations from 1989 to 2010 (US Fish and Wildlife Service 2010) (MVP p=0.06, Adj. R^2=0.11; SJBP p=0.56, Adj. R^2= -0.03).

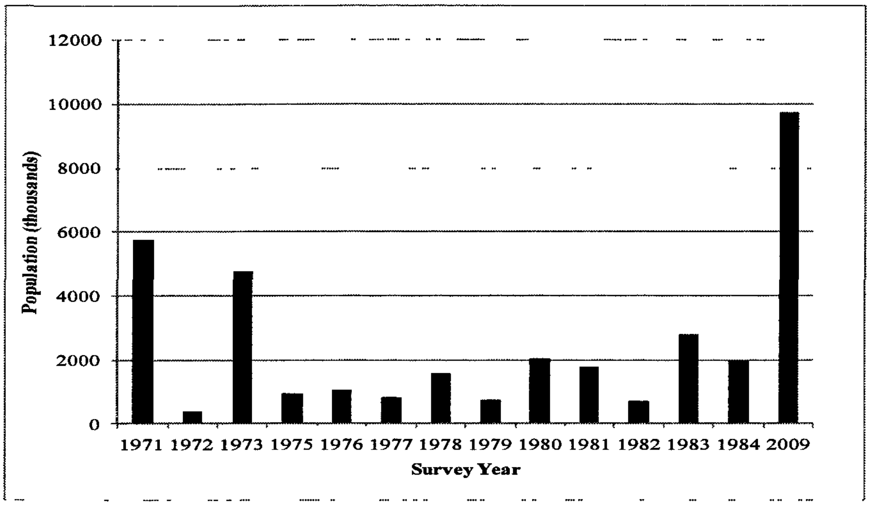


Figure 4.21. Fall aerial surveys of Canada goose abundance from coastal sections between the Albany River and the Quebec border, in southern James Bay from 1975 to 1984, and 2009 (OMNR unpublished data).

Canada geese of Southern Hudson Bay: the Mississippi Valley Population (MVP):

For Canada geese observed in southern Hudson Bay, of the 12 hunters in the WFN sample who reported on abundance, 5 said there are more in the spring in the last 20 years than in previous springs, 4 said the number was the same, and 3 said there are fewer. They were speaking of the last 40 years (since the 1970s), a longer time period than hunters in the MCFN. Six of the 10 WFN hunters who spoke of Canada geese in the fall could not comment, as they spend less time hunting now than before and were not confident in their observations. Three reported seeing more Canada geese in the fall now compared to previous years. One elder commented on the timing of the increase:

"Didn't see many geese in the 1940s 1950s, started growing after. The Canada goose population exploded in the 1960s to 1970s" (Elder, WFN).

Breeding ground surveys indicate that the MVP has been declining since 1989 (Figure 4.20; US Fish and Wildlife Service 2010). Mid-winter survey estimates indicate that MVP geese have increased since the 1950s (Abraham and Jefferies 1997), with local fall aerial surveys indicating that they have been increasing since the 1970s (Figure 4.22). Although mid-winter, spring breeding ground and fall aerial surveys cannot be directly compared due to their temporal and spatial differences, they do describe a trend in population. Overall MVP Canada geese have increased in population and because of the longer time period described by the hunters (since the 1970s) the observations are complementary, however with low confidence due to differences in temporal and spatial scale (Table 4.8).

Snow geese in James Bay:

In the MCFN, 8 of the 11 people who responded for the spring reported observing fewer snow geese than in the past. Seventeen people observed snow geese in the fall, and 14 commented on seeing fewer. One elder notes:

"*When we used to go up the north side when we were children there were so many geese and when we'd get there they would fly up and they would look like smoke, there were so many. Canada geese and wavies they would look like smoke there were so many. Like clouds. Never see that now*" (Agnes Corston, elder, MCFN).

"*Years ago there used to be thousands [of wavies]. If you pulled in they would disperse... but now you just see small flocks*" (Doug Rickard, MCFN).

Fall aerial surveys in James Bay were done by OMNR around the third week in September and were flown with the intention of capturing a consistent snapshot of the fall migration for snow geese (Prevett et al. 1982). The aerial surveys reported here extend from the Albany River to the Quebec border and show a population decline from over 60 000 snow geese in the 1970s, to just over 20 000 in the mid 1980s, to less than 8000 in the 2009 survey (Figure 4.23). These surveys indicate a decline in the snow goose population in the region, revealing a local deviation in trend not seen in the long term winter index used by the US FWS (2011), which is indicative of changes occurring on a continental scale (Figure 4.24). However, these fall survey data and the local observations reported here corroborate one another, with high confidence at the same phenomenological, temporal and spatial scales (Table 4.8).

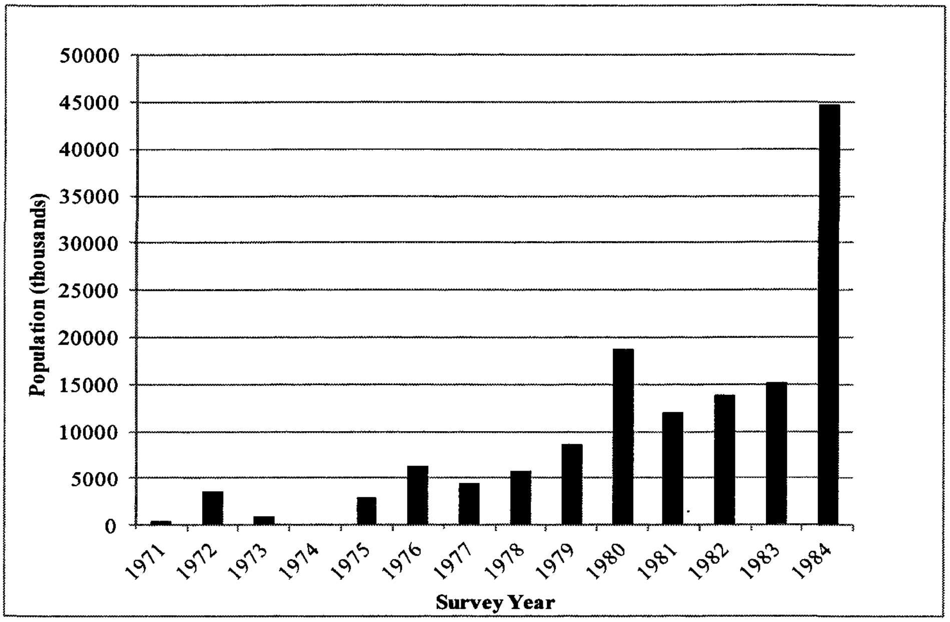


Figure 4.22. Fall aerial surveys of Canada goose abundance from coastal sections between the Severn River and Cape Henrietta Maria, in southern Hudson Bay from 1975 to 1984 (OMNR unpublished data).

Snow geese in Hudson Bay:

In the WFN, 5 of the 11 hunters who responded for snow geese in the spring reported seeing more geese now than they did 40 years ago. Three said that the number was the same, and three could not comment.

Local fall aerial surveys were only conducted between 1975 and 1984 between the Severn River and Cape Henrietta Maria, and also show a slight increase (Figure 4.25; OMNR unpublished). Other surveys indicate that snow geese in the southern Hudson Bay region have been increasing since the 1950s (Abraham and Jefferies 1997) and from the 1970s to the present (Kerbes et al. 2006). On a larger scale, mid-continent snow geese have been increasing since the 1970s (Figure 4.24; US Fish and Wildlife Service 2011). The local technical data is of a limited time frame and therefore has lower confidence, but does suggest that local observations and aerial surveys describing an increase may complement one another (Table 4.8).

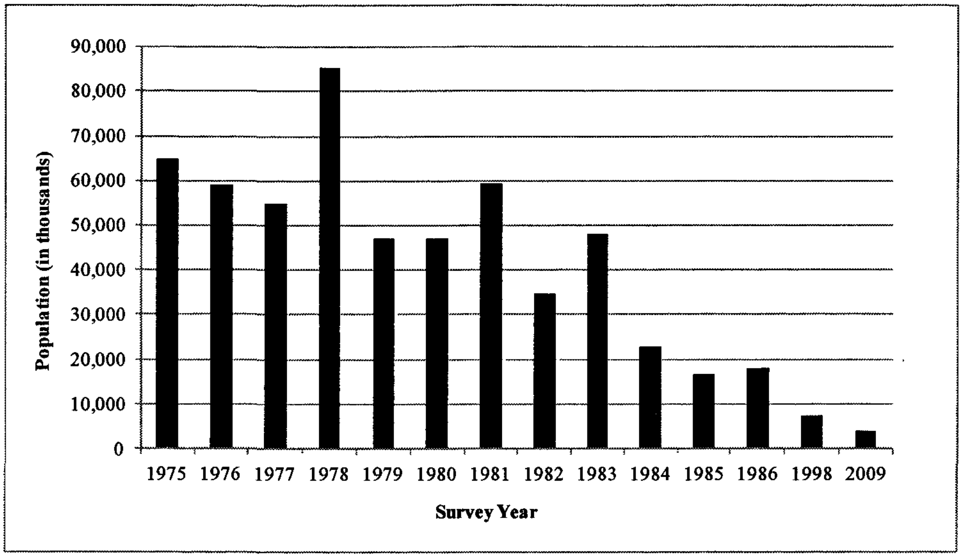


Figure 4.23. Fall aerial surveys of snow goose abundance from coastal segments between the Albany River and the Quebec border, in southern James Bay from 1975-1986, 1998, and 2009 (OMNR unpublished data).

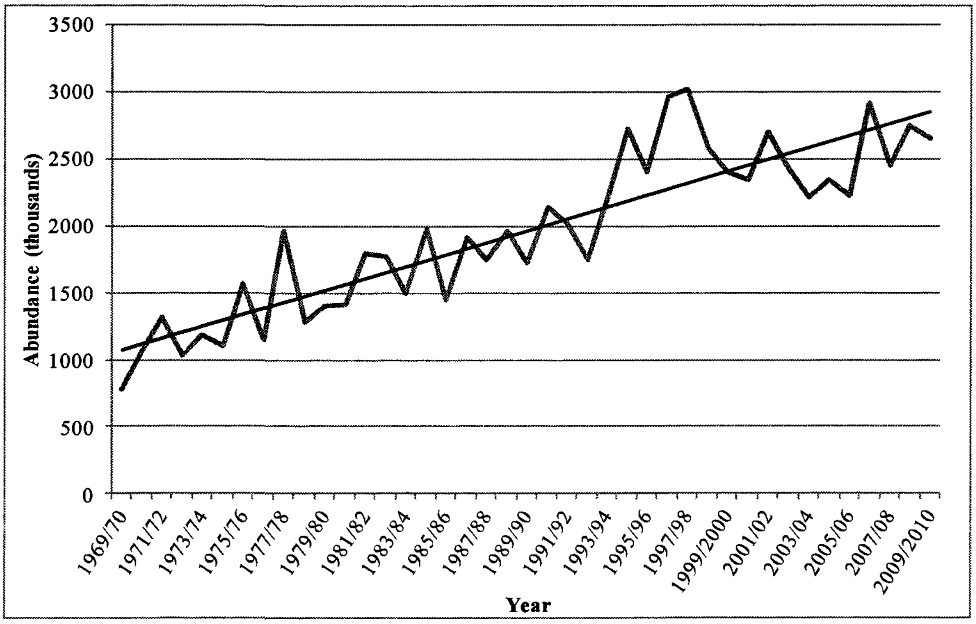


Figure 4.24. Abundance estimates (winter index) of the Hudson Bay Population of snow geese from 1969 to 2010 (US Fish and Wildlife Service 2010) ($p= >0.001$, Adj. $R^2 = 0.78$).

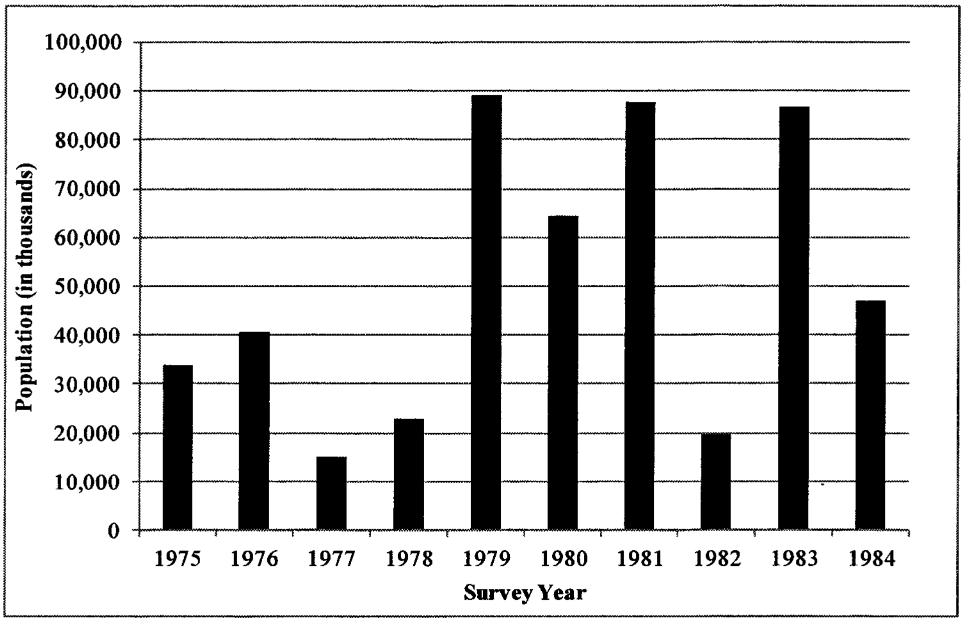


Figure 4.25. Fall aerial surveys of snow goose abundance from coastal segments between Severn River and Cape Henrietta Maria, in Southern Hudson Bay from 1975 to1984 (OMNR unpublished data).

Table 4.8. Local observations and technical data sources on goose abundance.

Observations gathered through interviews with northern residents	**Information gathered through technical data sources**	**Scale: Temporal, Spatial, Phenomenological**	**Corroborating, Contradictory, Complementary**
CAGO decreasing (1980 to 2009)	CAGO (SJBP*) have been stable (1989 to 2010)	Different temporal Different spatial	Contradictory- low confidence
CAGO increasing (1970 to 2009)	CAGO (MVP**) increasing (1970 to 2009)	Different temporal Different spatial	Complementary- low confidence
SNGO-James Bay decreasing (1980 to 2009)	SNGO decreasing (1975 to 1985, 2009)	Same	Corroborating
SNGO-Hudson Bay- increasing (1970 to 2009)	SNGO increasing (1975 to 1984)	Same- but limited temporal period	Complementary

CAGO: Canada geese
SNGO: Snow geese
*Referring to the Southern James Bay Population (SJBP)
**Referring to the Mississippi Valley Population (MVP)

Condition of the geese

There were limited responses to the question about taste and appearance of the geese. There was some confusion over the wording of the question, and no conclusive results were obtained about the condition of the geese. There was indication from the few responses, however, that there was a link between what the geese ate and what they tasted like. It has been documented that the geese taste better in the spring, due to the corn and other southern crops the geese feed on in the winter, than they do in the fall after they have been grazing on grasses all summer (Prevett et al. 1983). However, there were a few comments comparing fall geese between years, as one of the elders from the MCFN described:

"*I heard a lot of people say now that they taste different. Not like they did way back in the 50s and 60s. So around the 80s I think they were starting to taste different on account of the stuff they eat. I guess the weeds, the salt around where they usually eat I guess they don't get the stuff that used to grow around the tide mark*" (Robert Vincent, elder, MCFN).

It is this local observation that the fall geese taste different now than they did in previous fall seasons, based on changes in their summer diet, which is of interest for future investigation.

4.3.2 Distribution

The timing of migration into the Lowland is documented by communication with people along the coast in the spring and fall months. Notes are made in productivity surveys, based on local observations, and are at the same scales. The pattern of migration has been documented through band recoveries (Abraham and Warr 2003, Brook and Luukkonen 2010), although at a regional and therefore different spatial scale.

Timing

The results for the timing of migration are divided into the SJBP and the MVP of Canada geese, followed by snow geese (Table 4.9). Generally, Canada geese arrive earlier than snow geese in the spring and leave later in the fall (Cooch 1955).

Canada geese in James Bay: Southern James Bay Population (SJBP):

For the SJBP of Canada geese, all 20 participants responded in the MCFN. Six said that the timing of the migration has remained the same in the spring; 6 said it was later; 6 said it varied with the weather; and 2 said it was earlier (Figure 4.26). These varied observations do not indicate a clear pattern of change.

"Sometimes they come early, sometimes they come late... It all depends on the weather, really. If it's going to be an early spring they would come early, if it's a late spring they don't come that early" (Agnes Corston, elder, MCFN).

Eight of the hunters observed Canada geese in the fall, with 5 of those observing no change in the timing of the geese leaving.

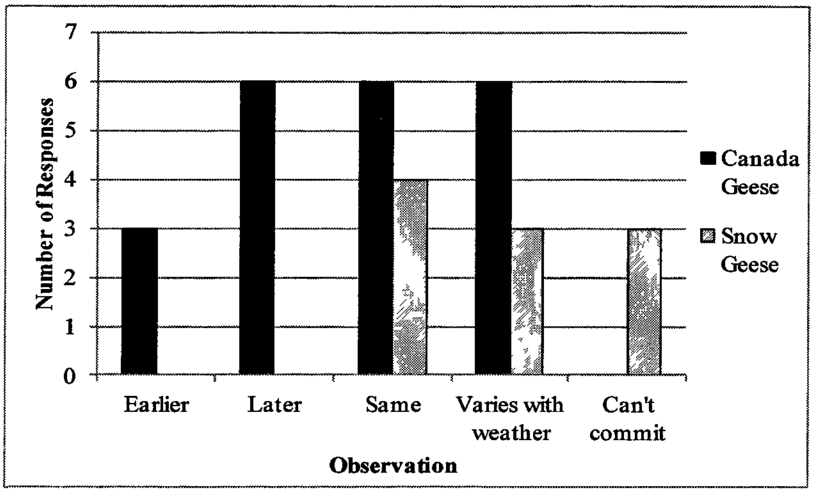


Figure 4.26. Local observations on the timing of spring migration for SJBP Canada geese and snow geese in the Moose Cree First Nation (n=20 for Canada geese, n= 10 for snow geese).

Canada geese in Hudson Bay: the Mississippi Valley Population (MVP):

For the MVP of Canada geese, of the 12 who responded in the WFN, 6 observed the timing of the spring migration as at the same time every year. Four could not commit to a trend of the geese arriving earlier or later, saying that the timing was variable with the weather and was different every year. There were similarly low responses for fall observations.

Information on the timing of migration is collected by scientists through correspondence with northern residents along the coast. Field notes are made, and there are references in the productivity reports done during nest surveys, but the timing of the arrival is still based on local observations. Where it has been published, Canada geese of both populations have not significantly changed the timing of their arrival in the Lowland, or their departure in the fall. Canada geese arrive in mid April to early May, and leave in mid-October, with some inter-annual variation (Tacha et al. 1991, McDonald et al. 1997). In the Peawanuck area, Tacha et al. (1991) reported the peak arrival of the geese in the years 1984 to 1986 as between April 17 and 22nd. Abraham et al. (1999) reported similar timing from 1985 to 1989 (between April 15th and April 25th), as well as an additional migration period and later arrival for molt migrants from late May to mid-June. This second migration had peaks between May 25th and June 5th (Abraham et al. 1999).

The fall migration of Canada geese between 1984 and 1986 was in one or two waves, the first from the end of September to early October, followed by a second in the latter half of October (Tacha et al. 1991). This observation is of a very limited time frame, and without comparable local observations any finding for the timing of the fall migration for Canada geese is inconclusive (Table 4.9).

Snow geese in James Bay:

For snow geese in James Bay, of the 10 people who responded on the spring migration, 4 said the timing was the same, 3 said it varies every year, and the remaining 3 said they could not commit because they are no longer on the coast to notice at that time. In response to the question about the fall migration, 5 of the 11 who answered said they could not commit to knowing when the geese leave, 3 said it was the same and 3 said it was later.

There are not enough local observations for spring or fall from this study for the Moose Factory area, and therefore this finding on a shift in timing of migration for snow geese is inconclusive (Table 4.9).

Snow geese in Hudson Bay:

For snow geese in southern Hudson Bay, 11 of the 12 people in the WFN reported that the timing of the spring migration has remained the same. Generally this is around the first week in May. A main determining factor was the weather, and the direction of the wind. This observation is supported by McDonald et al. (1997), where geese were observed arriving into the Peawanuck area from the Fort Severn area in pairs approximately the 12th of May.

Of the ten people who commented on when the snow geese leave in the fall, 9 said that it was earlier. Several hunters commented on how the geese no longer linger in large numbers at the mouth of the Winisk River before flying northwest towards Fort Severn. Several elders also commented on how migration used to occur around October 20th, and now it starts in mid-August, as soon as the geese can fly. These local observations are supported by other studies of snow geese leaving the Hudson Bay coast earlier in the fall (Table 4.9).

Table 4.9. Local observations and technical data sources on the timing of goose migration.

Observations gathered through interviews with northern residents	**Information gathered through technical data sources**	**Scale: Temporal, Spatial, Phenomeno-logical**	**Corroborating, Contradictory, Complementary**
CAGO arriving in spring at the same time, or varied	CAGO (SJBP*) arriving in spring at the same time	Same	Inconclusive
CAGO arriving in spring at varied times-no change	CAGO (MVP**) arriving in spring at varied times-no change	Same	Corroborating
CAGO leaving in the fall at the same time	CAGO (MVP) leaving in the fall at the same time	Same	Corroborating
SNGO in James Bay-inconclusive	SNGO arriving in spring at the same time	n/c	Inconclusive
SNGO arriving in Hudson Bay in the spring at the same time	SNGO arriving in Hudson Bay in the spring at the same time	Same	Corroborating
SNGO leaving Hudson Bay earlier in the fall	SNGO leaving Hudson Bay earlier in the fall	Same	Corroborating

*presumably the Southern James Bay Population
**presumably the Mississippi Valley Population

Pattern

Many people commented on a shift in the migration pattern of the geese, for SJBP Canada geese as well as for snow geese.

Canada geese in James Bay: the Southern James Bay Population (SJBP):
Local observations in the MCFN indicate that there has been a change in the route of the spring migration for Canada geese. Of the 14 people who commented on the pattern of migration, 11 observed a change in the route. Three types of changes in migration pattern were observed: geese flying further inland, geese coming from the west rather than the south, and changes related to the flying behaviour of the geese.

The shift from the geese following the coast to flying more inland was observed by several hunters:

"They're starting to fly more inland...I noticed that about 5 to 6 years ago, they started to fly over inland. Before they used to follow the James Bay coast" (youth, MCFN).

"They're flying more on the west side of my camp than they are on the east side. That's what I noticed. It's actually a change I noticed over the last probably 15 years, you know, to compare" (Chief Norm Hardisty, Jr., MCFN).

Seven of the 11 observing changes in migration pattern had additional observations, mostly related to the power lines, inland and between Moosonee and Attawapiskat. For example:

"I got invited hunting over here once, one year before they put the power line in. They asked me to come out again about 5 years after the power line went in, they noticed [the geese] follow the power line now. They didn't even come out to the coast like they used to do. Odd flocks would come out but not like they used to when I first went out...Following that opening, the power line" (Abel Cheechoo, elder, MCFN).

"*Yeah I used to see geese fly in the bush and ever since there were the hydro lines I don't see many. They must have a different flyway now, I don't know. All just following the hydro lines*" (Elder, MCFN).

Three people attributed the shift in migration pattern to environmental factors, such as a decreased availability of grass due to a drier coast and the increased presence of eagles in the region. Some comments include:

"Because it's all dried up over here, where they used to feed. It's all dry now" (Agnes Cortson, elder, MCFN).

"We're getting these eagles, bald eagles. And this is where they hang around too. Wherever there's geese, that's where they hang around. They go after the geese. They scare the geese away, you know" (Robert Vincent, elder, MCFN).

Another type of observation was related to the flying pattern of the geese. Several hunters commented on how the geese now arrive in smaller, more scattered flocks.

"And it's not from big flocks anymore like it used to be. They only come in maybe 10 or 20 flying in towards the blinds and they wouldn't all come at once. They're scattered" (Shannon Trapper, MCFN).

The MVP of Canada geese have not been observed by hunters as having changed their pattern of migration. Of the 7 people who observed changes to the pattern of the spring Canada goose migration, only 2 said that the geese had changed their flying route in some way.

Regionally, the band recovery distribution of Canada geese has not shifted for SJBP (Abraham and Warr 2003) or for MVP (Brook and Luukkonen 2010). These findings are contradictory for SJBP, however, are at a different spatial scale and there could be local deviations not seen in the regional maps. The observations for MVP are potentially complementary but with low confidence based on differences in spatial scale (Table 4.10).

Snow geese in James Bay:

For snow geese, people in the MCFN reported that the geese are migrating inland as well, but the more prominent observation was that they are coming from Manitoba in the west and across in the spring, as opposed to coming more directly from the south.

"They're all going over here, not even on the map (way west), Manitoba, that's where they go. There are lots over there. We went to northern Winnipeg a couple of years ago and a man said there, you should see the geese here in the spring he says, they're just running around all over. You should come over here he says and harvest some. They don't hunt them. They don't hunt geese over there" (Agnes Corston, elder, MCFN).

"I've seen the shift from our area, from our fly route, whatever they call it. The shift from our area over to Manitoba. If you look at the last number of years the number of snow geese that Manitoba is experiencing I think that's the shift. More and more have taken the other fly route, migration route" (Doug Rickard, MCFN).

There are no federal or provincial records documenting the mid-continent snow goose population having shifted their distribution inland, or to Manitoba. The specific local observation of snow geese having shifted their flying route to coming from Manitoba cannot be corroborated with these records at the same phenomenological or spatial scale, and is therefore contradictory, but with low confidence (Table 4.10).

Snow geese in Hudson Bay:

In the WFN, 9 of the 12 hunters noticed changes to the pattern of spring migration of snow geese. Five specifically observed changes to the flying route, and 3 had other observations. The flying route was not observed as being inland, but rather a shift in direction along the coast. Several hunters commented on how the snow geese used to arrive from the west, fly east past the mouth of the Winisk River, and then return two weeks later. The observation now is that the geese still come from the west, and fly east, but do not return until the fall migration. Hunters reported that the geese used to "hang around" in September at the mouth of the Winisk River until flying south near the end of October, and now fly straight west in the fall, as soon as they can fly, usually around the middle of August.

There is no evidence of this shift through band recoveries or any technical study (Francis and Cooke 1992), and therefore these local observations of snow geese leaving Hudson Bay is contradictory, but with low confidence based on differences in spatial and phenomenological scale (Table 4.10).

Table 4.10. Local observations and technical data sources on the pattern of goose migration.

Observations gathered through interviews with northern residents	Information gathered through technical data sources	Scale: Temporal, Spatial, Phenomenological	Corroborating, Contradictory, Complementary
CAGO shifting inland	No shift in band recoveries of CAGO (SJBP*)	Different spatial Different phen.	Contradictory- low confidence
CAGO not shifted	No shift in band recoveries of CAGO (MVP**)	Different spatial Different phen.	Complementary- low confidence
SNGO- James Bay- shifting west and inland	No shift in band recoveries	Different spatial Different phen.	Complementary- low confidence
SNGO-Hudson Bay-directional change (west)	No shift in band recoveries	Different spatial Different phen.	Contradictory- low confidence

*presumably the Southern James Bay Population
**presumably the Mississippi Valley Population

Wildlife

The last changing environmental factor described by hunters was a change in the wildlife on the coast. Wildlife was discussed by 13 of the 18 hunters in the MCFN, and by 8 of the 10 hunters in the WFN (4.11).

The local observations from individuals in both communities are that there are more bald eagles on the coast, and that there are fewer ducks (mallards and pintails). Five of the 13 hunters in the MCFN commenting on wildlife observed more eagles, and 7 observed fewer ducks. The change has been observed in the last 10 to 15 years. Some examples of hunter observations include:

"[The eagles] *they nest around that area* [his hunting grounds] *and they tend to be more and more every year. Anyplace you go now there's an eagle around and you go up these creeks here anyplace around this area here to Hannah Bay area there's eagles there too*" (Robert Vincent, elder, MCFN).

"I've noticed the decline of ducks also is quite high. There would be times that we'd go out and you would get 60 ducks in one day and today you're lucky to get 10 or 15 ducks to bring back" (Rick Rickard, MCFN).

There is also the role of eagles influencing the behaviour of the geese. Several hunters commented on the relevance of an increase in eagles in the region, and how they scare the geese from areas where they used to feed. Some examples include:

"[The geese] *could be gone because of the eagles that are flying around. Long time ago it was very rare that you'd see an eagle, maybe 10 years ago, but now you see them every day if you go out there*" (Billy Isaac, elder, MCFN).

"There seem to be more eagles too, bald eagles. Last 10 to 15 years on that. Yeah, they're scaring them off, scaring the snow geese off. Cause they're not really flying over here anymore... They bunch together, those geese. They used to fly around before, now they bunch together, because of the eagles" (Elder, MCFN).

In the WFN, 2 of the 8 hunters who commented on wildlife observed more bald eagles, and 4 commented on a decline in pintail and mallard ducks. One experienced hunter noted how 30 years ago there were very few bald eagles, and now there are many. They scare the Canada geese, and force them to "bunch up" on the coast. The decline in ducks was first noticed "a few" years ago. Other wildlife observations included a decline in frogs (45 years ago there were many), and fewer robins and jays, both in Peawanuck and on the coast. The general observation is that the coast is much "quieter" now.

The observation of an increase in the number of bald eagles in both the James Bay and Hudson Bay Lowland regions is corroborated by a Canadian Wildlife Service species status report comparing observations from 1980 to 1985 to observations from 2000 to 2005 (Ontario Partners in Flight 2010). The observation of fewer ducks, either mallards or pintails, cannot be corroborated with technical data. Aerial duck surveys conducted throughout Ontario between 1955 and 2009 indicate that pintails and mallards have remained stable or increased in regions of northern Ontario (Zimpfer et al. 2009). However, the data for the coastal segments of James and Hudson Bay (strata #51, 57, and 59) were not included in the report. Also, even if these segments were included, they are still regional and are not specific to the coastline as reported by the local hunters. Therefore, the finding of fewer ducks is contradictory to technical reports, but with low confidence based on differences in spatial scale (Table 4.11).

Table 4.11. Local observations and technical data sources on changes in species composition of wildlife.

Observations gathered through interviews with northern residents	**Information gathered through technical data sources**	**Scale: Temporal, Spatial, Phenomenological**	**Corroborating, Contradictory, Complementary**
More eagles	Increase in eagles	Same	Corroborating
Fewer ducks	Ducks are stable	Different spatial	Contradictory

Summary

The first objective of my study was to identify changes in climate and habitat in the Hudson Bay Lowland, and if there have been consequent changes in Canada goose and lesser snow goose abundance and distribution. I found links between local observations and technical data sources for changes in temperature, precipitation, vegetation, goose abundance and pattern of migration, and species composition of wildlife on the coast. Collectively, these changes have been more pronounced in the last 15 to 20 years. Many of these changes are corroborating or complementary between the local observations and technical data. However, there are also divergences between these data sets, and these are examined in the Discussion. The following chapter describes results on what the impact a changing climate, goose habitat, and abundance and distribution of geese might be on access to and hunting of geese by First Nations in the Hudson Bay Lowland.

5.0 CHANGES IN ACCESS TO AND HARVEST OF GEESE BY FIRST NATIONS

The previous chapter looked at the impact of climate change on geese, in terms of habitat, abundance, and distribution. These impacts, in turn, may have an impact on access to and harvest of geese by First Nations. This chapter focuses on that secondary impact, first in terms of access via timing and duration of the hunt, and secondly on harvest via the number of geese killed. The responses and adaptations to such impacts are examined in the Discussion.

5.1 DESCRIPTION OF HUNTING LOCATIONS

Hunters and their families have traditionally gone to family hunting camps, in the same locations, for many years. The number of people going to the camps has remained high, although fewer youth are joining their families on the land (A. Cheechoo, pers. comm.). School plays a deterring role, although both communities have a "goose hunting break" in April to allow students a week off school to join their families at the camps. In Moose Factory, it falls in the second week in April, and in Peawanuck it varies with the year but falls within the end of April or beginning of May. Employment is also a significant limiting factor, in Moose Factory more so than Peawanuck, although most people are still able to take some time off for the hunt.

Canada geese are hunted both inland and on the coast, and snow geese strictly on the coast. There were differences in the total number of people who hunt a given species in a given season, changing the overall sample size for each question (Table 5.1). In the spring, everyone interviewed in the MCFN reported hunting Canada geese both now and in the past. However, fewer people hunt snow geese now than they did in the past. In the WFN, everyone reported hunting both Canada geese and snow geese now and in the past. Only 2 people of those interviewed in the MCFN reported that they used to hunt Canada geese in the fall, whereas most used to hunt snow geese. In the WFN, the number of people who hunt either Canada geese or snow geese in the fall has also declined.

Table 5.1. Number of responses for each hunting question asked, in the present study.

Hunting	Moose Cree First Nation				Weenusk First Nation			
	Spring		Fall		Spring		Fall	
	Canada Geese	Snow Geese	Canada Geese	Snow Geese	Canada Geese	Snow Geese	Canada Geese	Snow Geese
Participate in hunt-past	20	8	2	16	11	11	6	8
Participate in hunt-present	21	3	0	6	13	13	2	4
Location-Past	20	8	2	16	11	13	6	8
Location-present	21	2	0	6	13	13	2	4
Duration	21		15		13		11	
Timing*	19		2		8		0	
Harvest	21	14	2	2	10	10	2	2

*Timing was not a direct question asked in the interviews

Interviewees were chosen based on the geographic distribution of their hunting camps to get a sample of inland and coastal locations throughout the community's homeland. However, the locations were mostly concentrated along the coasts and in major river systems, similar to those found in the studies done by Thompson and Hutchison (1987) and Berkes et al. (1995). Not all hunters hunt in both seasons, and the spring and fall camps of a family were not necessarily at the same location. There were also a number of situations where there were different hunting grounds in the spring depending on which species was being hunted. However, the results presented here include the total sample sizes for each separate question across all camps, so the differences between camps (and families) should be negligible.

The present study included 15 coastal and 9 inland spring camps in the MCFN. These were divided further into segments, for easier comparison between space and time with previous studies. The segments include four coastal and two inland hunting areas: the west James Bay coast (the coastal area from the Moose River up to Halfway Point); the Moose River mouth (from Shipsands Island to Long Point); the south James Bay coast (the coast from Long Point to Nettishi Creek); Hannah Bay (from Nettishi Creek to the Missicabi River); inland southeast of the Moose River; and inland northwest of the Moose River (Figure 5.1).

The areas where these individuals chose to hunt have shifted slightly. For Canada geese in the spring, there are fewer locations on the west James Bay coast now than in the past, and more on the southern James Bay coast. Three people also reported hunting at the mouth of the Moose River, which none of the respondents had reported doing previously (Figure 5.2). For snow geese, some people used to hunt in areas on the west James Bay coast as well as Hannah Bay. Now, only 2 hunters reported that they still hunt snow geese in the spring, and both have camps in Hannah Bay (Figures 5.3, 5.4).

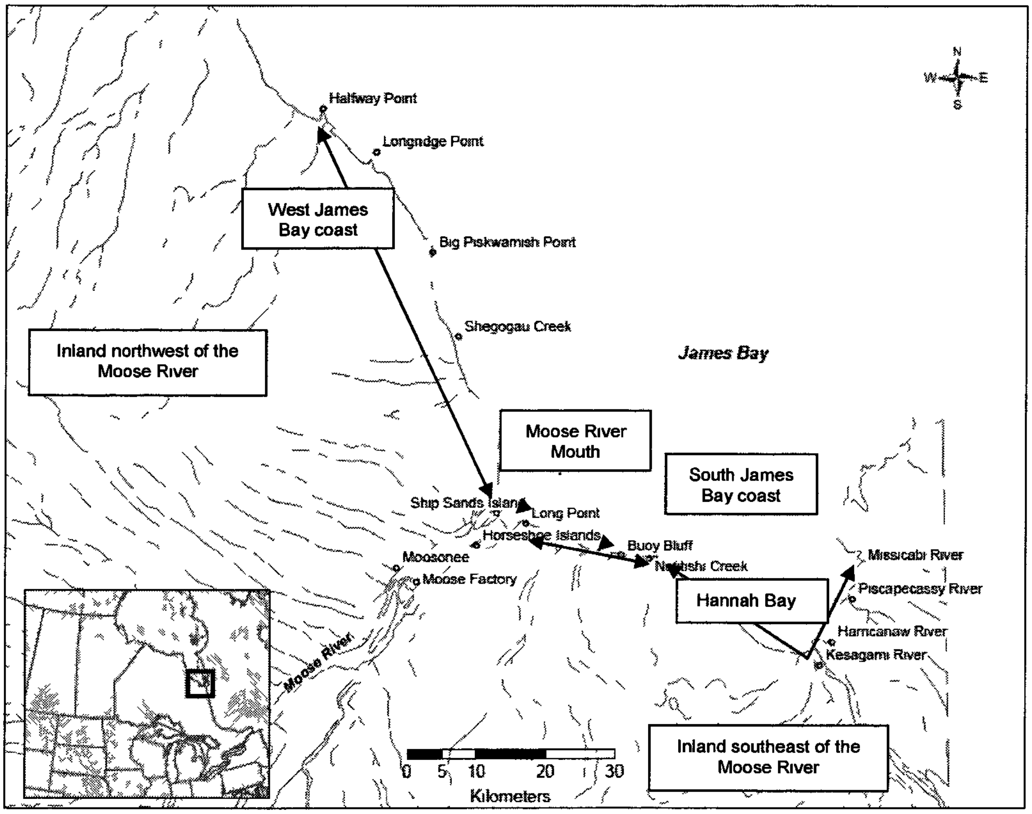


Figure 5.1 Inland and coastal segments of southern James Bay.

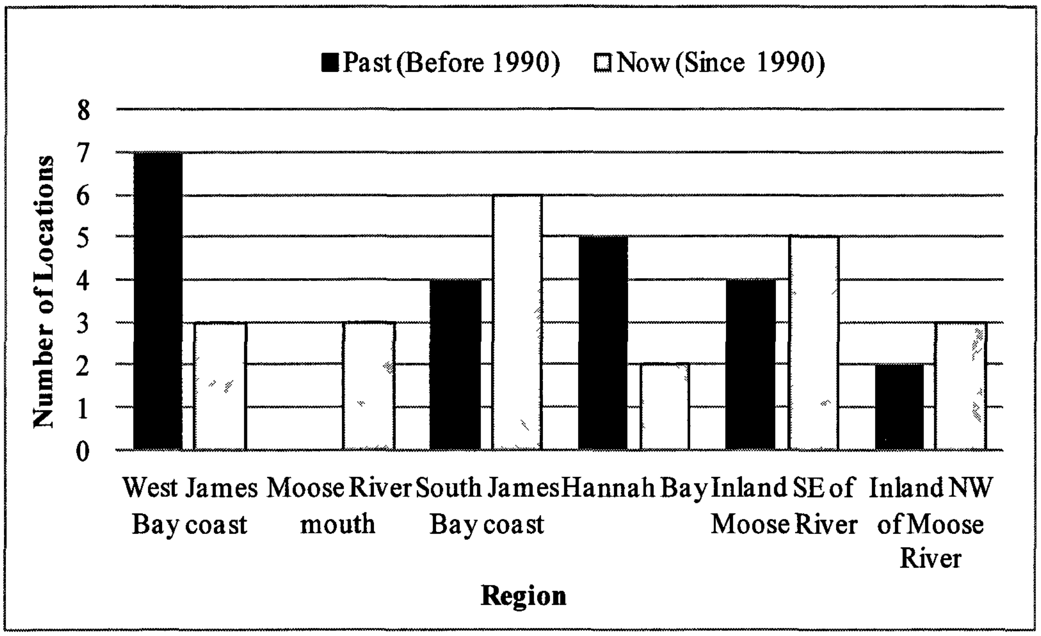


Figure 5.2. Number of hunters in the Moose Cree First Nation using specific hunting locations for Canada geese in the spring. n=21(prior to 1990), 22(from 1990 to 2009).

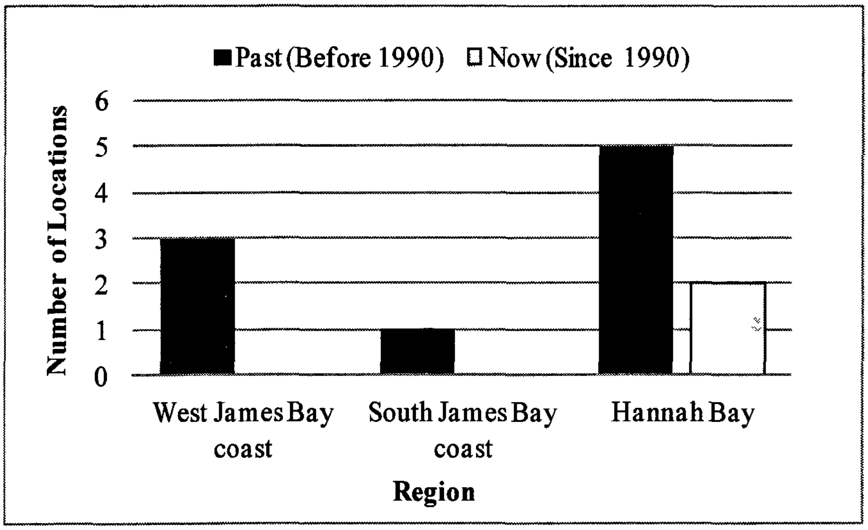


Figure 5.3. Number of hunters in the Moose Cree First Nation using specific hunting locations for snow geese in the spring. n=9(prior to 1990), 2(from 1990 to 2009).

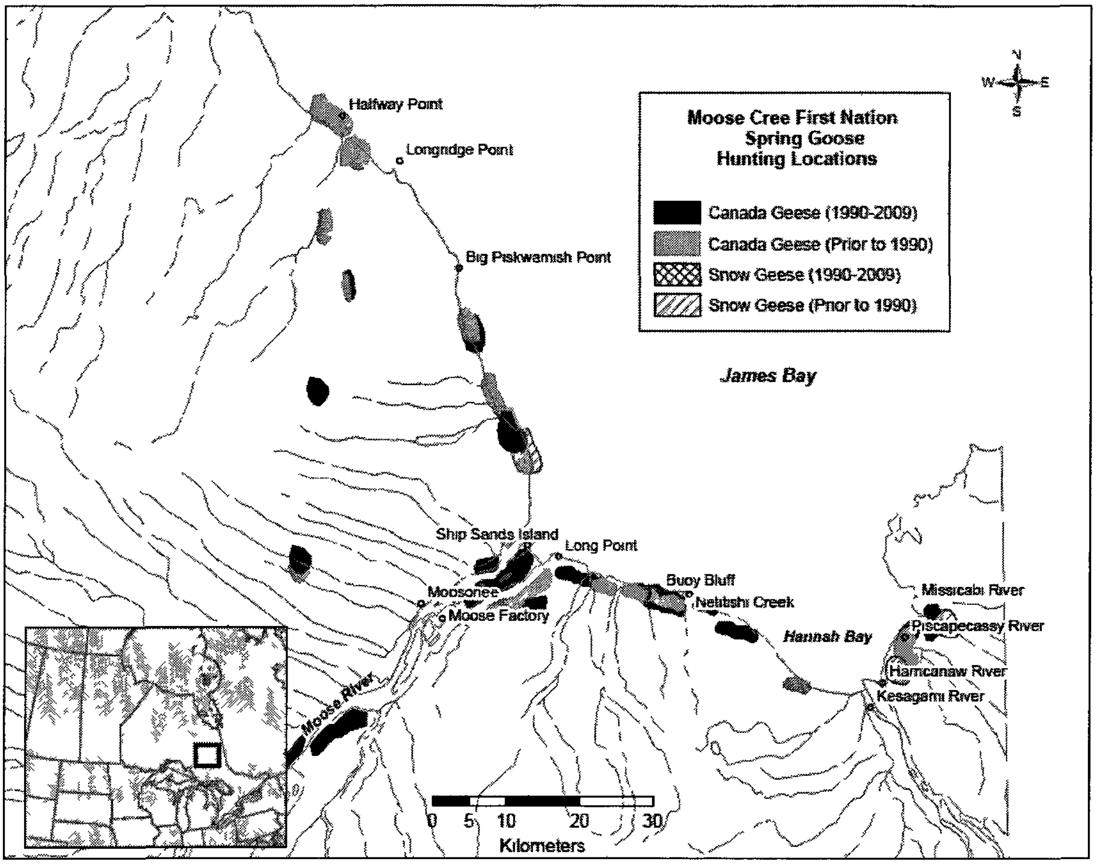


Figure 5.4. Spring hunting locations of the Moose Cree First Nation, prior to 1990 and from 1990 to 2009, for Canada geese and snow geese.

In the WFN, there were 13 coastal and 8 inland spring goose camp locations reported, among three coastal and two inland segments: the Hudson Bay coast west of the Winisk River (from Wabuk Point to Goose Creek); the Winisk River mouth (from Wabuk Point to Oman Point); the Hudson Bay coast east of the Winisk River (from Oman Point to Little Cape); inland on the Winisk River (south of Mishamattawa River and including Peawanuck); and inland, southeast of the Winisk River (Figure 5.5).

In general, the regions where people choose to hunt have not changed significantly over time (Figure 5.6). Ten of the 11 respondents reported hunting in more than one location. For Canada geese, the main difference is that more people hunt at the river mouth and inland or around Peawanuck now than they did in the past. The results are the same for snow geese (Figure 5.7).

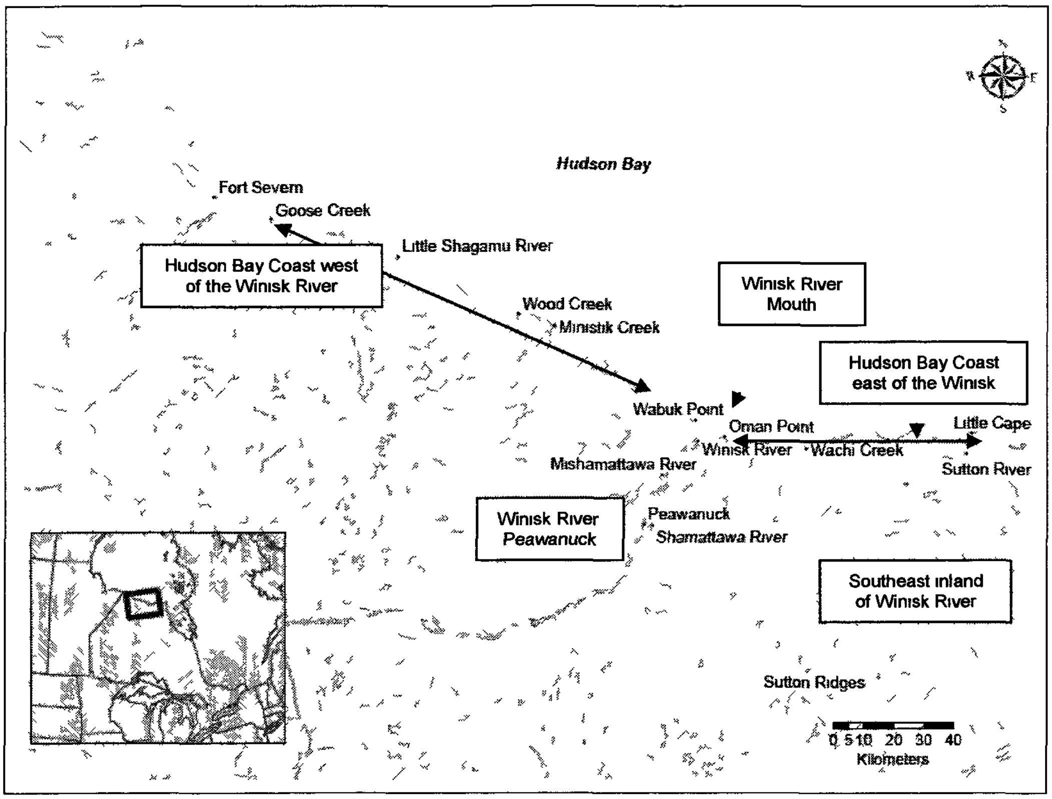


Figure 5.5. Inland and coastal segments of southern Hudson Bay.

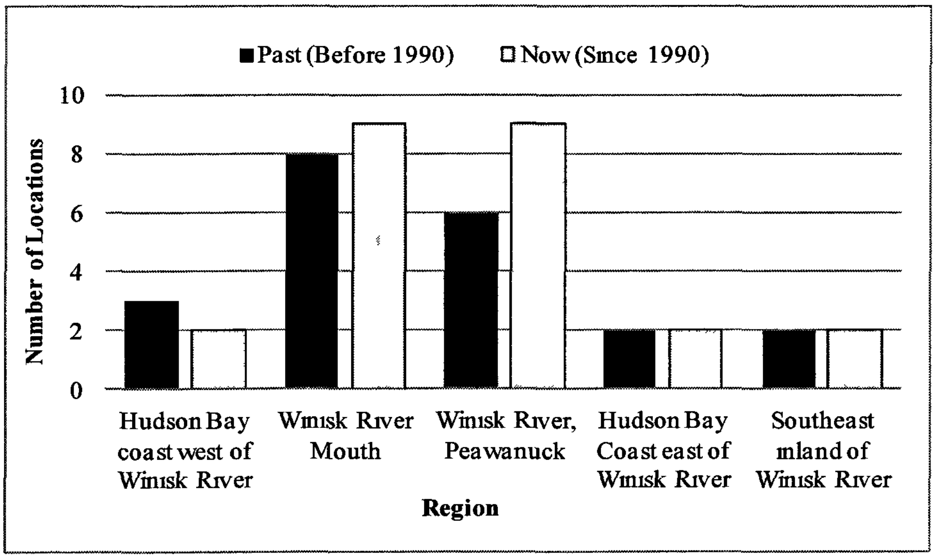
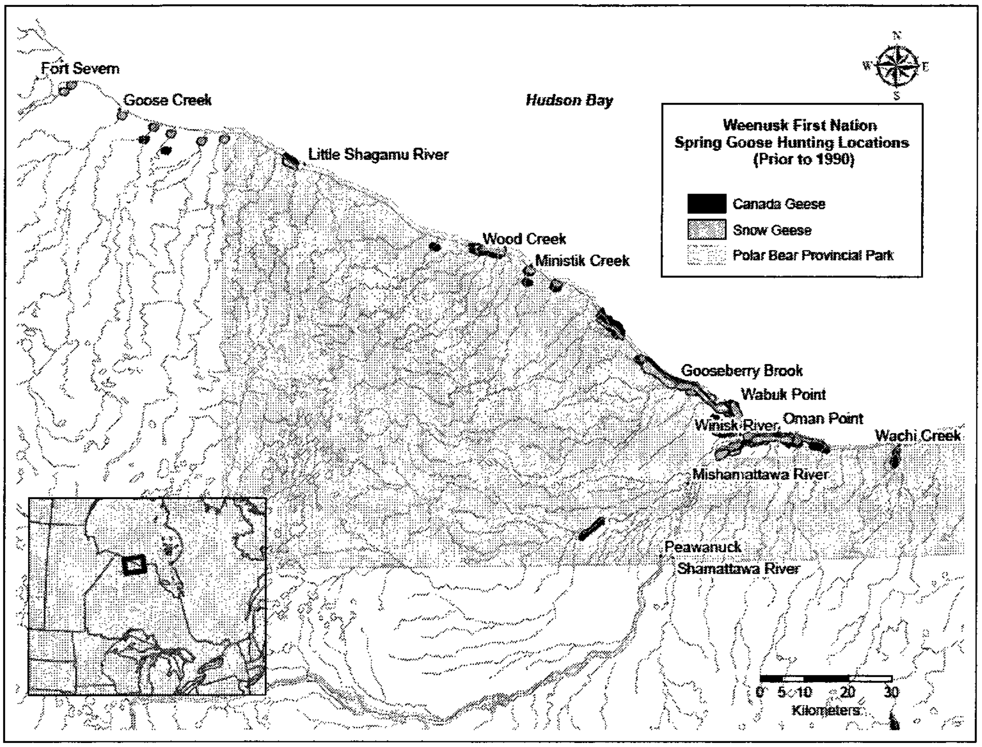


Figure 5.6. Number of hunters in the Weenusk First Nation using specific hunting locations for Canada geese in the spring. n=21(prior to 1990) and 24 (from 1990 to 2009).



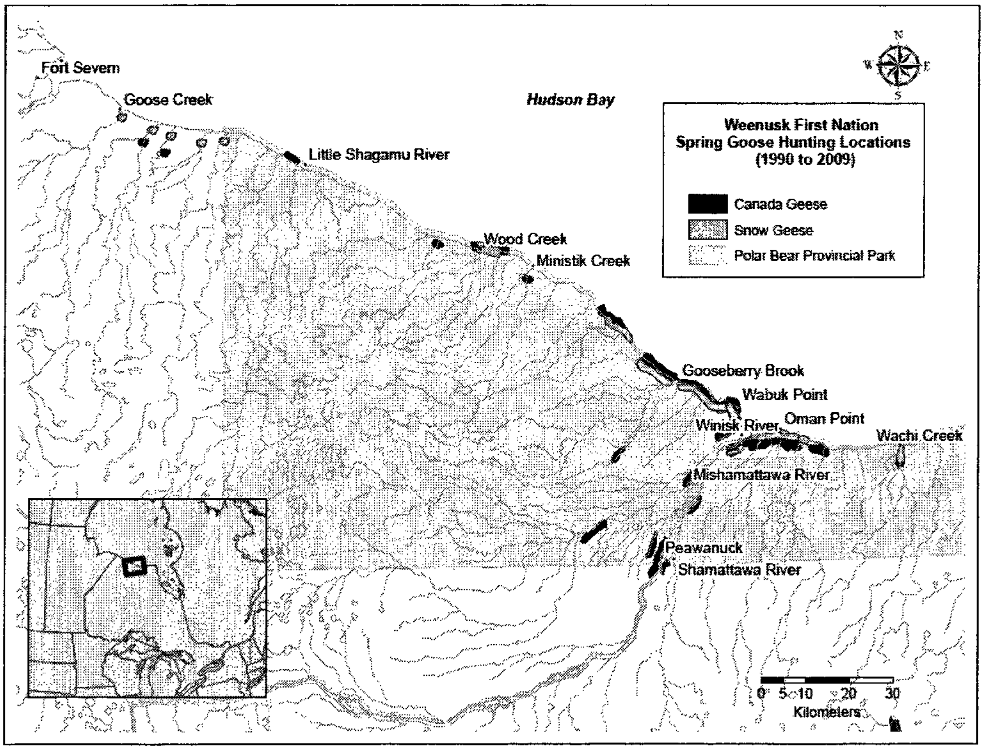


Figure 5.7. Spring hunting locations for Canada geese and snow geese in the Weenusk First Nation; prior to 1990, and between 1990 and 2009.

Only 2 of the 21 hunters in the MCFN sample reported hunting Canada geese in the fall in the past, and none reported hunting Canada geese in the fall now. While 16 reported having hunted snow geese in the past, only 6 currently do. All snow goose hunting areas in the fall are on the coast, both in the past and present. Eleven hunters said they used to hunt snow geese in Hannah Bay, however, only 4 still report doing so today (Figure 5.8).

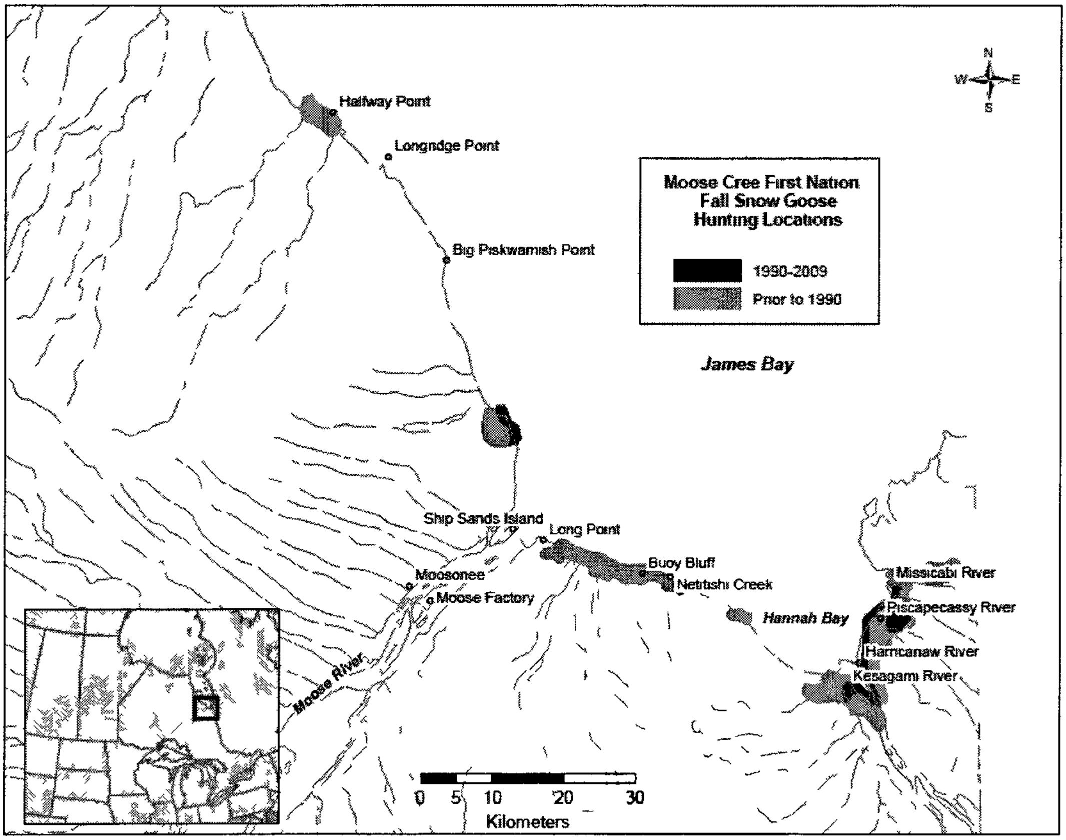


Figure 5.8. Fall snow goose hunting locations by the Moose Cree First Nation, prior to 1990 and from 1990 to 2009.

In the WFN, the number of people who hunt either Canada geese or snow geese in the fall has declined, and therefore so have the number of regions being hunted. While 6 people reported hunting all four of these regions in the past, only 2 still do for Canada geese, and they hunt near the community or at the Winisk River mouth. For snow geese, 7 reported hunting at the Winisk River mouth in the fall in the past, with only 3 reporting that they still do today (Figure 5.9).

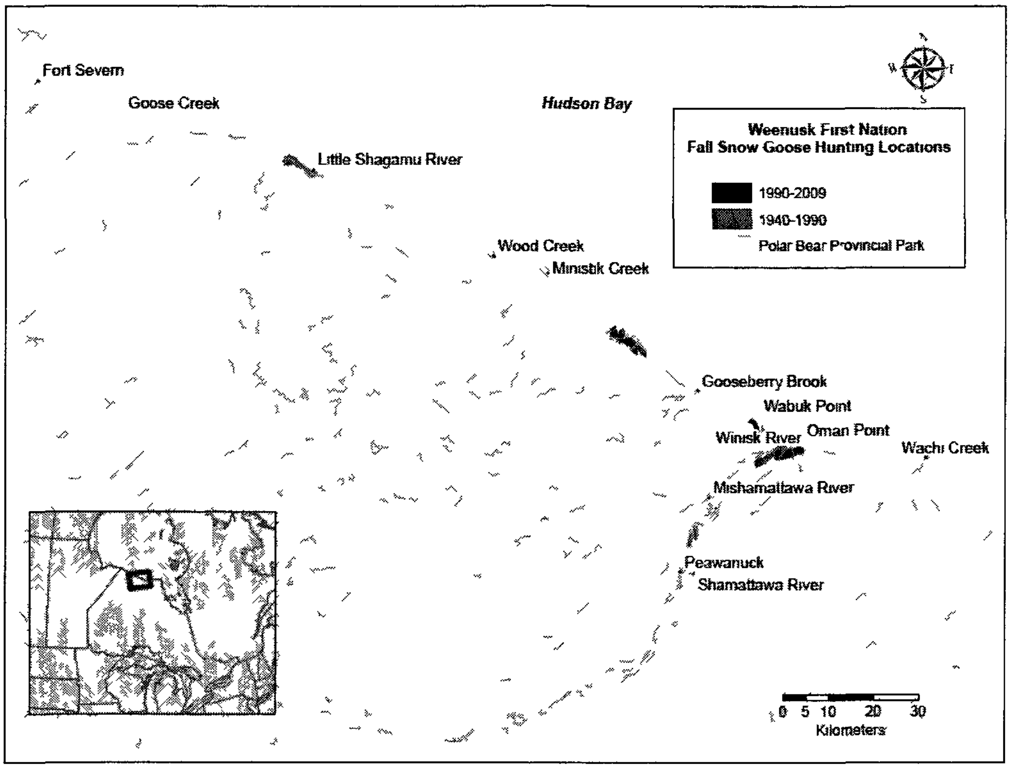


Figure 5.9. Fall snow goose hunting locations by the Weenusk First Nation, prior to 1990 and from 1990 to 2009.

Generally, hunting locations have not changed over time, with the exception of an increased concentration of hunters in the rivers near the communities. The next section describes changes to the timing and duration of the goose hunt.

5.2 CHANGES TO ACCESS VIA TIMING AND DURATION OF THE GOOSE HUNT

In this section, I describe the impact of climate change on access, via timing and duration of the goose hunt. Many of the previous studies documented time spent hunting, however, none documented the timing of the hunt itself.

Timing of the goose hunt

Although weather conditions vary from year to year, most people (12) in the MCFN still get ready about the same time, and head out about the same time, around the second or third week in April. Even if it means that they miss the geese in a late year because they have already returned to the community. As one hunter notes:

"I mean sometimes we're there for when they (Canada geese) come and sometimes we're not there...They start showing up the end of April. Like I said sometimes we're there and sometimes we leave before that" (Chris Isaac, youth, MCFN).

Only 2 hunters reported going earlier, and 5 said that they actually go later now. In the WFN there is an even division, as 6 hunters reported going at the same time, and the other 6 said that the timing of their trip varied with the weather (presumably related to the timing of the spring break up).

Duration of the goose hunt

In the spring, 8 hunters in the MCFN sample said that they hunt for less time now, 3 said they hunt more, and 10 said that the number of days they spend hunting in the spring has not changed over time. Hunting days reported averaged 15.3 days (range 3-28). When asked if his time spent hunting in the spring has changed, one hunter summed what several had been saying:

"Yes (it has), due to employment reasons. I used to spend about 30 days out there, now it's down to a week, a week and a half" (Derek Moses, MCFN).

Other harvest studies which reported number of days spent hunting corroborate the local observations in showing that the time spent hunting has remained the same, although the range of time spent has decreased (Figure 5.10, Table 5.2).

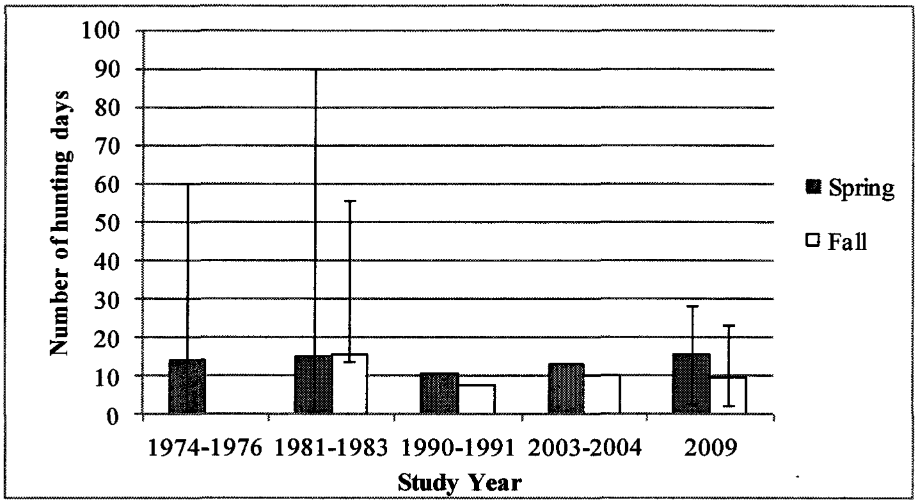


Figure 5.10. Average duration and range of time spent hunting in the Moose Cree First Nation (Prevett et al 1983, Thompson and Hutchison 1987, Berkes et al. 1992, Hughes and Walton 2005, present study. See Table 5.3 for n).

In the WFN, 4 hunters said they spend less time hunting now, with 8 saying the time is the same. These reports corroborate previous harvest surveys (Prevett et al. 1983, Thompson and Hutchison 1987, Berkes et al. 1992), which show that the range of time spent hunting has fluctuated only slightly (Figure 5.11). Hughes and Walton (2005) did not include Peawanuck in their study.

For the fall hunt, 12 hunters in the MCFN said that they hunt for fewer days now, with the remaining 3 saying the number of days they spend hunting has not changed over time. This is corroborated with the current study of 9.3 days (range 7-14), as well as other harvest studies (Figure 5.10). The range of days spent hunting, however, has decreased. Prevett et al. (1983) did not report mean hunting days for the fall.

In the WFN, 8 hunters said they spend less time hunting now, with only 2 saying the time is the same. This is contradictory with the previous studies (Thompson and Hutchison 1987, Berkes et al. 1994) or with the reported mean number of hunting days in the present study (Figure 5.11). The mean number of days spent hunting has not fluctuated significantly, and the range in duration of time spent hunting has decreased slightly.

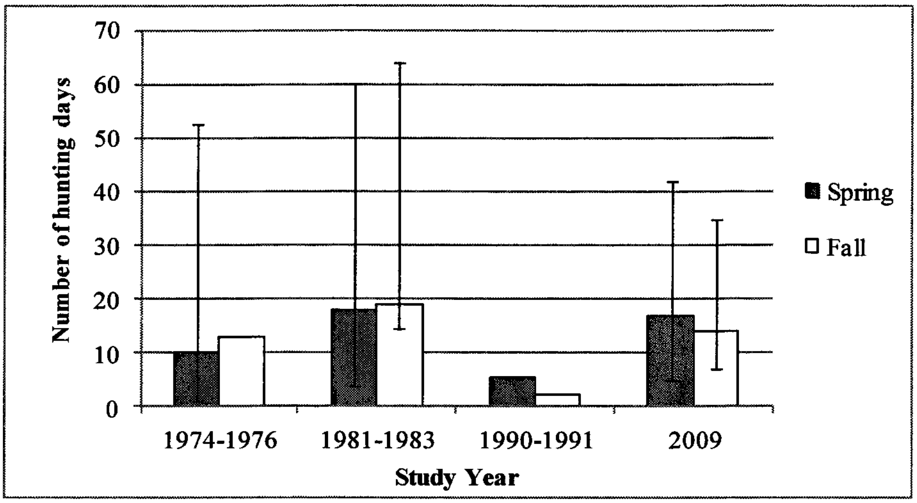


Figure 5.11. Average duration and range of time spent hunting in the Weenusk First Nation (Prevett et al. 1983, Thompson and Hutchison 1987, Berkes et al. 1992, present study. See Table 5.4 for n).

The method of travel to and from the family hunt camps has also changed. As several elders noted, when they were children, people used to take dog sleds and walk long distances to their camps, over a period of many weeks. That was in the 1940s and 1950s. Now, most either take a snowmobile or fly in via plane or helicopter. It is faster, and they can go for a week or just on weekends. An elder commented on the changes in technology:

"Now we're living in high tech. We come in by chopper, out by chopper, but I don't mind. We used to walk from Moose Factory to here. My mom and dad would have two dogs and a toboggan and all our stuff there. Me and my sister we used to walk ahead of the dogs… (It would take) one day and a half. Straight walking. My younger brother and sister would sit on the sled. The dogs would pull the sled, my older sister and I we used to lead the dogs. Now it only takes me 15 minutes to go camping" (Agnes Corston, elder, MCFN).

These results suggest that hunters in both the MCFN and WFN have not altered their timing of hunting in the spring. However, there are differences in terms of duration, as hunters in the MCFN spend less time hunting in the spring now than in the past while hunters in the WFN hunt for the same amount of time. The influence of timing and duration of the hunt on harvest is presented in the discussion.

Table 5.2. Local observations and historical harvest survey data on duration of goose hunting.

Observations gathered through interviews with northern residents	Information gathered through historical harvest surveys	Scale: Temporal, Spatial, Phenomenological	Corroborating, Contradictory, Complementary
MCFN-less time	Less time	Same	Corroborating
WFN- same length of time	Same length of time	Same	Corroborating

5.3 CHANGES IN HARVEST VIA THE NUMBER OF GEESE KILLED

Through an analysis of past harvest studies and including the present study, several trends emerge for the average number of geese killed per hunter per day. The average number killed per hunter was determined to be the best indicator of change over time, as overall harvest numbers would not necessarily be accurate given differences in the number of hunters participating any one year. Reported (as opposed to projected) numbers were recorded when possible, although earlier studies tended to omit the reported data in their published articles. Note this data was not available for the Hanson and Currie (1957) study in the 1950s. The results are split between the spring and fall hunts, and also by community. The harvest by species for each community, as well as data used in the calculation for kill per hunter per day is summarized in Tables 5.2 and 5.3.

Spring Hunt: MCFN

Fourteen of the 21 interviewees in the MCFN said that the number of Canada geese that they kill in the spring has decreased over time. One experienced hunter from the MCFN commented on the decline in harvest of Canada geese in the spring:

"[Hunting] used to be every day, go out in the morning you shoot geese, go back in the afternoon- you take a break actually- and you still see geese going by, you don't have to worry about that. But now you got to kind of sit out there all day and hope for one. Really one or two good days, but that's it" (Peter Gagnon, Jr., MCFN).

Table 5.3. Mean number of geese killed per hunter, and mean number of days spent hunting, including ranges, used to calculate the mean number of geese killed per hunter per day in the Moose Cree First Nation.

Study	Number of completed surveys	Spring: Mean number killed per hunter (Range)		Spring: Mean number of days spent hunting (Range)	Fall: Mean number killed per hunter (Range)		Fall: Mean number of days spent hunting (Range)
		Canada Geese	**Snow Geese**		**Canada Geese**	**Snow Geese**	
1974-1977 (Prevett et al. 1983)*	Unknown	16.4	3.1	14 (1-60)	0.5	22.4	n/a
1981-1983 (Thompson and Hutchison 1987)	91	17.6 (2-240)	23.3 (1-190)	14.8 (1-90)	5.4 (1-60)	37.2 (5-200)	15.7 (2-40)
1989-1991** (Berkes et al. 1992)	235	18.2	0.9	10.5	n/a	17.9	7.6
2003-2004 (Hughes and Walton 2005)	41	13.2	0.3	13	8.1	4.5	10.1
2008-2009	21	18.4 (0-40)	0	15.3 (3-28)	0	10 (5-15)	9.3 (7-14)

Used only Moose Factory data where both Moosonee and Moose Factory were included
* All data taken from March 1977 progress report, except mean days spent hunting. Fall data for Moose Factory from Moose River Check Station.
**Used Projected data

Table 5.4. Mean number of geese killed per hunter, and mean number of days spent hunting, including ranges, used to calculate the mean number of geese killed per hunter per day in the Weenusk First Nation.

		Spring			Fall		
Study	**Number of completed surveys**	**Mean number killed per hunter (Range)**		**Mean number of days spent hunting (Range)**	**Mean number killed per hunter (Range)**		**Mean number of days spent hunting (Range)**
		Canada Geese	**Snow Geese**		**Canada Geese**	**Snow Geese**	
1974-1977 (Prevett et al. 1983)	46	30.1 (2-150)	30.2 (4-200)	10 (1-52.5)	5.2 (1-60)	52.8 (3-250)	13
1981-1983 (Thompson and Hutchison 1987)	23	47.1 (8-150)	79.2 (20-300)	18.1 (4-60)	29.9 (1-150)	60.4 (15-152)	18.9 (4.5-45)
1989-1991 (Berkes et al. 1992)*	44	43.3	49.9	5.6	12.8	24.7	2.3
2008-2009	13	79.6 (15-150)	139.6 (20-300)	16.7 (5-42)	0	42.5 (25-60)	14 (7-21)

*Used Projected data

An elder recalled how the harvest has declined since she was a child:

"When we were kids we used to get over 100, this spring we only got 40" (Agnes Corston, elder, MCFN).

There were also comments referring to the timing of the decline, usually in reference to the decline in numbers of geese seen. As an example, one hunter noted:

"*Yeah from the eighties to now there's a big decrease...we used to kill hundreds and see thousands and thousands out there. It used to be like an island out in the bay, just black. I haven't seen that for years*" (Derek Moses, MCFN).

According to the analysis in the present study, the number of Canada geese killed per hunter per day during the spring hunt in Moose Factory remained the same from the 1976 study to the 1983 study, and then increased slightly in 1991 (Figure 5.12). The kill of Canada geese per hunter dropped slightly according to the 2004 survey (Hughes and Walton 2005), and has since increased in 2009 (Figure 5.12). Note, however, the ranges for both number of days spent hunting and Canada geese killed per hunter have decreased (Table 5.3). These findings do not corroborate the local observations reported in the present study that hunters are killing fewer geese (Table 5.5).

Eight hunters in the MCFN sample discussed hunting snow geese in the spring, with 5 reporting that their kill has decreased over time. One elder notes about killing snow geese in the spring:

"We used to get lots. Over 200 we used to get when we were kids. (Now) we get none" (Agnes Corston, elder, MCFN).

The number of snow geese killed per hunter per day in the MCFN has remained low, with the exception of a spike in the Berkes et al. (1992) study (Figure 5.12).

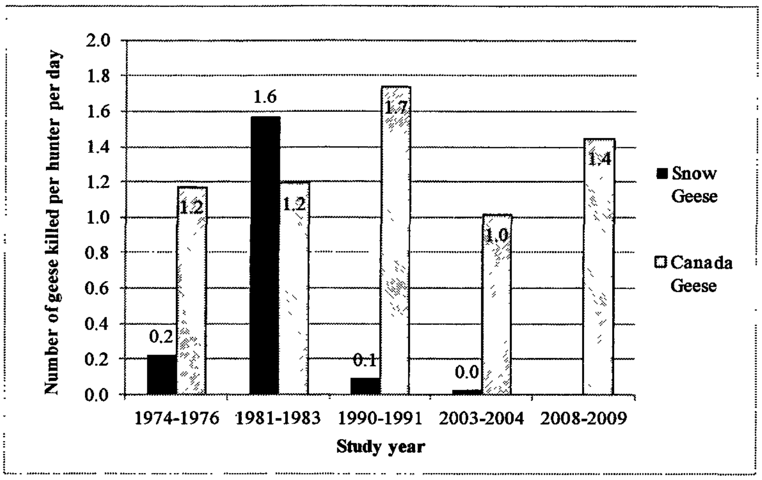


Figure 5.12. Average number of geese killed per hunter per day in spring in the Moose Cree First Nation (Prevett 1977, Prevett et al. 1983, Thompson and Hutchison 1987, Berkes et al. 1992, Hughes and Walton 2005, present study).

Spring Hunt: WFN

In Peawanuck, the responses in the interviews were mixed when asked about any trend in their kill of Canada geese in the spring, with only 3 responding that their kill has increased, and 5 responding it has remained the same. Four people were unable to commit to an answer, saying that the number varied too much from year to year to have noticed a distinct trend.

According to previous harvest surveys, the average for Canada geese killed per hunter per day has increased (Figure 5.13) while the range in number of Canada geese killed per hunter has remained the same (Table 5.4). The qualitative observations reported in the present study contradict the quantitative finding of an increase in harvest (Table 5.5). Note also the much higher harvest in Peawanuck than the more southern community of Moose Factory, which is similar to previous studies (Thompson and Hutchison 1987, Berkes et al. 1992).

In Peawanuck, a higher proportion of the spring kill is snow geese, which is contrary to the southern James Bay area but consistent with previous studies on the southern Hudson Bay coast (Prevett et al. 1983). Six of the 11 respondents commented on how their kill of snow geese in the spring has not changed. Only 2 of the 11 said that the number has increased. The average kill per hunter per day has increased threefold since the Prevett et al. (1983) study (Figure 5.13). The range in number of geese killed per hunter, however, has remained the same (Table 5.3). The qualitative observation that the harvest has not changed is contradictory with quantitative data (Table 5.5).

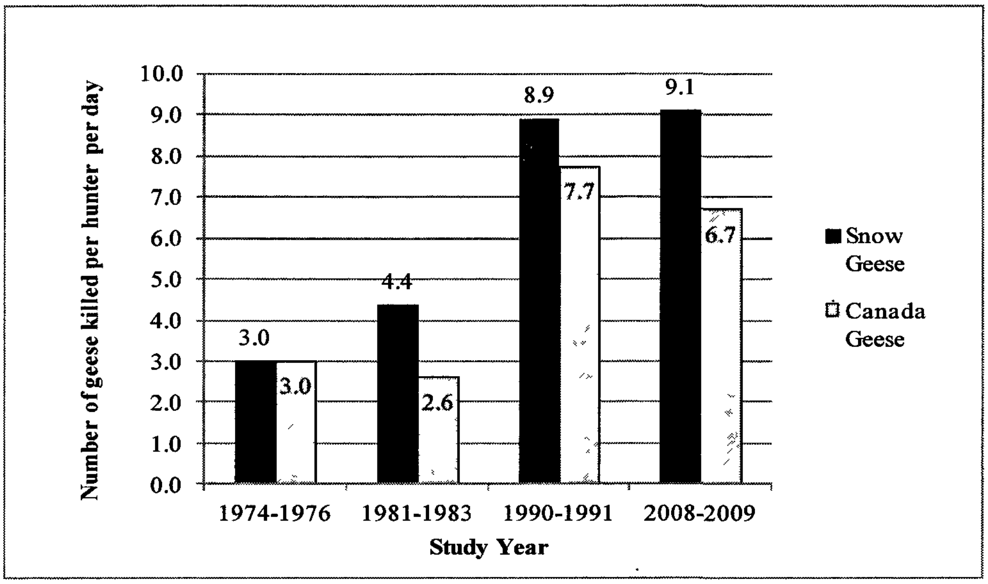


Figure 5.13. Average number of geese killed per hunter per day in spring in the Weenusk First Nation (Prevett 1977, Prevett et al. 1983, Thompson and Hutchison 1987, Berkes et al. 1992, present study).

Fall hunt: MCFN

In the present study, 15 hunters reported that the number of snow geese they kill in the fall has decreased over time. The calculated average number of geese killed per hunter per day has declined (Figure 5.14). These quantitative results are corroboratory with the local observations obtained in this study of a decrease in kill. Interesting to note is the slight spike in kill for Canada geese in 2004, which is contrary to interviewee comments on how most people do not and never have hunted Canada geese (intentionally) in the fall. In that particular year, the kill of Canada geese was higher than that of snow geese. The comments of never hunting Canada geese in the fall are contradictory to previous studies which indicate that Canada geese were commonly included as part of the fall hunt (Hanson and Currie 1957, Thompson and Hutchison 1987).

One MFCN elder recalls about the fall snow goose hunt:

"I remember in late 60s we used to get quite a bit in the fall too, we used to harvest the waveys we used to get lots. Hundreds. And they'd do us all winter too eh until the next time they'd come around" (Agnes Corston, elder, MCFN).

Several elders commented on changes to the fall hunt:

"One time I got 130 (waveys), 132 (another) time, in the fall. Now, in two weeks, not even 10" (Elder, MCFN).

"There was a lot of waveys, there would be thousands out there, big flocks. You could kill, get 200 easy. It's not like that anymore" (Charlie Small, MCFN).

An experienced hunter comments on why he no longer hunts snow geese in the fall:

"Waveys, I haven't hunted in the last few years. The reason why, they've declined considerably in the past 10 years. There used to be clouds of geese. You'd be out hunting for one day, get your amount of geese that you needed, last you for a week, 2 weeks. But now they're very scarce, I've noticed. In the last 10 years they've dropped considerably" (Rick Rickard, MCFN).

Fall hunt: WFN:

The decline in harvest for the fall goose hunt is also seen in Peawanuck. Hunters reported in the current study that the number of geese they kill has decreased over time, for both species. More specifically, 8 hunters said that the number of Canada geese and 9 hunters said that number of snow geese they kill has declined. This observation is corroborated with previous studies (Figure 5.15). The spike in 1990 is the same as in Moose Factory, with an interesting comparable spike for Canada geese.

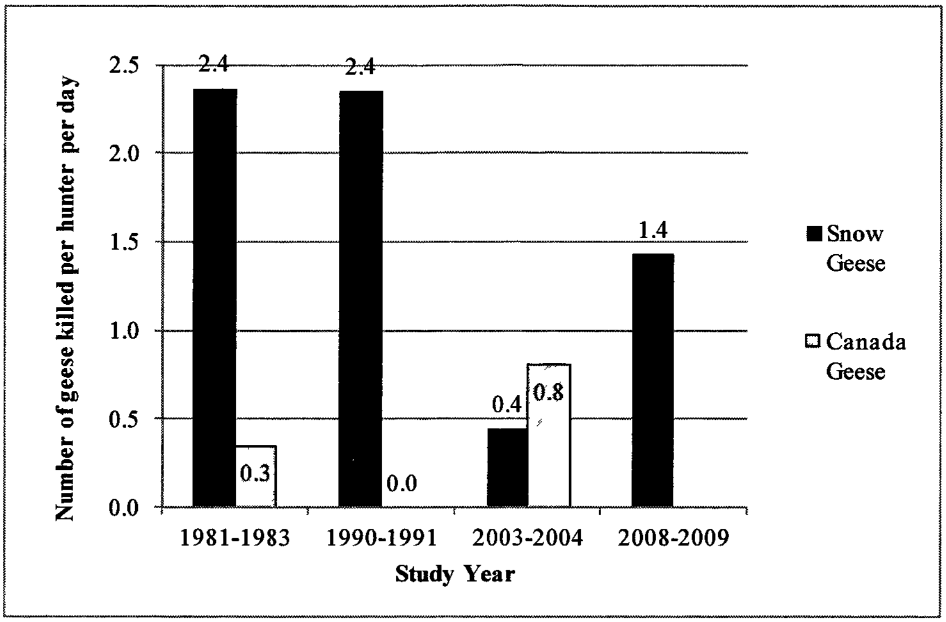


Figure 5.14. Average number of geese killed per hunter per day in the fall in the Moose Cree First Nation (Thompson and Hutchison 1987, Berkes et al. 1992, Hughes and Walton 2005, present study).

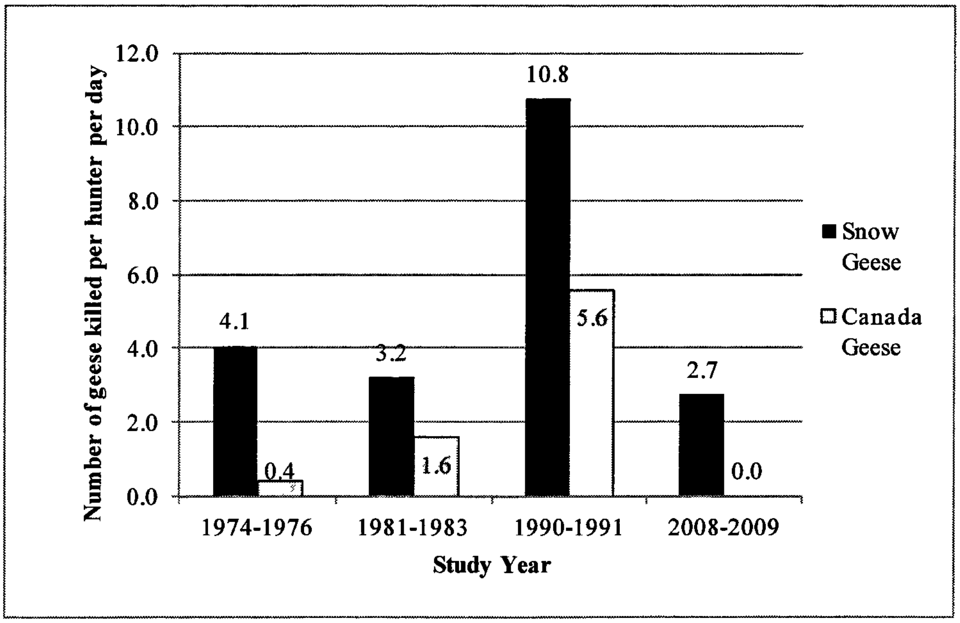


Figure 5.15. Average number of geese killed per hunter per day in the fall in the Weenusk First Nation (Prevett 1977, Prevett et al. 1983, Thompson and Hutchison 1987, Berkes et al. 1992, present study).

Table 5.5. Currently reported and historical harvest survey records for harvest of geese in the Moose Cree and Weenusk First Nations.

	Currently reported via interviews with northern residents	Data gathered through historical harvest surveys	Scale: Temporal, Spatial, Phenomeno -logical	Corroborating, Contradictory, Complementary
MCFN				
CAGO -spring	Decrease	No change	Same	Contradictory
CAGO -fall	Never have	Have in past	Same	Contradictory
SNGO -spring	Decrease	Decrease	Same	Corroboratory
SNGO -fall	Decrease	Decrease	Same	Corroborating
WFN				
CAGO -spring	Same	Increase	Same	Contradictory
CAGO -fall	Decrease	Decrease	Same	Corroborating
SNGO -spring	Same	Increase	Same	Contradictory
SNGO -fall	Decrease	Decrease	Same	Corroborating

*CAGO Canada Goose
**SNGO Snow Goose

Summary

In summary, there have been several changes in terms of access to and harvest of geese by First Nations in the Hudson Bay Lowland as they relate to changes in goose habitat, abundance and distribution. Identified changes in for Moose Cree included those to hunter demographics, hunting locations, and timing and duration of the goose hunt. The harvest of geese has not notably changed for Moose Cree other than a decline in the fall harvest of snow geese. Access to geese has not changed as significantly for Weenusk, and the spring harvest has increased. There have also been important social and cultural shifts with respect to geese.

Many of these changes are corroboratory between both local observations and technical data. However, as with the impact of climate change on goose habitat, abundance and distribution, there are also instances of divergence between these data sets. The following Discussion examines these changes, providing insight into possible mechanisms for divergences, and discusses the importance of linking knowledge systems to understand these changes in the Hudson Bay Lowland.

6.0 DISCUSSION

The primary objective of this study was to identify changes in climate and habitat in the Hudson Bay Lowland, and if there have been consequent changes in Canada goose and lesser snow goose abundance and distribution. This study has found changes in vegetation, species composition of wildlife on the coast, and pattern of goose migration. Collectively, these changes are reported to have been more pronounced in the last 15 to 20 years.

The secondary objective was to identify changes in access to and harvest of geese by First Nations, as they relate to climate change impacts on goose habitat, abundance, and distribution. Identified changes in Moose Cree included those to hunter demographics, hunting locations, timing and duration of the goose hunt, and changes in the harvest of geese. Access to geese has not changed as significantly in Weenusk, although the harvest has increased. There have also been important social and cultural shifts with respect to geese.

The overall findings are that, related to geese, there are several ecological and social changes taking place in the Hudson Bay Lowland. In many cases the findings from the local observation interviews were corroboratory or complementary to technical data sources, although areas of divergence were also found. In instances where data sets from each knowledge source were not aligned, it was largely an issue of differences in either temporal, spatial, or phenomenological scale.

6.1 IMPACTS OF CLIMATE CHANGE ON GOOSE ABUNDANCE, DISTRIBUTION, AND HABITAT

Climate and Habitat

Specific questions related to habitat were not asked in the interviews; however, changes in the weather or climate, changes in the vegetation, and changes in the species composition of wildlife were all topics raised in the discussion. All relate to changes to habitat, and the interaction between hunters, hunting, and geese.

Hunters in both Moose Factory and Peawanuck reported an increase in warmth of springs over the last 50 years, and a shift to an earlier spring break up of the Moose and Winisk Rivers. An increase in temperature between 1960 and 2009 of an average of 3°C from weather data for both communities is corroboratory to the local observation. Other studies support the observation of an earlier spring melt in the Hudson Bay region (Gagnon and Gough 2002). While annual trends in river ice of the James and Hudson Bay region are not well known (Ho et al. 2005), spring break up has been documented for the Moose River, and shows a significant advance (i.e. earlier break up) over the last 50 years. There are no official records of the timing of the break up for the Winisk River, however, studies on lakes in northwestern Ontario and rivers in the James Bay region do indicate earlier break up leading to a longer ice free season (Schindler et al. 1990, Ho et al. 2005, Duguay et al. 2006). At a larger scale, there has also been an increase in inter-annual variability in both freeze and break up dates for lakes and rivers across the northern hemisphere since the 1950s (Magnuson et al. 2000).

Hunters also reported an increase in variation in temperature in the months of April and May notable in the last 10 years. Hunters linked this observation with having an increased difficulty in predicting characteristics of the spring melt. The local observation of increased difficulty in predicting the timing of freeze/thaw has also been documented by other studies in western James Bay (McDonald et al. 1997, Ho 2003). Daily mean temperature readings from local weather stations indicate variation within the spring months, but not an increase in variation either within the months of April or May or between years for the last 50 years. Missing data can lead to loss of insight (Ho et al. 2005) and this study had missing data points from 1993 to 1997, which could also contribute to the divergence in data sets, as the 1990s were a critical time of change described by the community members. Therefore, the local observation of an increase in daily temperature variation (sudden thaws and refreezing) within the month of April (or May) for the Moose Factory area is contradictory to technical data, however, it may be corroborated with further investigation.

Hunters also described the relationship between the changing weather and the geese, including interaction between the geese and the hunters. Weather was identified as the primary variable determining goose behaviour. For example, characteristics of spring onset influence the amount of time that the geese are vulnerable to hunters in the Lowland. Prevett et al. (1983) also documented weather being the most important variable impacting the harvest of geese; a fast spring break up leads to Canada geese dispersing quickly to their inland nesting areas from the coast whereas a late and prolonged thaw delays nest initiation and increases their vulnerability.

Another local observation was related to spring winds. Wind direction was observed by several hunters as being increasingly varied within a single day, and contributing to their difficulty in predicting weather patterns during the hunt. This observation was also noted by hunters in McDonald et al. (1997). Cree in northern Quebec also noted wind as influencing goose flight patterns (Peloquin and Berkes 2009). Wind direction is not documented multiple times a day at the local weather stations; however, other studies correlate the importance of wind direction and speed with the arrival of geese (Frederick and Klaas 1982, Ball 1983, Wege and Raveling 1984), supporting the local observation. Studies show that geese can compensate for wind drift, from changes in speed and direction (Wege and Raveling 1984); however, these studies are referring to large sections of the migration route, and so at a much larger geographic scale. They are also beyond the temporal scale of a day, as observed by hunters. Increased variation within a single day is therefore a new finding.

Precipitation was observed by hunters as decreasing over time, leading to drier land and changing vegetation on the coast. This in turn was reported to lead to fewer open water areas for the geese to feed, forcing them to feed elsewhere. This observation is supported by McDonald et al. (1997), who reported that the Moose and Harricanaw river estuaries have also become quite shallow, and many river channels have been drying up. Precipitation records from the local weather stations contradict this observation, as they do not show any significant change in the last 50 years for the months of April or May (McKenney et al. 2006). Other studies in the James Bay region indicate an increase in precipitation (Gagnon and Gough 2002). Possible explanations for this divergence could be differences in methods of measuring precipitation or calculating statistics between studies, as well as potential differences in temporal scale between studies. Other factors contributing to observations of decreased precipitation could be the location of the observations, the timing of the hunt, and seasonal differences.

Another factor is the role of evaporation and evapotranspiration, and the possibility of increased surface drying of soils and wetland areas despite non-significant changes in precipitation. Evapotranspiration is greatest in the wetland areas 10 to 20 km inland from the coast, due to wind direction, vapour and temperature gradients (Rouse 1991). Increased temperatures would lead to an increase in evapotranspiration in these wetland areas (Rouse 1991) and in turn increased drying. So while precipitation might be similar, the wetlands of the coast could still be becoming drier, thus corroborating the local observations.

Many hunters, in both communities, had observations on changes in the types of vegetation on the coast. They observed changes in the types of grasses, as well as the willows now growing further out towards the bay.

Significant change in vegetation cover and species composition was documented in a study at Shegogau, a site on the coast of southern James Bay, which corroborates this local observation (OMNR unpublished). It found that vegetation cover for grasses had declined in abundance in the intertidal zone, or coastline, and increased in abundance in the supratidal zone. The species composition of grasses had also shifted, with a decline in *Puccinellia phryganodes* in the intertidal zone and an increase in *Festuca rubra* in the supratidal zone (OMNR unpublished).

Although particular grass species were not described by the hunters, *P. phryganodes* and *F. rubra* are two of the primary grasses in this region (Riley and McKay 1980), and are also the main plants selected for by both Canada geese and snow geese (Prevett et al. 1985), so there is high confidence that the local observation of a change in these species of grasses on the coast is corroboratory to the technical data. Since these grass species are important food sources for geese, and geese feed primarily in the intertidal zones, a decline in grass biomass in could ultimately have implications for where they choose to forage. A shift in foraging location might also affect the availability of the geese to hunters.

A decrease in abundance of grasses in the intertidal zone could be related to erosion, and the effects of rapid isostatic rebound occurring in the Lowland (Webber et al. 1970). It is possible that the grasses are not able to colonize as readily in a rapidly emerging system. Also, the vegetation community on the coast could still be recovering from an abundance of snow geese in the earlier part of the 20^{th} century.

The local observation of an increase in shrubs in the coastal regions is supported by other local observations that willows, brush and grass have started growing in primary feeding areas in the Lowland (McDonald et al. 1997). There is also evidence of an increase in shrub and tree cover during the same time period (1970 to 2007) in the Churchill region (Ballantyne 2009). However, while Churchill is located in the same ecoregion, it is also much further north, making it a different spatial scale. As comparative vegetation studies have not been done in the southern Hudson Bay region, the observation of changes in composition of vegetation has only complementary convergence.

Differences in vegetation could be related to climatic changes, including increases in temperature and growing degree days as reported in this study. Warming temperatures affect plant distributions and characteristics through changes to processes such as photosynthesis, transpiration, decomposition, and nutrient cycling (Ayres 1993, Hughes 2004), leading to changes in secondary succession and productivity (Ayres 1993).

However, there are many additional factors contributing to vegetative growth. The role of atmospheric nitrogen, carbon dioxide, and other factors such as cloud, snow and ice cover were not examined in this study, but are also important in vegetative growth (Ayres 1993) and would be worth further investigation.

Abundance

According to local observations, there has been a decrease in Canada goose and snow goose abundance in southern James Bay in the last 30 years, and an increase in Canada goose and snow goose abundance along southern Hudson Bay in the last 40 years.

According to technical sources, Canada geese of the SJBP increased in the 1970s, declined in the late 1980s and early 1990s, and have since remained stable (Leafloor et al. 1996, Abraham and Warr 2003, US Fish and Wildlife Service 2010). Canada geese of the MVP have also increased since the 1970s (Abraham and Jefferies 1997), and have remained relatively stable since the mid-1990s (Brook and Luukkonen 2010). These surveys are indicative of population growth on a continental scale, reflective of changes in agricultural practices on the wintering grounds in the United States (Abraham and Jefferies 1997). Local observations, however, are reflective of only a small subset of the breeding grounds and so are at a different scale.

For SJBP Canada geese, the only technical data available at the same scale are spring population estimates on the breeding grounds since 1989, which indicate that SJBP Canada geese have remained stable (US Fish and Wildlife Service 2010). There are no local spring surveys before 1989 for direct comparison, although there is one on Akimiski Island in James Bay for 1985 (Leafloor et al. 1996). Other available data sets include mid-winter surveys from 1982 to 1989 which estimate that the population has fluctuated, but decreased in size during that time (Abraham and Warr 2003). There are also coastal fall aerial surveys, which show a decrease in population from the mid 1970s between the Albany River and Quebec border (OMNR unpublished). Although, the temporal and spatial scales of these surveys are different, as well as the frequency of the surveys has declined and methods used have changed. Also, aerial surveys were not conducted for a population index, but rather to determine distribution and habitat use on the coast and are done at a time when the geese are staging for their fall migration. The fall surveys might also include Canada geese from other populations, for example moult migrant temperate geese. Hunters were speaking of geese in the spring during migration. The local observation of a decline in SJBP Canada geese is contradictory to spring surveys, although with low confidence as the temporal scales within years (and spatial scales) are different.

For the MVP, spring population estimates on the breeding grounds indicate that the population has been declining since 1989 (US Fish and Wildlife Service 2010). There are no local spring surveys before 1989. Coastal fall aerial surveys between the Severn River and Cape Henrietta Maria indicate that they have been increasing since the 1970s (OMNR unpublished). Also, mid-winter survey estimates indicate that MVP geese have increased from the 1950s to the 1990s (Abraham and Jefferies 1997). As with the SJBP, there is also the complication that increasing numbers of temperate geese were included in those counts, potentially inflating the actual MVP population estimate. As MVP Canada geese have increased in population continentally and because of the longer time period described by the hunters (since the 1970s) the local observations and technical data of an increase are complementary, although with low confidence based on differences in temporal and spatial scale of the local observations and aerial surveys.

Local observations report a decrease in snow geese in James Bay. On a continental scale, mid-continent snow geese have been increasing since the 1970s (US Fish and Wildlife Service 2010). On a regional scale, breeding ground surveys indicate that the southern Hudson Bay population has also increased (Kerbes et al. 2006). This pattern of growth might suggest increased numbers of snow geese in all regions of the range at all times; however, that is not the case. In a specific area such as southern James Bay, where snow geese are found only during the migration seasons, local fall aerial surveys conducted between 1975 and 1984 agree with local observations, and indicate a declining use of the area between the Albany River and the Quebec border (OMNR unpublished). As fall surveys are flown during the fall hunt, when local observers are obtaining information, the finding of a decline in snow geese in James Bay is complementary between local observations and aerial surveys. This finding contrasts with the continental picture of the goose population; however, the strong evidence from local observations complementing the little technical data that exists at the same scale is a significant finding of this study.

Local observations report an increase in snow geese along Hudson Bay. Coastal fall aerial surveys conducted between 1975 and 1984 indicate an increase in snow geese between the Severn River and Cape Henrietta Maria (OMNR unpublished). Other surveys indicate that breeding snow geese in the southern Hudson Bay region have been increasing since the 1950s (Abraham and Jefferies 1997) and from the 1970s to the present (Kerbes et al. 2006), suggesting more birds should be available for the fall hunt. The local technical data is from a longer time frame than the local observations. However, the temporal overlap does suggest that local observations and aerial surveys describing an increase are corroboratory, although with low confidence based on the limited overlap in temporal period of observation.

Timing of Migration

In addition to changes in abundance, my study identified particular changes in the distribution of geese, specific to timing and pattern of migration. While there was no difference in the timing of the spring migration, for either species, there were observations on an earlier migration for snow geese in the fall. Hunters observed the timing of the spring migration within their regions as remaining generally consistent, varying from year to year with the weather but occurring around the same time. Canada geese in southern James Bay arrive during the second week in April, and Canada geese in southern Hudson Bay arrive during the third week in April. Snow geese arrive just after breakup of the rivers, between the last week in April and the first week in May. This observation is supported by information in published reports of spring migration through each region (Blokpoel 1974, Tacha et al. 1991).

It is also interesting to note the connection between the timing of the arrival of geese in the Lowland, and when they are able to nest. Geese in Hudson and James Bay do not appear to be arriving in the Lowland any earlier than historically. However, hatch dates on Akimiski Island in James Bay indicate that Canada geese are nesting earlier (MNR unpublished). So while Canada geese are arriving at the same time, it appears they are spending less time staging before nesting. This phenomenon has also been shown in modelling studies, where the onset of migration remained consistent, but the speed of the migration increased (Hedenström et al. 2007). According to optimal migration theory, the speed of migration is the most relevant variable in timing of migration schedules related to climate change (Hedenström et al. 2007). Also, the speed can only increase as much as food availability will permit (Bauer et al. 2008). Satellite imagery using NDVI (Normalized Difference Vegetation Index) shows that the green up date is earlier in the Hudson Bay Lowland, although with a weak trend (R Brook, pers. comm.). Green up date is an index of responses to conditions, including snow cover, temperature, and flooding. An earlier green up date might support earlier nesting dates in the region, although the advancement of green up is not as pronounced as in other regions (such as Europe).

A change in the interval between arrival and nesting could have implications in terms of a mismatch with hunting. Geese are most vulnerable when they are in flocks of pre-breeding birds. If hunters continue to go out hunting at the same time every year, and the geese are dispersing in pairs earlier to nest, there will be a reduced availability to hunters of geese when they are in flocks. The window of optimal hunting is already short, and if this pattern continues of a shorter time between arrival and nesting, hunters might be required to shift the timing of their hunt to coincide with the shifting peak in migration.

Hunters in both communities observed snow geese leaving James Bay and Hudson Bay earlier in the fall. Several hunters in the WFN described how the geese no longer linger at the mouth of the Winisk River, and start their migration south in mid-August, as soon as the geese can fly, as opposed to waiting until the third week in October. McDonald et al. (1997) also documented local observations of snow geese no longer migrating from the Hudson Bay region in mid-October, but leaving in early September.

The documented information on timing of migration (Blokpoel 1974, Tacha et al. 1991) is obtained through local observations by people along the coast, and it is only published incidentally. Since it is based on local observations, it cannot be directly linked as technical data with the local observations in this study. Given that there are no formal technical studies done on the timing of the migration, a finding of an earlier fall migration remains inconclusive. This could be a new finding, and there are speculations as to why the fall migration of snow geese has shifted.

If the geese are leaving earlier, such changes in migration schedules could be due to phenotypic plasticity, in that the birds are adapting to changing environmental conditions, such as temperature or food availability (Hedenström et al. 2007). This could correlate with increased summer temperatures or changes in composition and timing of vegetation on the coast, which have been documented in the James Bay region (OMNR, unpublished), or habitat degradation along the Hudson Bay coast (Jano et al. 1998, Jefferies et al. 2006). It could be that geese do not linger on the coast when there is nothing to eat, or if their forage of choice is not as easily available.

Pattern of Migration

Although there were minimal changes observed to the timing of the migration, there were several local observations on changes to the pattern of the migration. The majority of respondents in the MCFN observed a change in the pattern of the spring migration for Canada geese, specifically a change in the route of migration. They observed a shift from the geese following the coastline to flying inland within the last 15 years. The shift was attributed to human development, for example the observation that the geese are following the relatively recently constructed transmission line along the west coast of James Bay. Hunters also attributed the inland shift to environmental factors, such as the coast being drier where the geese used to feed, and there being less grass available for them to eat.

The local observation of snow geese shifting from a southward fall migration to flying west and inland, since the 1980s, is supported by local observations collected by McDonald et al. (1997). However, this observation has not been documented in technical reports or surveys. Based on the lack of comparable data, this finding is inconclusive. However, food availability is an important determinant in choosing feeding patches (Tombre et al. 2005). Transmission lines were constructed between Moosonee and Attawapiskat between 1998 and 2002 (Five Nations Energy Inc 2002), with a second parallel set constructed in 2005 to access the Victor mine. It could be speculated that the geese are drawn to the open areas around the transmission lines in spring, as the snow melts earlier and exposes areas of open water or thawed ground for feeding (Fitzwater 1988).

Also, while geese are philopatric, a shift in route could be influenced by the increased human disturbance and hunting mortality from an increase in hunting pressure on the coast. Hunting pressure alone can influence a change in distribution (Raveling 1978). Human disturbance has been shown to influence the appeal of different patches or habitats (Tombre et al. 2005), speed the dispersal of birds from staging areas (Madsen 1994), as well as reduce energy intake from reduced foraging time (Belanger and Bedard 1990). Therefore, an increase in the number of hunters, blinds, and hunting camps could be contributing to the geese flying more inland.

Changes in habitat suitability could also be influencing the decline of snow geese using the coast of James Bay, and in turn their availability to hunters. For example, confirmed changes in coastal vegetation (as reported in this study as well as other related studies) could be contributing to the inland flying pattern of the geese, which make them less visible to hunters on the coast.

There was also the local observation in the MCFN that snow geese are now coming from Manitoba. There are no technical studies documenting the population having shifted their distribution inland, or to Manitoba. However, there could also be local deviations not seen in the regional distribution mapping, and there are studies documenting migration which might explain these local observations. It could also be speculated that what hunters are observing is a more subtle shift.

Studies indicate that in the 1950s snow geese migrated from the southern United States to James Bay in the spring (Cooch 1955, MacInnes et al. 1990). In the fall, they followed the same corridor, migrating straight south from Hudson and James Bay to the Louisiana and Texas gulf coasts (Cooch 1955, Prevett et al. 1982). In the 1970s, a second group was documented as flying through Manitoba on their way to the James Bay coast (Blokpoel 1974, Gauthier et al. 1976), and in theory followed the same route back in the fall. The group flying a north-south route wintered in the Mississippi Delta, and were disadvantaged by reduced forage in comparison to the corn in the mid-continental U.S. That small population shrank, and is no longer. It is possible that the local hunters were referring to this first group.

It is logical that while the spring migration has always come from Manitoba, it would have appeared to be from the south to those living in James Bay, as the geese would make their way across the inner muskeg and arrive from a southwesterly direction. However, MCFN hunters are not observing this anymore. It could be speculated that the geese are migrating a little further north when they come across northern Ontario, due to changes in vegetation, availability of open water areas, or extinguishment of local migration traditions, thereby arriving in southern James Bay to the north of the MCFN and suggesting arrival from more of a western direction.

There were also observations on changes in the species composition of wildlife on the coast, which was linked to changes in patterns of goose migration. Local observations indicate there are more eagles in the region, which scare the geese as they feed, and fewer ducks and frogs. While there is no local technical evidence to compare with these observations on ducks or frogs, regional surveys do corroborate an increase in bald eagles in both the Peawanuck and Moose Factory areas (Ontario Partners in Flight 2010). An increase in the presence of bald eagles on the coast could be a deterring factor for geese and influencing their inland behaviour.

In summary, there have been several changes on the Hudson Bay and James Bay coast with respect to goose habitat, abundance and distribution in the past 30 to 40 years. There have been changes in climate, vegetation, species composition of wildlife on the coast, and abundance, timing and pattern of goose migration. These changes have been more pronounced in the last 15 to 20 years. Such changes are undoubtedly going to continue, and it is crucial that they be documented and monitored for the purposes of understanding ecosystem processes and adaptation.

6.2 CHANGES IN ACCESS TO AND HARVEST OF GEESE BY FIRST NATIONS

The second objective of this thesis was to identify changes in access to and harvest of geese by First Nations in the Hudson Bay Lowland, as they relate to climate change impacts on habitat, goose abundance and distribution. Identified changes included changes in hunter demographics, hunting locations, timing and duration of the goose hunt, and changes in the harvest of geese. Responses and adaptations are also discussed.

Hunter Demographics

Overall, the number of hunters in participating communities has increased, as overall community populations have increased over the last 50 years (Thompson and Hutchison 1987, StatsCan 2006). Hunters in the MCFN reported the spring harvest of snow geese as not having been significant to them in their lifetimes, while hunters in the WFN reported that it has always been important to them. These findings support other harvest surveys in the region, where while snow geese have historically been harvested in the spring in James Bay, they have not been harvested in large numbers (Prevett et al. 1983, Thompson and Hutchison 1987, Berkes et al. 1992). This explains why a decline in snow geese in James Bay has not had a significant impact on the spring goose hunt.

Few hunters in either community reported hunting snow geese in the fall today, although many did in the past. Comments were made on how the geese "taste fishy" in the fall and how hunters now harvested enough Canada geese from the spring hunt to last throughout the fall and winter months. This finding is supported by other studies (Thompson and Hutchison 1987, Berkes et al. 1992, McDonald et al. 1997).

Hunting Locations

The locations where people reported hunting have shifted, but only slightly and only in the MCFN. Hunters and their families in the WFN have gone to traditional family hunt camps in the same locations, for many years. The shift in Moose Factory is subtle in that people still largely hunt from their traditional grounds, but there has been an increase in the number of people who hunt on the Moose River and at the river mouth in spring. Fewer people hunt on the west side of James Bay, and more on the southern segment of the traditional hunting territory. Snow geese are harvested only in Hannah Bay (in the south eastern segment). Hunters explained that many hunting locations are now within closer proximity to the community as a function of time and cost. It does not take as long to travel to closer destinations, so people do not have to take as much time off work, and the cost of travel is less.

In the WFN, there has been a shift to people hunting inland and around Peawanuck, but this shift occurred when the community was moved from its original coastal location near the Winisk River mouth after the flood in 1986. These locations were also documented in an earlier study (Thompson and Hutchison 1987).

The Timing and Duration of the Hunt

The timing and duration of the hunt, as reported by hunters in both communities participating in this study, has not changed. People said that even though the weather might change from year to year, the timing of the goose migration has remained the same, and therefore they prepare and leave for the hunt at the same time. Most hunters in the MCFN reported spending the same amount of time for the spring goose hunt as they have in the past, which is about two weeks, starting around the middle of April. Those who reported spending less time were largely due to now being employed. Some hunters, who used to go out for a month or more, now only go for a week or just on weekends. Hunters in the WFN have not changed the length of time they spend hunting, with most still going out for two weeks to a month or more, also towards the middle of April.

On a related topic, while the geese are arriving in the Lowland at the same time, they are dispersing to nesting areas progressively earlier, thus reducing their availability to hunters. It is interesting that in light of this, hunters in each community have not significantly altered their timing to get ready and head out for the spring hunt. Most people in the MCFN still get ready about the same time, and head out about the same time, the second or third week in April, even if it means that they "miss the geese in an early year".

The timing of the goose hunt is based on long term knowledge and tradition. While knowledge is a process that is adaptable, rapid ecological change presents a new challenge. Some authors suggest that Indigenous ways of dealing with complexity in ecological systems are to employ a fuzzy logic approach (Peloquin and Berkes 2009). Fuzzy logic is a "form of multivalued logic that seeks explanation through approximate rather than numerically precise reasoning" (Peloquin and Berkes 2009). In theory, this approach involves constantly monitoring (even subtle) shifts and changes which inform the hunter's decision making process on where, when and how to hunt (Peloquin and Berkes 2009). Based on this reasoning, it would be expected that hunters would modify their timing in response to the shifts in behaviour of the geese; they have not.

This lack of adaptation could be a reflection of sampling error or bias, in that my sample predominantly contains traditionalists (people set in their traditional ways), and that if it contained more non-traditionalists perhaps those hunters might adjust their hunting times. It could also be a reflection of the cultural or economic difficulties in altering hunting times, such as modifying the "goose break" time in the schools, which is currently set. Or it could be that the mismatch between the timing of the hunt and optimal goose availability has not reached the critical threshold that would be necessary to adapt and modify hunter behaviour. It might also be possible that hunters only perceive that they are continuing to prepare and go out at the same time, when in reality they have adjusted their timing, if only slightly.

There has also been a change in the range of duration for time spent hunting, which could influence the harvest. The range of time spent hunting has decreased, in both communities. If people are only going hunting for a day or two at a time, and the timing is not aligned with the timing for the geese, then that could also contribute to a decline in harvest.

Also, changing characteristics of the spring melt have led to difficulties in access for the goose hunt. For example, the earlier and more rapid melting period has led to increased flooding in the hunting grounds. As one hunter commented:

"People are having to go home early and a lot of people are starting to flood, I hear, that are hunting along James Bay, along the coast line. It's because of the sun and it's so hot nowadays and it just melts a lot quicker and there's no access to and from their hunting grounds. So everybody is pretty much stuck inside their tents until the water level goes down or drains out of the swamps, drains into the river" (Darrell Isaac, youth, MCFN).

Changes in participation, location, timing, duration, and access to the goose hunt all influence the goose harvest, and the relationship between hunters and geese.

The evolving relationship between hunters and geese

The goose harvest is, and always has been, an important subsistence and cultural activity for all communities of the Lowland (Berkes et al. 1994). Northern communities, such as Peawanuck, are more reliant on the goose hunt for subsistence than the more southern Moose Factory, due to their more remote locations and isolation from southern influences (Thompson and Hutchison 1987). Moose Factory experiences a strong southern influence in terms of store bought foods and other goods (Lytwyn 2002), however, wildlife or country foods are still an important part of the diet (Berkes et al. 1992, George et al. 1993). Some of these influences include resource and industrial developments, which have increased access to and reliance on waged labour and reduced the time that people spend hunting on the land (Berkes et al. 1994, Peloquin and Berkes 2009).

Household income has shifted away from hunting and trapping and towards waged employment (George and Preston 1987). The Victor diamond mine, Ontario Northland, Air Creebec, the hospital, the band office, and other local small businesses all contribute to this social and economic shift, much more heavily in Moose Factory than in Peawanuck.

Related to the economic shift has been a social shift, where fewer youth are joining their families on the land. This is due to outside interests, including attending southern schools or pursuing waged employment, and is considered a concern by many community members. Participants observed the youth who do attend, as seeming more and more disconnected from the cultural component of the camping experience. However, cultural values towards geese have not changed and the spring Canada goose hunt retains its cultural importance. The first goose killed of the season is still celebrated at most hunt camps (Darrell Isaac, pers. comm.), symbolizing the relationship of reciprocity. Hunters are still respectful of the geese, harvesting only what they need, without wasting any of the birds (Darrell Isaac, pers. comm.). The feathers, trachea, organs and meat were reported as being utilized in most cases for food or for cultural purposes, which is consistent with past practices (Berkes 2008).

There have also been important technological and social changes in the last 50 years which influence the hunt. One elder describes several of these changes:

"Now we're living in high tech. We come in by chopper, out by chopper, but I don't mind. We used to walk from Moose Factory to (our camp). My mom and dad would have two dogs and a toboggan and all our stuff there... (It would take) one day and a half. Straight walking...Now it only takes me 15 minutes to go camping...I often tell kids that when we go to the schools, tell them how we used to go camping. We wouldn't take all kinds of junk. All we'd take was flour, baking soda, lard, tea, oats, rice, stuff like that. Now we take pop and chips and vegetables. We used to live off the land. You should see the chopper when we leave...Now when we go camping, we radio in can you bring this, can you bring that? We even made pizza there. All we ate was rabbit, partridge, goose, beaver when we were camping way out here. Those (the 1940s and 1950s) were the good old days" (Agnes Corston, elder, MCFN).

The method of travel to the hunting camps has changed. As several elders noted, when they were children in the 1940s and 1950s, people used to take dog sleds and walk long distances to their camps, over a period of many weeks. Now, most either take a snowmobile or fly in via plane or helicopter. It is faster, and they can go for a week or just on weekends. A shift from using dog sleds and canoes to snowmobiles, planes, helicopters, and freighter canoes, has increased access and speed of the hunt since the 1960s (George and Preston 1987, Tsuji and Nieboer 1999).

However, this shift in transportation is costly, in terms of capital as well as operational costs (Berkes et al. 1994). To compensate, there have been initiatives to fund helicopter access to hunting grounds since the 1980s (K. Abraham, pers. comm.). The Harvester's Program in both the MCFN and WFN is an example of an initiative to help fund travel expenses for hunters to facilitate going on the spring goose hunt.

There has also been a shift in hunters killing more geese in the spring than they need, to freeze for the spring and fall months, and lessen the need for the fall hunt. This could be partially attributed to technological advances in firearms and ammunition, and also in the ability to freeze birds beyond the spring season (Tsuji and Nieboer 1999). However, the shift to killing fewer geese has been more recent than the time of technological advancement in the 1960s. The fall hunt has been well documented until the late 1980s (Thompson and Hutchison 1987), raising questions on other potential factors contributing to a decline in the fall hunt in the last 20 years.

The decline could be related to the taste of the geese, as most hunters commented on a preference for the spring goose. Geese harvested in the spring have spent the winter eating corn, which gives the meat a much better flavour than geese in the fall which have spent the summer eating grasses on the coast (Thompson and Hutchison 1987, Berkes et al. 1992). While the shift in agriculture and a preference for the spring goose is not a new phenomenon, perhaps with the additional food subsidies available in communities in more recent years people have more choices as to what they eat and can afford to choose not to eat geese killed in the fall.

It is also possible that a shift in the timing of the fall migration has led to hunters missing the snow geese in a fall hunt. If the geese have already migrated through a hunting area, then they would no longer be available to hunters. However, the reports from most hunters interviewed in both communities indicated that very few hunters go hunting explicitly for geese in the fall, making this second speculation unlikely.

Changes in Goose Harvest

There have been changes to the number of geese killed by hunters in both Moose Cree and Weenusk. Hunters in the MCFN reported harvesting fewer Canada geese in the spring over the last 30 years and only harvesting geese of either species incidentally in the fall. The decline in spring harvest was attributed by hunters as human disturbance on the coast including an increase in hunters and camps, a decline in geese, and geese altering their flying routes to areas which do not overlap with traditional hunting grounds. Harvest is documented in other surveys, although it does not show the same trend (Prevett et al. 1983, Thompson and Hutchison 1987, Berkes et al. 1992, Hughes and Walton 2005). The number of geese killed per hunter per day has not declined significantly.

However, other factors offer possible explanations for the divergence between studies for reported kills per hunter. The first contributing factor is that harvest data are temporally limited as they are based only on one or two annual cycles, and when done only periodically they do not account for broader inter annual variation (Berkes et al. 1992). The current study has compared harvest surveys conducted over two to three year periods in 10 year intervals, with no way of accounting for the remaining years. There are also limitations in hunter reporting and data collection which could influence the calculations for numbers of geese killed per hunter per day. For example, hunters were asked to report only their personal kill, but some likely included the kills from others at their camps, inflating the overall total. Also, the time spent hunting varied significantly between hunters. This was largely due to the reported days spent hunting including non hunting days, so the results are not necessarily an accurate reflection of how many birds were killed in just one day.

Also, comparing summary results for goose harvest between studies was challenging. In addition to using slightly different combinations of communities, the specific methods and objectives also varied greatly between studies. The variables of the past studies included the number of potential hunters, the mean number of days spent hunting, the mean number of geese killed per hunter (by season as well as species) and the total harvest number for each species by season. The Hanson and Currie (1957) study had only a few raw data points, and none that could be used for this comparison. The earlier studies did not differentiate between goose species or seasons (Hanson and Currie 1957, Prevett et al. 1983). An additional difference was the use of the Moose River Check Point Station for fall data collected by Prevett et al. (1983). This is different because the check point station collected data through hunter reported kills as hunters were traveling through the area, as opposed to by interviews as in the spring, however should not affect the results. While a standardized comparison was used, it is possible that the above factors could influence its accuracy.

A second explanation is the influence of hunter perception of success. Studies on pheasants in Utah show that the number of birds seen is positively correlated with the satisfaction of the hunt (Frey et al. 2003). Several Cree hunters recalled stories passed on by their elders of black clouds of geese filling the sky. These hunters could be expecting far more birds in the sky than they actually see, and therefore determine that the number they kill has declined, when it fact it has not.

Another speculation is related to declines in goose availability not being directly linked to meta-population trends (Peloquin and Berkes 2009). There are many factors which influence the interaction between hunters and geese, including goose flight and landing pattern, feeding habits, congregation size, as well as human factors such as noise and visual disturbance (Peloquin and Berkes 2009). Hunters in the MCFN observed geese flying higher, flying at night, and flying inland, which would make them less available to hunters. These observations were also documented in McDonald et al. (1997). The number and concentration of hunters also influences goose availability and hunting success. Hunters in the MCFN with higher harvest success were at camps further from the community and the Moose River mouth, along coastal segments where the number of camps (and hunters) was more limited. This finding is supported by a study on Cree hunters in northern Quebec, who attributed these same behavioural changes of the geese (flying inland, flying at night, flying higher), as well as those of hunters, to making the hunt less successful in recent years (Peloquin and Berkes 2009). These reported behaviours of geese are also documented in the literature as responses to hunting pressure (Belanger and Bedard 1990, Madsen 1994, Riddington et al. 1996). Considering these convergences in observations on the interactions between hunters and geese, it is reasonable to suggest that these factors and behaviours could be contributing to a decreased harvest in James Bay.

There have also been changes in the range of time spent hunting and in the range of geese killed per hunter. With the exception of the spring hunt in the WFN, the ranges for both time spent hunting as well as number of geese killed per hunter has decreased. People are spending less time hunting, and depending on when they are going to their camps, this could influence the number of geese available to them to hunt.

In addition to impacts related to the goose harvest, there are also local cultural repercussions to declining goose populations or availability for hunting. One elder commented on the cultural impact of seeing fewer snow geese surrounding Moose Factory:

"The younger generation now, when they kill a wavy, they don't know what kind of bird they killed. They bring it home and say, what kind of bird is this? They didn't know whether or not they should be eating it" (Agnes Corston, elder, MCFN).

This type of observation, along with other social and technical changes to hunting, has led to the desire of community members for cultural programming, which has recently become heavily emphasized in the MCFN (Lillian Trapper, pers. comm.). Youth are being encouraged to be interested and participate in cultural events, such as the spring goose hunt, to retain some of the culture and knowledge that is being lost as communities become more connected to the south.

For harvest in the WFN, hunters reported that they are killing more geese than they have previously. This shift has occurred over the last 30 years. Also, a higher proportion of the spring kill in this community is snow geese, which is contrary to the southern James Bay area but consistent with previous studies on the southern Hudson Bay coast (Prevett et al. 1983). The increased harvest in the WFN is corroboratory with previous harvest surveys (Prevett et al. 1983, Thompson and Hutchison 1987, Berkes et al. 1992). The kill per hunter per day has increased over time, and without the increased variation between individual hunters.

A second spring hunt

A phenomenon that was expected but did not come up in any of the interviews was that of a second spring Canada goose hunt. In the early 1980s molt migrant Canada geese coming up from the northern United States and southern Ontario in late May and June received some attention by hunters (K. Abraham, pers. comm). It was considered an easier hunt as the weather was warmer, and molt migrants are large and relatively easy to kill.

It is possible to speculate as to why hunters did not mention this later spring hunt. Perhaps while the molt migrants are bigger than *interior* Canada geese, when they migrate through James Bay they are not breeding, making them leaner and possibly tougher. Geese in April are coming from the United States and southern Ontario and are fat from eating corn. It could also be due to economic or social influences. There is an established goose hunting break in April, and a Harvester's Program specifically for the April spring hunt. So perhaps hunters have already spent the time and money in April, and do not require or want to go for a second hunt. Also, the wetlands are thawed and open by June, providing more opportunity for the geese to disperse and be less available to hunters. There may also be a negative opinion about these southern geese because of their association with urban goose problems (e.g., one local phrase used to describe them was "popcorn" geese, K. Abraham, pers. comm.)

Summary

In summary, there have been changes in terms of access to and harvest of geese by First Nations as they relate to changes in goose habitat, abundance and distribution. These include changes in hunter demographics, hunting locations, timing and duration of the goose hunt, and changes in the harvest of geese in both the MCFN and WFN. There have also been important social and cultural shifts, with respect to geese. These changes have not necessarily been significant in all cases, but are reflective of a changing environment, evolving hunting practices and the relationship between hunters and geese in these two communities. The next section describes more specifically how this study has linked local observations and technical data sources, as well as some of the challenges associated with linking knowledge systems.

6.3 LINKING KNOWLEDGE SYSTEMS TO UNDERSTAND THE GOOSE-LOWLAND SYSTEM

This study has supported links between changes in climate and goose habitat in the Hudson Bay Lowland, and goose abundance, distribution and availability for hunting. (Bauer et al. 2008, Murphy-Klassen et al. 2009, Peloquin and Berkes 2009). In many cases the findings from the local observations (in the interviews with northern residents) were corroboratory or complementary to the technical information (as represented through past data sets), although areas of divergence were also found. In instances where data sets from knowledge sources were not aligned, it was largely an issue of difference in scale, either temporal, spatial, or phenomenological.

Several patterns emerged on where the data sets were corroboratory, complementary, or contradictory to one another. The instances of local observations corroborating technical data sources with the highest confidence were those where all three scales were matched. There were, however, very few of these examples. Most of the comparisons involved data sets at the same spatial scale, but differing temporal or phenomenological scales and so the confidence in comparison was low. The instances of the most corroboratory or complementary evidence was when the data sets were at the same spatial scale. The instances where data sets were the least corroboratory were with the temporal scale. While several technical studies examined the same local regions, not many of them spanned the same temporal periods discussed by hunters. There were also several instances where the data sets were incomplete or inconclusive for a particular finding, as there were only local observations or only primarily quantitative data available.

My original conceptual model for the state of the goose-lowland system was based on technical data and reports. This study has expanded the model, with findings which drew from both local observations and technical data sources (Figure 6.1). The model highlights areas of convergence, where both ways of understanding agreed on observations and suggested linkages.

Both ways of knowing identified a change in climate, along with human disturbance, as the drivers of change in the system. The relationship between hunter abundance, disturbance and flight pattern leading to goose availability was a new finding, but is supported by studies on disturbance (Madsen 1994, Tombre et al. 2005) as well as hunting pressure (Raveling 1978). The finding of a relationship between climate change and habitat suitability to goose abundance, as well as nesting, timing of migration is also supported in the literature (Bairlein et al. 2004, Visser and Both 2005). All these factors play a role in the availability of geese to hunters for harvest. The confidence level in each of these observations varies slightly depending on the scales and information available, as well as between communities.

It is relevant to discuss differences in type and scope of the knowledge being linked. This study aimed to sample different climatic regions experiencing different levels of change. The MCFN and WFN were not intended to be directly compared to each other. Although they are both coastal Cree First Nations communities who observe and rely on geese for subsistence, they are also different. They are in different ecological regions, they observe different goose populations, and they have different socio-economic conditions. The intention was to capture those differences. However, there were also important differences in linking qualitative observations specific to each community. There was a noticeable difference in the depth of knowledge of interviewees between the two First Nations. The observations by hunters in the WFN reflected a community more closely tied to the land, in terms of time spent and depth of knowledge on occurring changes. This is likely due to their remote location, smaller population, and less southern cultural influence. Generally, people in the MCFN do not spend as much time on the land as they once did (Agnes Corston, pers. comm..), and this was reflected in the information which was shared. Also, people's perception is influenced by means and extremes. In other words, people are more likely to remember extreme events than they would an average year, and these nuances could also influence the information being shared.

This model is evidence that linking different ways of knowing can be beneficial in expanding the understanding of a complex issue such as goose-ecological-human interactions in the Hudson Bay Lowland. The following section describes some of the challenges associated with this type of mixed methods approach, and how this study addressed these challenges.

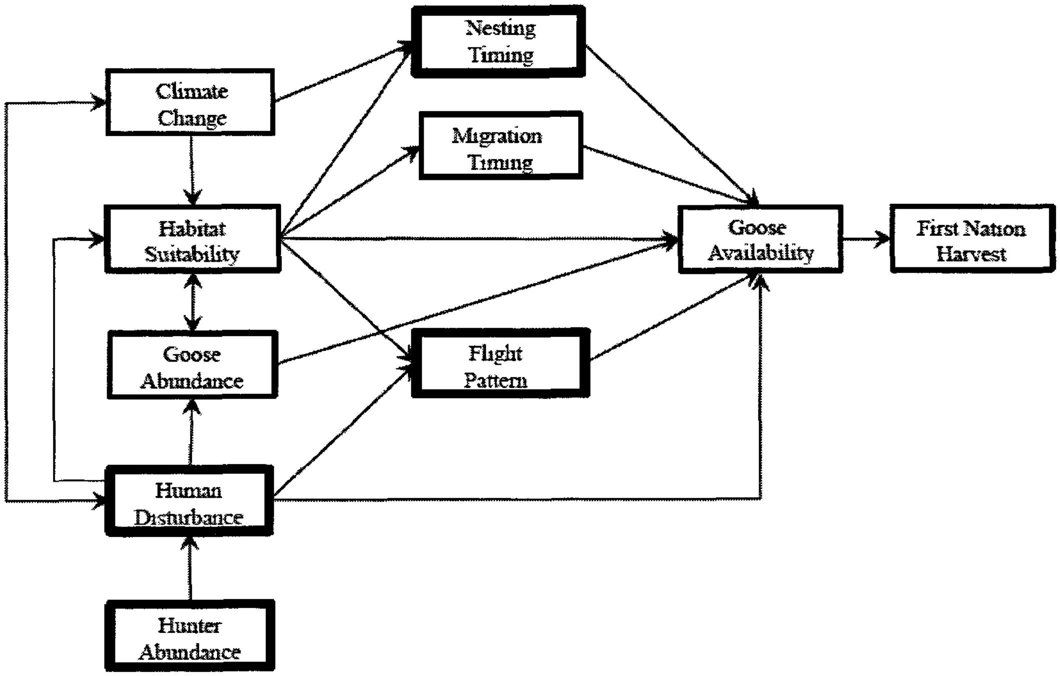


Figure 6.1. Goose-Lowland system and interactions, as observed and reported by local hunters and technical data sources. Darker boxes indicate findings specifically through linking data sets.

6.4 LINKING KNOWLEDGE SYSTEMS: SOME CHALLENGES

There are many challenges inherent to a project with a research design that involves linking knowledge systems. The challenges involved in a project using mixed methods, such as this one, are multi dimensional, and multi faceted. There are political, social, cultural, and logistical factors which add dimension to the process, and it is important to both recognize and consider these factors when designing and implementing methods.

There are issues of communication, scale and context, balance of power and ownership of information. These factors lead to challenges and limitations in initiating the project, in gathering information, in interpreting the information, and in disseminating the information. Some of these challenges and limitations are discussed, including means of addressing them for this study. Also described are recommendations on effectively overcoming these challenges, and bridging the gap between TEK/IK and science in a mixed methods research design.

Communication

Open and meaningful communication is central to the success of any research project, but especially in instances of collaboration between First Nation communities and research scientists. This communication begins with building relationships and trust, and an adequate process of determining research goals and a design that fall within the interests of both the community and the researcher. The initial contact and discussion surrounding a research project is critical for these objectives (Furgal et al. 2006). This project was initially designed with three communities in mind, but after a visit and discussion in Attawapiskat, it was determined that the timing was not ideal for that community. Initial proposals and discussion went well in both the MCFN and WFN, and minor changes were made to accommodate each community's individual interests. Contact liaisons within each community were established, and kept apprised of the project's progress, as well as aiding in planning subsequent community visits. While communicating via phone and e-mail was usually sufficient, most dialogue took place in person, while in the community. The time I spent interacting with community members, band councils, and lands and resources personnel was the most effective method of communication and building meaningful relationships.

Scale and Context

The second component and challenge to open and meaningful communication involves the gathering, interpreting, and dissemination of information. Specific challenges within this component include scale and context, knowledge possession, documentation, and the balance of power. Scale and context are fundamental components in maintaining the validity and integrity of TEK (Duerden and Kuhn 1998, Bonny and Berkes 2008), and present a challenge in both gathering and interpreting data. Interpretation of information gathered through TEK by scientists often takes TEK out of its original scale and context. Scientific studies often span larger geographic ranges than TEK research. Also, scientific terminology is not always accurate or appropriate in translating specific indigenous concepts.

These obstacles have been described by Duerden and Kuhn (1998) as abstraction and transmutation. Abstraction is where inferences are made from TEK beyond the original context and scale of which the information was collected, and transmutation is where TEK is transformed into a more contemporary form (for example from oral to written) (Duerden and Kuhn 1998). Both take TEK out of its original context and leave the contents and analysis open to often incorrect interpretation and assumptions.

In general, TEK is locally focused and provides observations for the local scale and area in which it is directed (Duerden and Kuhn 1998). Researchers cannot take local TEK and broaden its meaning to a larger geographic scale and expect the interpretations to be equally accurate. To aid with this, quotes taken from elders or hunters need to be referenced in their geographical or temporal context.

On the other hand, there is the challenge of local knowledge holders extending their observations to areas for which they have no direct knowledge. This occurred in my study where hunters were speaking to changes taking place outside their own personal experience, for example with the snow geese migration shift to Manitoba. It is therefore paramount to maintain the scales of information. Data from my interviews and scientific sources were linked using temporal, spatial, and phenomenological scales. Conclusions were strongest in instances where it was possible to verify the scales at which the observations took place and all scales matches across knowledge sources. If the scales were different, the findings could be considered linked, but only with low confidence.

Balance of Power and Documentation

There are also challenges with knowledge possession, documentation, cooperation, and the balance of power. This includes source credibility and recognition of ownership of information. The methods of documenting any TEK/IK are crucial in maintaining as much meaning and context as possible. Related to documentation is cooperation. Local people can and should be involved in the process of gathering and analyzing the documented information to ensure proper interpretation and retain cultural context and meaning, but this is often not the case (Brook et al. 2006).

The power imbalance is perpetuated by the scientific community, where science is often given priority or credence over TEK/IK when both are valid sources of information and should be balanced. "Expert based science" and "expert based knowledge" need balanced power if there are to be any successful linkages (Brook et al. 2006). This imbalance is largely maintained by what several authors term inertia and inflexibility, on behalf of researchers (Huntington 2000). Inertia is a general resistance to change, and can be overcome by continued collaborative research (Huntington 2000). Inflexibility is a resistance more specific to TEK/IK and changes required by its use, and is much more engrained and difficult to overcome because of the long standing disconnect (Huntington 2000). For these reasons I included local liaisons in the collection and interpretation of information, to ensure context, meaning and balancing power between knowledge holders. The inertia and inflexibility is not something that can be overridden overnight, however this study contributes to the growing number of projects aimed to overcome this disconnect.

Related to the balance of power is the issue of source recognition in documenting TEK and assigning credit and responsibility for the research. In TEK or IK studies, credit goes to those individuals who provided the knowledge, in addition to the researcher who collected it. However, some people may feel uncomfortable taking credit for what they perceive to be widely communal knowledge (Huntington 2006), as was the case in Peawanuck for this study. No one wanted their name affiliated with their observations, and therefore all quotes remained anonymous. Sometimes researchers can avoid this issue by assigning credit with an entire community, but this can also be problematic in that it may falsely give the impression that everyone is an equal holder of the knowledge (Huntington 2006). Or even more problematic, it may falsely imply that everyone in the community believes or knows the same thing. This is therefore an example of where there needs to be communication on both sides as to what both parties are comfortable with. In this study, it was agreed to give credit to those individuals anonymously, but as members within their community.

Data Cleaning and Verification

Additionally, informants should be given the opportunity to ensure the accuracy of the interpretations reported by the interviewers, as a type of data validation (Gagnon and Berteaux 2006). This step was also taken with my study. I distributed transcripts and presented preliminary findings in a community meeting in Moose Factory in March of 2010, with the intention of soliciting feedback from participants. Unfortunately the meeting was not well attended due to poor advertising, and I relied on the feedback of the Lands and Resources director to ensure accuracy of results. I met with each of my interviewees in Peawanuck, and we went over the interview transcript together, in some cases with the aid of a translator. This was very important as the transcripts were my notes from the sessions, and not transcribed from tape recordings. I also went back for follow up meetings at the end of the project in March 2011, to present final results and gain consent for the use of quotes. This process was more challenging in Moose Factory than Peawanuck, given that many individuals frequently leave the community, and I had to leave information and fact sheets with the lands and resources contact for distribution.

These challenges are not insurmountable, but need to be taken into careful consideration when bridging the gap between TEK/IK and science in a mixed methods research design. Communication, scale, context, documentation, and recognition are all crucial to a successful collaborative project. The next section describes the value and some of the limitations of the study.

6.5 VALUE AND LIMITATIONS OF THE STUDY

By using a novel approach and drawing on two knowledge systems, this study has expanded the way of knowing and understanding changes taking place in the Hudson Bay Lowland. Local observations and technical evidence agree on many of these changes. Areas of divergence were largely due to differences in spatial or temporal scales of the information being linked, and although potentially corroboratory or complementary, there is lower confidence in those findings. However, these findings are still valuable in providing additional points of comparison as well as set benchmarks for future work. This study has identified many areas where there is little technical data available, and emphasized the importance and relevance of including other forms of observations to understand these changes and impacts. It has also identified areas where there is no local consensus, for example the change in variation in temperature within the months of April and May.

This project has been informed of changes from hunters in Moose Factory and Peawanuck who spend a large amount of time on the land. It focused on learning from the community's perspectives and knowledge about how environmental changes may be impacting interactions with geese and traditional hunting grounds. Benefits specific to the community included the opportunity for hunters to express their knowledge and observations about geese in the lowland and to inform the needs of future programs. The study has also identified current and possible impacts of climate on an important traditional food and cultural resource. It has provided information that could aid in the development of adaptation strategies to minimize impacts of climate and other forms of environmental change on the community. In these ways, it is an important project in terms of building meaningful relationships with communities. These relationships are beneficial both to researchers, as well as community members, as both sides can expand their understanding by working together on common interests and goals. It also sets the precedent for other projects of this kind, such as the community driven harvest surveys which are currently being planned.

There were also challenges and limitations to this study. Some of these were related to the mixed methods framework and use of TEK/IK and science, some were logistic, and some were specific to the project objectives.

The foremost challenge was the difficulty in finding information at all three of the appropriate scales: temporal, spatial, and phenomenological. While this difficulty was useful in identifying gaps in understanding, it was limiting in what could be determined as corroboratory with high confidence. Much of the analysis determined complementary findings, based on differences in one or two of the three scales.

Another challenge was the affiliation I had with the Ontario Ministry of Natural Resources. There is a history of tension between the government and Cree First Nations of northern Ontario, and I had to be very careful how I presented myself when corresponding and building relationships of my own in the communities. I was able to identify myself primarily as a university graduate student, with a university project, as opposed to being primarily a representative of the OMNR. This distinction was a large contributing factor to my success with this project. People were more inclined to talk with me as a student, than as a representative from the government. It also helped that I was not asking intrusive questions, and the study was on a topic that most people greatly enjoy discussing. Community members are also keen on encouraging youth and the pursuit of learning, and my presence and interaction with youth was considered a positive influence. It had less to do with my project on geese, and mostly to do with the concept of learning and sharing knowledge.

I was limited in which communities I could conduct this study. I wanted to get a sample of changes occurring across the region, and ideally would have liked to work in Moose Factory, Attawapiskat, and Peawanuck. Moose Factory and Peawanuck were the most amenable to collaborating on the project, and also had the best working relationships with the OMNR. Logistically, they were easier to get to (via train, MNR charter or Twin Otter), and affordable accommodations were available. While I began with also including Attawapiskat due to connections there, challenges arose which made it too difficult a working relationship at this time.

The time frame of a Masters program was also limiting. Projects that involve building relationships and working with First Nations communities take a much longer time period than the two years allocated for a Masters degree. It took several months to initiate contact and establish foundations in each of the communities. Also, community visits were largely dictated by what times worked for the communities. As an example, it was not possible to visit Moose Factory in the weeks around break up or freeze up due to the inability to safely cross the river from Moosonee to Moose Factory Island. This, combined with other reasons such as various hunting seasons or community events, meant waiting a number of weeks or months past an ideal time for the graduate program timeframe.

While the objectives to the project remained unchanged, the scope of the project grew considerably. It was difficult to determine which components to examine and to what depth, given the range of topics and issues which were raised. I ended up looking at many different areas at a superficial level, instead of a few areas in greater depth. This was not a negative result, per se, but was limiting in terms of what could be focused on.

One of the biggest difficulties with this project stemmed from a series of miscommunications, and changes in community interests over the course of the project. Initial discussions with community members led to my belief that a declining goose population was of substantial interest in Moose Factory, as it was negatively affecting the harvest. Then, during the interviews, it became apparent that the decline was a concern, but not a pressing one. The topic of interest was more the change in environmental conditions, and the changing wildlife composition on the coast. This was valuable, however, the objectives of the study would have been altered had this information been known from the onset.

There were challenges in language, as many of my interviewees did not speak English. In and of itself this was not an issue, as I had the assistance of a translator. However, there were concepts that did not directly translate and it was difficult to communicate what I meant, or what the interviewee meant. There was also a complication when one of my translators began truncating interviewee responses, when hunters began saying similar things. Potentially important details got lost, or left out of the discussion.

6.6 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The climate is changing at an accelerated pace in the North, and northern First Nations communities living closely with the land are the most heavily and noticeably impacted by these changes (Huntington et al. 2004, ACIA 2005). There are many scientific studies documenting changes to wildlife populations and their habitats in northern regions; however, few studies have documented changes with respect to the impacts on and observations of the northern people (Ho 2003, Peloquin and Berkes 2009). Fewer of these have been in the Hudson Bay Lowland.

TEK/IK and science are two distinct ways of knowing, overlapping in some epistemological areas and remaining distinctly different in others. They can examine common natural phenomena and ask similar questions, however differ in worldview, methodology, and temporal and spatial scales. Comparisons and collaborations are valuable, but only when these differences and conditional bases are recognized and incorporated into the process. Also needed is the recognition of when the realities of each system are not their stereotypical ideal: each community and each project is going to be different. This recognition can best be achieved through thought out collaborative projects between local residents and researchers and properly documented and interpreted interviews. TEK must be treated as an acceptable, valid, primary source of information, and must be communicated respectfully and remaining within its ethical, cultural and contextual boundaries. In most cases, neither TEK/IK nor science in isolation is sufficient, but rather a combination of approaches is best in understanding climate impacts in the North (Riedlinger and Berkes 2001). The political, social and logistic challenges will undoubtedly remain, however if acknowledged and dealt with appropriately and respectfully, then collaborative research becomes a much more realistic endeavour.

This study has drawn from those two ways of knowing, in a study design unprecedented in the Hudson Bay Lowland. It has provided supporting evidence that there are climate changes occurring in the region, with changes to goose abundance and distribution. There are several major findings of the study. There have been changes to grass in the feeding areas, which is important as it could have implications for where geese choose to forage and in turn affect their availability to hunters. There has been a shift in pattern of migration from along the James Bay coast to inland. This shift is a new finding in western James Bay, but has been documented on the eastern side in Quebec (Peloquin and Berkes 2009). There has been a decrease in Canada geese and snow geese in James Bay, which is contrary to regional and continental population trends (US Fish and Wildlife Service 2011). There has not been a notable change in harvest, which was not expected. The timing of the hunt has not changed to coincide with earlier dispersal of geese to nesting areas; however, it could be a function of the earlier nesting not having reached a threshold which would motivate modified hunter behaviour. If the pattern continues of a shorter time between arrival and nesting, hunters might have to shift the timing of their hunt to coincide with the shifting peak in migration.

This study has also been important in the use of another scale to link data in a mixed methods design. Duerden and Kuhn (1998) emphasize scale, Gagnon and Berteaux (2009) emphasize temporal and spatial scales, but no one has included the importance of the phenomenon being examined as also being at the same scale. While the phenomenon was not always aligned between data sets, my findings were supported with higher confidence when it was. It was also a consideration in speculating for divergence. This study has supported the inclusion of phenomenological scale as an important consideration when linking ways of knowing.

This study has improved understanding of goose-environment-community interactions, and strengthened researcher-community relations in the two coastal communities of the MCFN and WFN. It has built on existing benchmarks for change and established new ones. It has identified key areas of interest for further research, including changes to vegetation and wildlife on the coast. It has contributed to the larger studies of goose ecology, human ecology, and mixed methods. This type of study is challenging, but it is also important. Such linking of knowledge and meaningful collaboration will improve the collective understanding of both communities and research partners in changing environmental conditions in these coastal regions. The climate is changing at an accelerated pace in the Hudson Bay Lowland, and it is crucial to both northern communities and resource managers to more fully understand these changes to help plan meaningful adaptation strategies.

Recommendations

Linking knowledge systems

TEK/IK and science can both provide valuable insight into understanding goose ecology in the Canadian Arctic, however there are several important factors which need to be considered in building "conceptual bridges" between these two areas of expertise (Laidler 2006). First, there needs to be an understanding that the knowledge systems are distinct and their differences in philosophy, methodology and application need to be acknowledged and respected. Second, in the context of joint projects between communities and scientists, there needs to be agreement and commonalties in the goal, scale, and interest of the phenomena being examined. Third, meaningful partnerships need to be established between the researchers and the communities involved, with open communication and ongoing dialogue. If these factors are carefully considered then the likelihood of a successful linkage between knowledge systems becomes much more feasible.

TEK and science develop from different philosophies and world views, often aim to address different questions and have different techniques for knowledge application. The first consideration is to understand an issue from both perspectives, including these underlying differences (Furgal et al. 2006, Laidler 2006, Woo et al. 2007). For the purposes of attempting to link or bring together TEK with science, each side is not meant to validate or verify the other, but rather to complement the inherent gaps of each approach and take advantage of their differences (Huntington et al. 2004). The goal with this approach is to be able to gauge confidence in individual observations and conclusions, identify new areas of investigation, compare spatial and temporal scales, and to examine potential mechanisms to explain both sets of observations (Huntington et al. 2004). That is exactly what this study attempted to achieve in gathering observations, identifying areas of interest, and explaining findings and mechanisms through linking data sets based on comparable scales.

The second factor is having the goals, interests or scale of the study aligned within both TEK and science perspectives (Furgal et al. 2006). The goals, applications and interests can be broad, such as the impact of a changing climate on goose distribution or their shifting migration patterns. The geographic and temporal scales however should be more focused to be comparable between knowledge systems (Duerden and Kuhn 1998). As in this study, it is clear that not all observations can be linked, most commonly at the absence of comparative information at a local scale. This is not necessarily insurmountable, but needs to be addressed in discussions on the confidence level of a given finding or conclusion.

Third, there needs to be a meaningful partnership between the scientific researchers and the communities involved. This meaningful partnership involves both the utilization and improvement of collaborative research methods, as well as having an open and ongoing dialogue (Furgal et al. 2006, Hotain 2006, Laidler 2006). True collaborative methods involve both sides in all steps of the research process, from project design and question/hypothesis formulation to gathering of the data to the analysis and presentation of the results. Open dialogue is important for establishing and maintaining partnerships based on respect and understanding of the other's perspectives within an "ethical space" (Hotain 2006). The main way of remaining completely transparent is to involve both sides at all stages of the project. For example, community meetings are a good way for local residents (not necessarily on the project boards or committees) and scientists to come together to share information and ideas in an open environment (Woo et al. 2007). I tried to have several of these meetings, and while not all were well attended, it was indeed an effective way of engaging interested community members and affording the opportunity for open dialogue and discussion. Effective communication will also help facilitate maintaining scale and context, both in terms of gathering and documenting IK/TEK, as well as interpreting it correctly (Duerden and Kuhn 1998).

In summary, TEK/IK and science can both provide insight into understanding goose ecology and climate change in the north, however they stand a greater chance of successful collaboration when the factors of understanding both perspectives, having common goals and scales, and establishing partnerships based on respect and ongoing dialogue are taken into consideration.

Climate change, hunting and geese in the Hudson Bay Lowland

There are additional recommendations from this study, beyond the importance of drawing from multiple ways of knowing and understanding. The importance of communication and clarity cannot be overstated. It is critical that both the communities and researchers are able to establish common goals, and be clear on their individual intentions from the beginning. While plans can evolve or change, it is crucial that all people involved are on the same page and continue to communicate throughout the project.

I would recommend the use of a university affiliation and student as a liaison between communities and government agencies, in instances where there is known tension between the groups. When done respectfully, this type of collaboration can bridge some of the tension, and offers the opportunity to overcome some of the bias by encouraging dialogue in an environment that does not resonate with negative previous experience. It is true that there are instances where students or faculty from universities have also created negative impacts and tensions, so this recommendation is project specific. However, the tensions with the government are more prevalent, or at least more recognized.

This study has raised awareness of the limitations of scientific or technical studies in the region, and areas of focus for future work. For example, one area could be sampling and studies on vegetation in key areas identified by local hunters as being significant goose habitat. Another area of interest is studies on ducks, eagles, and frogs, to expand understanding of changing biodiversity and ecosystem dynamics.

A final recommendation and deliverable from this study is the development and implementation of a community driven harvest survey. This survey would include climate related observations in addition to typical harvest collection information, and ideally be carried out annually. A template for this survey is currently being planned, and will be carried out upon completion of this study. It will be designed in collaboration with members from the communities and OMNR, and implemented by the communities. The goal is to continue to build community capacity, as well as continue to document local observations on changes in wildlife populations and landscapes in the Hudson Bay Lowland.

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APPENDIX

A.1. Letter of approval from the Trent University Research Ethics Board.

TRENT UNIVERSITY
Research Office

January 14 2009

File # 21039
Title: The Impact of Climate Change on dependence and use of waterfowl by First Nations in the Hudson Bay Lowland

Dear Ms. Robus

The Research Ethics Board (REB) has given approval to your proposal. Please provide the REB a copy of the AEC approval when it is received.

Please add a running footer to your consent form, with the date of Trent REB approval and consent revision number (e.g., 20-Nov-07, Version 2), so that the consent form used can be easily identified in future.

In accordance with the Tri-Council Guidelines (article D.1.6) your project has been approved for one year. If this research is ongoing past that time, please submit a Research Ethics Annual Update form, available through the Office of Research and Graduate Studies.

Please note that you are reminded of your obligation to advise the REB before implementing any amendments or changes to the procedures of your study that might affect the human participants. You are also advised that any adverse events must be reported to the REB.

On behalf of the Trent Research Ethics Board, I wish you success with your research.

With best wishes,

Gillian Balfour, PhD
Associate Professor, Department of Sociology
Chair, Research Ethics Board

Phone: (705) 748-1011 ex. 7607
Fax: (705) 748-1213
Email: gillianbalfour@trentu.ca

c.c.: Karen Mauro, Office of Research

A.2. Project proposal letter to Chief George Hunter of the Weenusk First Nation (same letter sent to Chief Norm Hardisty Jr of the Moose Cree First Nation).

TRENT UNIVERSITY

Environmental Life Sciences Graduate Program
1600 West Bank Drive
Peterborough, Ontario K9J 7B8

Chief George Hunter
Peawanuck First Nation
P.O. Box 1
Peawanuck. Ontario
P0L 1A0

January 30 2009

Dear Chief Hunter,

A partnership of researchers from across Canada and northern Europe has recently received funding for an International Polar Year (IPY) project on northern ecosystems and climate change. This project is called ArcticWOLVES (which stands for Arctic Wildlife Observatories Linking Vulnerable Ecosystems). Within Canada. the study areas include six locations in the eastern Canadian Arctic and the sub-Arctic of Southern Hudson Bay and James Bay. You may see more information on the web at: http://www.cen.ulaval.ca/arcticwolves/en_intro.htm

Trent University and researchers with the Ontario Ministry of Natural Resources are partners in ArcticWOLVES. One sub-project of ArcticWOLVES is designed to gain a better understanding of the current abundance. distribution and harvest of a variety of wildlife species, as well as changes over time in the numbers, movements and habitats of these animals. In Ontario, this will focus on waterfowl and will be based on interviews with northern residents who have acquired an intimate knowledge of the land through years of direct experience and observation. We hope to learn about changes they have observed in waterfowl populations and the land and especially about how environmental changes are impacting their interactions with waterfowl.

The species of most interest to this study are geese. Other waterfowl may also be included depending on what northerners would like to discuss. Information on observed changes in habitats are also important and of interest. A comparison of trends for geese will aid in understanding the biological and social impacts of climate change.

The Ontario Hudson Bay Lowland project will be undertaken by myself as a graduate student at Trent University, with financial support from the IPY program and Ontario Ministry of Natural Resources.

I hope to conduct surveys and interviews in three of the seven main communities: Peawanuck, Attawapiskat, and Moosonee/Moose Factory. These communities were chosen based on their locations, as they represent three different regions experiencing different impacts of change across the Hudson Bay Lowland. All three communities hunt Canada and Snow Goose during spring and fall migration, however, proximity to nesting birds and abundance of migrants differ among them. Peawanuck is located near the Hudson Bay coast where both goose species have increased significantly over the past 3 decades and where both nest in high density. Attawapiskat is located on the western James Bay coast where migrant snow geese are still abundant and nesting snow geese and Canada geese are also in high numbers. Moose Factory and Moosonee are located at the southern end of James Bay. Until the early 1990s, snow geese were abundant during fall migration and supported both subsistence and tourist harvest.

I have already been in contact with the Attawapiskat and Moose Cree First Nations, and both have shown significant interest in my project. I would like to discuss my proposal with your community and hope that you will be interested in participating. Copies of any and all of the information would be left with the community, in addition to being used for my graduate thesis and publication. In view of the many changes occurring at a rapid pace in the north, we feel that this study will give local residents, researchers and the public an awareness of what is happening on the land. We also hope that the information we propose to gather will help predict future changes and impacts and provide the tools for communities and governments to make appropriate management decisions to ensure sustainability of the resources.

I look forward to building a partnership with you. I will contact you in the near future to follow up this letter, to discuss the proposal and answer any questions you might have. In the meantime, please feel free to contact us if you have any questions or concerns.

Sincerely,

Jenn Robus
Graduate Student
Environmental Life Sciences Program
Trent University

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Wildlife Research and Development Section
Ministry of Natural Resources

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IPY·API
International Polar Year
2007-2008 Année polaire internationale

Wildlife Research & Development Section
Ontario

A.5. Consent form used in the Moose Cree First Nation for interviews with northern residents (same consent form used in the Weenusk First Nation).

TRENT UNIVERSITY

Environmental Life Sciences Graduate Program
1600 West Bank Drive
Peterborough, Ontario K9J 7B8

Consent Form:

Study on the Use of Waterfowl by First Nations Communities in the Hudson Bay Lowland

This study builds on a preliminary harvest survey conducted by Mushkegowuk Environmental Research Centre (MERC) in conjunction with Canadian Wildlife Service (CWS) and the Ministry of Natural Resources (MNR) in 2005. At that time, community members expressed an interest in sharing their experiences and working together in the future on the topic of habitat changes in coastal communities. This project is in direct response to that interest. The main focus of this study is to examine how climate change and its impacts on habitat may be impacting waterfowl populations, and what that means in terms of impacts for First Nations communities in the Hudson Bay Lowland. Specifically, this study would look at whether goose hunting patterns are changing over time, how, why and what impacts these changes may be having on your community. This project would be informed of changes in goose populations and the land from your community and the hunters and families that spend a large amount of time on the land. It would focus on learning from the community's perspectives and knowledge about how environmental changes may be impacting their interactions with waterfowl and their hunting grounds.

All data collected through the community members as part of this project will be fully recognized as such in the reports and additional products, and the ownership of the data collected will remain with the Moose Cree First Nation. Ethics approval for this proposal has been received from Trent's Research Ethics Board, in addition to the Trent Aboriginal Education Council. Information regarding the ethics process can be obtained directly from the Office of Research through the contact information below.

I understand that by signing this form I am agreeing to voluntarily participate in an interview with the understanding that I can withdraw at any time. I understand that I will be financially compensated for my time, upon completion of the interview. I understand that the ownership of the data will rest with the community, and that only aggregate data will be used in the reports. I understand that my name and identifying information may be used in the final report but I will be given the opportunity to review the report and consent to the inclusion of such information in the final report.

☐ I would like to remain anonymous

☐ Upon request and review of the report I may consent to the inclusion of my name and identifying information in the final report

Contact Information:

Graduate Student: Jenn Robus. Environmental Life Sciences Program, jenniferrobus@trentu.ca
Faculty Supervisor: Ken Abraham, Ontario Ministry of Natural Resources, ken.abraham@ontario.ca
Trent Research Ethics Board- Research Office: Karen Mauro at 1 (705) 748-1011 ex 7050 or e-mail: kmauro@trentu.ca.

Name of Participant: ______________________________

Address (to mail cheque to): ______________________________

Signature of Participant: ______________________________

Date: ______________

IPY-API International Polar Year 2007-2008 Année polaire internationale

Wildlife Research & Development Section Ontario

Approved by Trent REB January 14 2009-draft 2

A.6. Interview Guide for interviews with northern residents in the Moose Cree First Nation (the guide was the same in the Weenusk First Nation, with the exception of the Harvester's Support Program section).

TRENT UNIVERSITY

Environmental and Life Sciences Graduate Program
1600 West Bank Drive
Peterborough, Ontario K9J 7B8

MOOSE CREE FIRST NATION SPRING HARVEST 2009

This survey has two parts. The first part is part of my project studying geese and their changing patterns in the Moose Cree community. The second part is a survey of the Harvester's Support Program, as directed by the Moose Cree Lands and Resources.

PART ONE: OBSERVED CHANGES

Section 1: Hunter Profile

1. Date of Interview ______________
2. Interviewer Name ______________
3. Interpreter/Note taker Name ______________ Voice recorded ☐
4. Community ______________
5. Hunter's Name ______________
6. Gender Male ☐ Female ☐
7. Elder (>40 yrs) ☐ Experienced Hunter (25-40 years) ☐ Youth (10-25 years) ☐
8. Coast or Inland Hunter Spring: Coast ☐ Inland ☐ Both ☐
   Fall: Coast ☐ Inland ☐ Both ☐

Section 2: Change Questions

1. Has the number of geese you've killed per year changed (in the last 10 years)? Any explanation as to why you think this has occurred?

FALL- Canada Geese

____
____
____
____

FALL-Snow Geese

____
____
____
____

SPRING-Canada Geese

____
____
____
____

SPRING-Snow Geese

____
____
____
____

OTHER- (ie Ross' Goose, Small Canada Geese)

____
____
____
____

July 26 2009-final

2. Has the number of days you spend hunting changed (in the last 10 years)? Any explanation as to why?

SPRING

____

FALL

____

3. Thinking of one location you know best and over the years you have been on the land, have you noticed changes in the timing of goose migration? Any explanation as to why?

Location: ______________________________

SPRING: Snow geese Earlier ☐ Later ☐ Same/No difference ☐

When does it occur now? ______________

How much earlier/later is this than 10 years ago? __________

(Are they arriving earlier, leaving earlier?

Has the hunting period changed? Ie the peak of migration seems to be the same)

____

SPRING: Canada Geese Earlier ☐ Later ☐ Same/No difference ☐

When does it occur now? ______________

How much earlier/later is this than 10 years ago? __________

____

FALL: Snow geese Earlier ☐ Later ☐ Same/No difference ☐

When does it occur now? ______________

How much earlier is this than 10 years ago? __________

____

FALL: Canada geese Earlier ☐ Later ☐ Same/No difference ☐

When does it occur now? ____________________

How much earlier/later is this than 10 years ago? __________

4. Thinking of one location you know best and over the years you have used / visited on the land, have you noticed a change in the number of geese in the area? Any explanation as to why?

Location: ____________________

Spring.

Snow geese	More ☐	Less ☐	Same/No difference ☐
Canada geese	More ☐	Less ☐	Same/No difference ☐

Fall:

Snow geese	More ☐	Less ☐	Same/No difference ☐
Canada geese	More ☐	Less ☐	Same/No difference ☐

5. Have you noticed any other major changes in the environment or kinds of waterfowl (ie ducks) in this location that you have been hunting / visiting / using, in the past 10 years? Please explain

6. Have you noticed a change in the condition of the geese? (ie if they look, act, taste different)? *(spring vs fall)*

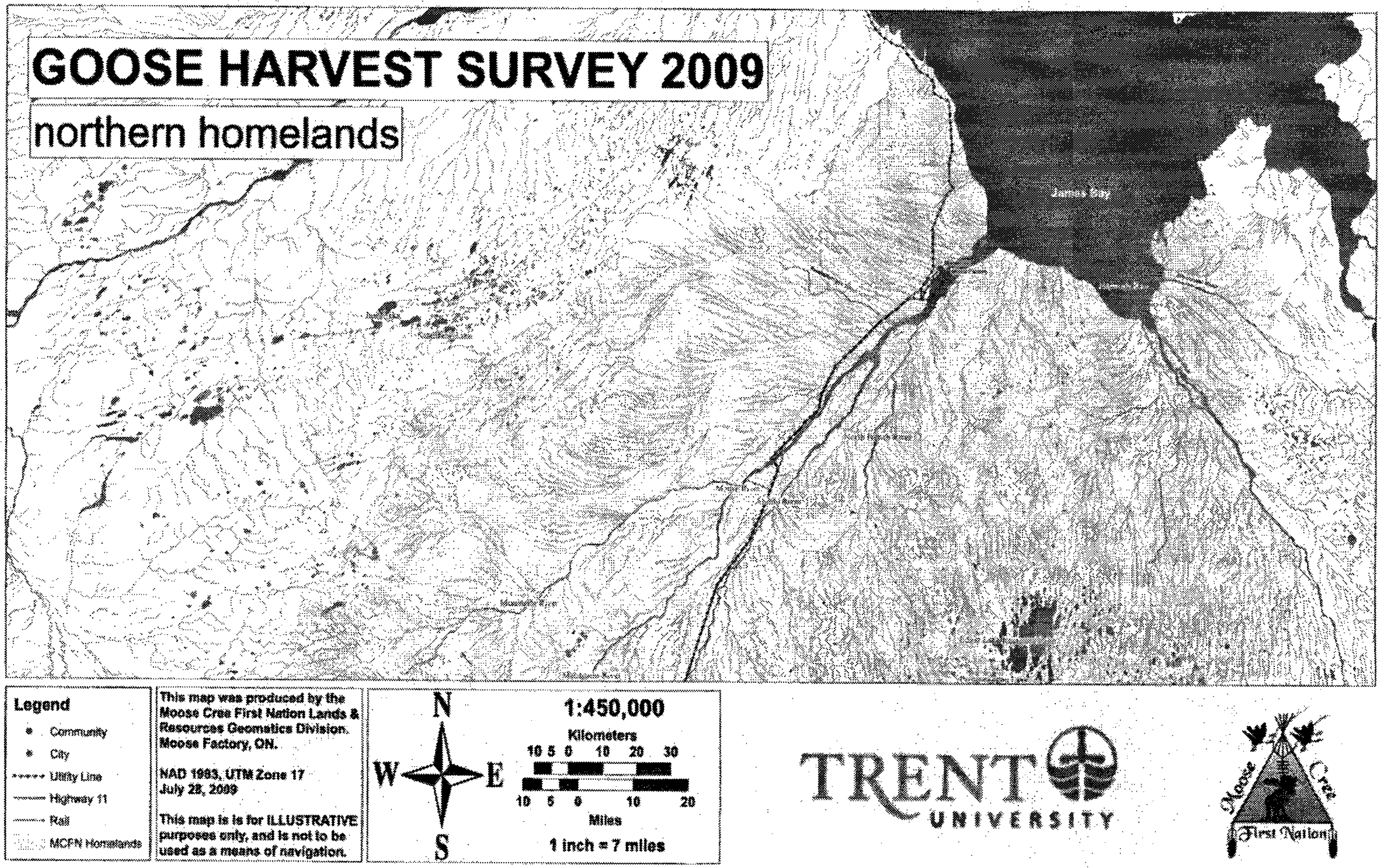
July 26 2009-final

Other notes of interest:

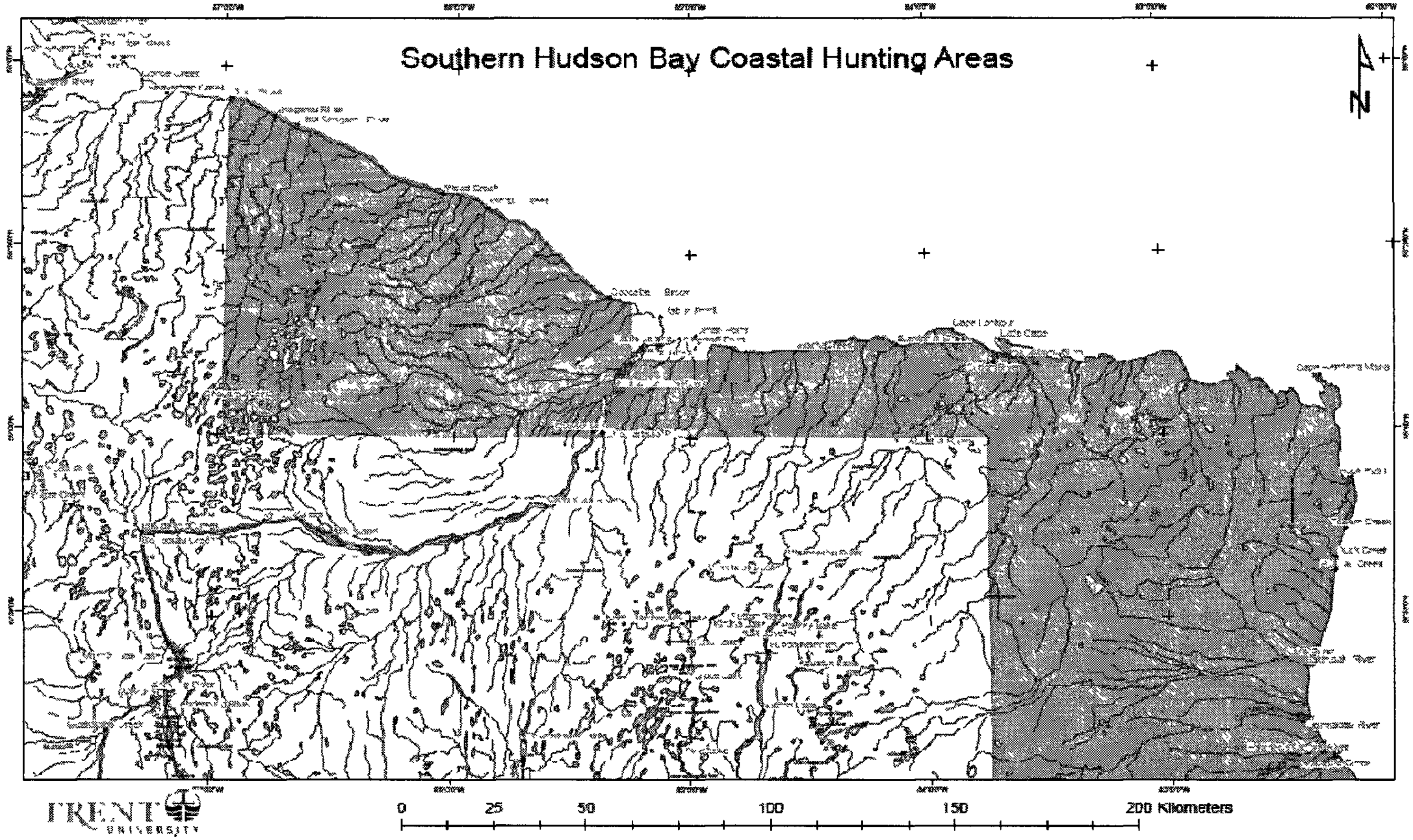
IPY-API
International Polar Year
2007-2008 Année polaire internationale

Wildlife Research & Development Section
Ontario

A.7. Map used in interviews with northern residents in the Moose Cree First Nation. Created by Allan Cheechoo.



A.8. Map used in interviews with northern residents in the Weenusk First Nation. Created by Kevin Middel, OMNR.



A.9. Master table for linking data sets between local observations and technical data sources.

Observations gathered through interviews with northern residents	Information gathered through technical data sources	Scale: Temporal, Spatial, Phenomenological	Corroborating, Contradictory, Complementary
WEATHER			
Spring is warmer	Spring temperatures have increased	Same	Corroborating
Spring is earlier	Earlier break up of Moose River	Different phen.	Complementary
Freeze up is later on lakes and rivers	Later freeze up on James and Hudson Bay, not significantly later on lakes and rivers	Different spatial	Contradictory- low confidence
Increased variation in temperature within the months of April and May	Not a significant increase in number of extreme days or inter annual range of temperature	Different phen.	Contradictory
Sudden shifts in wind direction	n/a	n/a	Inconclusive
HABITAT			
Coast is drier	Decrease in precipitation	Different spatial Different phen.	Contradictory-low confidence
Change in the types of grasses on the coast	Shift in the composition of coastal grasses (James Bay only)	Same	Corroborating
Fewer berries	No local data available	n/a	Inconclusive
More eagles	Increase in eagles	Same	Corroborating
Fewer ducks	Ducks are stable	Different spatial	Contradictory
GOOSE ABUNDANCE			
CAGO decreasing (1980 to 2009)	CAGO (SJBP*) now stable (1989 to 2010)	Different temporal Different spatial	Contradictory- low confidence
CAGO increasing (1970 to 2009)	CAGO (MVP**) increasing (1970 to 2009)	Different temporal Different spatial	Complementary- low confidence

*SJBP- Southern James Bay Population **MVP- Mississippi Valley Population

Observations gathered through interviews with northern residents	Information gathered through technical data sources	Scale: Temporal, Spatial, Phenomenological	Corroborating, Contradictory, Complementary
SNGO-James Bay decreasing (1980 to 2009)	SNGO decreasing (1975 to 1985, 2009)	Same	Corroborating
SNGO-Hudson Bay- increasing (1970 to 2009)	SNGO increasing (1975 to 1984)	Same- but limited temporal period	Corroborating- low confidence
GOOSE MIGRATION - TIMING			
CAGO arriving in spring at the same time, or varied	CAGO (SJBP) arriving in spring at the same time	n/c	Inconclusive
CAGO arriving in spring at varied times- no change	CAGO (MVP) arriving in spring at varied times-no change	Same	Corroborating
CAGO leaving in the fall at the same time	CAGO (MVP) leaving in the fall at the same time	Same	Corroborating
SNGO in James Bay-inconclusive	SNGO arriving in spring at the same time, leaving early in the fall	n/c	Inconclusive
GOOSE MIGRATION - PATTERN			
CAGO shifting inland	No shift in band recoveries of CAGO (SJBP)	Different spatial Different phen.	Contradictory- low confidence
CAGO not shifted	No shift in band recoveries of CAGO (MVP)	Different spatial Different phen.	Complementary- low confidence
SNGO- James Bay-shifting west and inland	No shift in band recoveries	Different spatial Different phen.	Complementary- low confidence
SNGO-Hudson Bay-directional change (west)	No shift in band recoveries	Different spatial Different phen.	Contradictory- low confidence
DURATION OF GOOSE HUNT			
MCFN-less time	Less time	Same	Corroborating
WFN- same length of time	Same length of time	Same	Corroborating

A.10. Currently reported and historical harvest survey records for harvest of geese in the Moose Cree and Weenusk First Nations

	Currently reported via interviews with northern residents	**Data gathered through historical harvest surveys**	**Scale: Temporal, Spatial, Phenomenological**	**Corroborating, Contradictory, Complementary**
MCFN				
CAGO -spring	Decrease	No change	Same	Contradictory
CAGO -fall	Never have	Have in past	Same	Contradictory
SNGO -spring	Decrease	Decrease	Same	Corroboratory
SNGO -fall	Decrease	Decrease	Same	Corroborating
WFN				
CAGO -spring	Same	Increase	Same	Contradictory
CAGO -fall	Decrease	Decrease	Same	Corroborating
SNGO -spring	Same	Increase	Same	Contradictory
SNGO -fall	Decrease	Decrease	Same	Corroborating

CAGO: Canada geese
SNGO: Snow geese