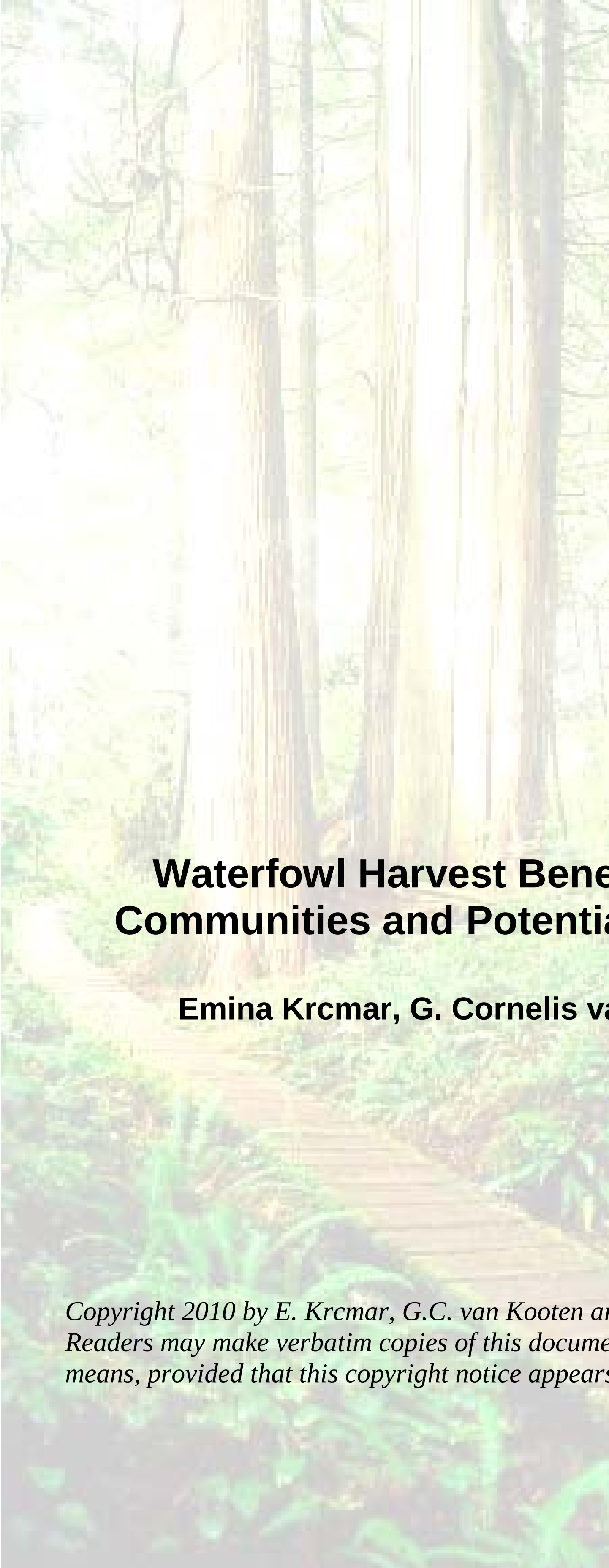

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Waterfowl Harvest Benefits in Northern Aboriginal Communities and Potential Climate Change Impacts

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Waterfowl Harvest Benefits in Northern Aboriginal Communities and Potential Climate Change Impacts

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ABSTRACT

Migratory waterfowl are important to the diets of residents in Canada's northern communities. Contrary to recreational hunters, indigenous peoples have rights to harvest wildlife for subsistence needs without permits. As a result, migratory waterfowl are an important component of diets of Aboriginal peoples in northern Canada, substituting for expensive beef transported from the south. Wild geese and duck provide many benefits to native people, including improved nutrition and health. In this paper, scaled-down data from global climate models are used in a wildlife model to project potential migratory waterfowl abundance in the Northwest Territories for three future periods up to 2080. The models project potential future harvests of geese and ducks by Aboriginal hunters and the financial and nutritional benefits. It turns out that northern Aboriginal peoples can benefit significantly as a result of climate change that affects migratory waterfowl, but likely at the expense of hunters and recreationists in other regions of North America.

Keywords: subsistence harvests by indigenous peoples; diet and nutrition; climate change
JEL Classification: Q54, O13

1. INTRODUCTION

Canada is a major breeding ground for the Pacific, Central, Mississippi and Atlantic flyways. In most North American studies of migratory waterfowl, the focus is on the value of waterfowl to U.S. hunters (e.g., Johnson et al. 1997). Neglected in studies of migratory waterfowl is the importance of waterfowl to the subsistence needs of native North American communities and the impact of climate change on the abundance, harvest and consumption of waterfowl. The specific objective of this study is, therefore, to assess the current and future supply of waterfowl to communities located in the far northwest of Canada. We also focus on the potential climate-induced changes in the future supply of migratory waterfowl, and analyze possible adaptation strategies to address subsistence needs as waterfowl availability changes.

The study region of far northwest Canadian is located in the northernmost part of the Western Boreal Forest, which is the third most important waterfowl habitat in North America. Climate change effects are expected to be more pronounced in this region than elsewhere in North America (Nicholls et al. 1995; Zhang et al. 2000). Meanwhile, waterfowl are a critical non-commercial food source for many First Nations and northern communities in this region of Canada (Lévesque and Collins 1999). Previous impact studies have reported a general tendency for waterfowl to move northwards (Peterson 2003). It is important, therefore, to identify potential range shifts for waterfowl as early as possible to facilitate gradual adaptation processes.

Subsistence use of migratory waterfowl (especially ducks and geese) is impacted not only by climate change and other biological factors, but also by socioeconomic factors and policies that may be even more important. In particular, subsistence use of migratory birds is impacted by (1) hunting patterns over time; (2) the number of active sport hunters, including ones without hunting permits; (3) the number of subsistence hunters who are not required to have a hunting permit; (4) average harvests per hunter (harvest efficiency); and (5) changing dietary preferences due to readily available non-traditional foods, health considerations, potential contamination of traditional food and waterfowl, relative food prices, and other factors. We analyze the first four factors, along with waterfowl abundance, with the fifth considered to be beyond the scope of this study.

2. HARVEST PATTERNS AND TRENDS

Sport harvest

Hunters in Canada (including foreigners) are legally obliged to buy federal permits in addition to provincial hunting licenses, although an exception is made for Aboriginal peoples. The permitting process was introduced in 1966 and is used to estimate the numbers of hunters and annual harvest of waterfowl. The Canadian Wildlife Service of Environment Canada conducts an annual National Harvest Survey (NHS) to estimate the numbers of hunters and actual annual harvests of migratory game birds in Canada.[1] The results of the NHS do not include estimates of illegal harvest and legal hunting (but without permits) by Aboriginal people.

Over the period 1974 through 2008, an annual average of 2921 ducks were harvested by 218 hunters in the NWT, with an average take per hunter of 14.3 ducks. Comparable figures for geese, but then for the period 1974 through 2006 (for which data are available), are 357 birds harvested per year by 62 hunters for an average take of 5.8 geese. The patterns of annual harvests and average take per hunter for ducks and geese are provided in Figure 1. Notice that harvests, numbers of successful hunters and average takes are quite variable from one year to the next,

[1] According to the National Wildlife Research Center's website, "the most recently published data from the National Harvest Surveys" end in 1993 (see http://www.cws-scf.ec.gc.ca/nwrc-cnrf/default.asp?lang=en&n=CFB6F561 viewed April 20, 2010). The reference is to a report by Lévesque and Collins (1999). Yet, with a little effort, it is possible to obtain more recent data.

although this may be partly due to sampling methods as standard errors of estimates are relatively high. The sales of hunting permits are very low in the NWT and Yukon, and are typically not reported, thereby explaining the low and variable annual harvest levels and differences in mean take per hunter compared with those elsewhere in Canada (Boyd, Lévesque and Dickson 2002).

<Insert Figure 1 about here>

Subsistence harvest

The total numbers of ducks and geese shot in Canada in any year are much higher than estimates based on information from purchasers of hunting permits (Lévesque and Collins 1999; Boyd et al. 2002). Unlike the NHS data reported in Figure 1, studies of the subsistence harvest, share and consumption of waterfowl are rare. Indeed, the only truly comprehensive study of subsistence harvest in far northwestern Canada was conducted for the period 1988-1997 in the Inuvialuit Settlement Region (ISR) shown in Figure 2 (Inuvialuit Harvest Study, or HIS, 2003). The ISR consists of six communities: Aklavik, Holman, Inuvik, Paulatuk, Sachs Harbour and Tuktoyaktuk.

<Insert Figure 2 about here>

Traditional food is defined as culturally-accepted food that comes from the local environment (Kuhnlein 2003). For some Aboriginal peoples, traditional food plays a central role in the life of the individual, the household and the community. Traditional food use is highest in Inuit communities, followed by Dene and Métis communities of the Northwest Territories and then the First Nations people of the Yukon (Receveur et al. 1997). Even though a relatively small portion of total dietary energy may come from traditional food, its nutritional benefits and contribution to the total diet are substantial. Research findings are consistent across the Canadian Arctic and confirm that traditional food improves diet quality because it has lower fat and saturated fat content with significant quantities of protein, iron and zinc. For some Aboriginal peoples, traditional food contributes to more than 50% of daily intake of protein and some vitamins and minerals (Wein 1995).

Traditional food is an integral component of Aboriginal health, with the increased physical activity associated with the outdoor activity providing an additional health benefit. The hunting, fishing and gathering of traditional food and sharing it among community members brings individuals and families (including the older generation) together, while passing the common culture to the next generation. A survey of communities in the Yukon and western NWT found that traditional foods (i) helped keep people in tune with nature; (ii) promoted sharing and interpersonal relations in the community; (iii) taught children survival and food-preparation skills; (iv) provided opportunities for learning; (v) promoted respect for others; and, if a hunt was successful, (vi) instilled confidence and self assurance (Kuhnlein et al. 2004).

To obtain data on Inuvialuit harvest levels, a harvest survey was conducted from 1988 to 199. Inuit hunters were asked to report the total number of animals of each species that they harvested for subsistence use or commercial sale. Subsistence use was defined as “the taking of wildlife by Inuvialuit for their personal use for food and clothing and includes the taking of wildlife for the purpose of trade, barter and sale among Inuvialuit and trade, barter and sale to any person of the non-edible by-products of wildlife that are incidental to the taking of wildlife for their personal use” (IHS 2003). Total annual migratory waterfowl harvests, number of Inuit hunters of geese and ducks, and mean harvest per Inuit hunter are provided in the Figure 3 for the years 1988 through 1997.

<Insert Figure 3 about here>

The waterfowl subsistence harvests of geese and ducks, and the number of Inuit goose and duck hunters, in the ISR are depicted in Figures 3(a) and 3(b), respectively. Interestingly, but not unexpectedly, there were significantly more Inuit (non-permit) goose hunters in the decade beginning in 1988 than sport (permit) hunters, while subsistence harvests of geese greatly exceed those of sport goose harvests. There were slightly less Inuit duck hunters than ‘permitted’ duck hunters in the NWT, with the latter having somewhat higher average harvests (compare Figures 1(c) and 3(c)) for the decade in question (probably because the lower part of the NWT, outside the IRS, is more productive of ducks). The reason why Inuit hunters focused more on geese than ducks is because geese are much larger and have more meat. This indicates that native harvests are truly for subsistence and not sport purposes.

3. PROJECTED CLIMATE-INDUCED CHANGES IN WATERFOWL HARVEST

In this study, analyses of the historic climate effects on waterfowl abundance are conducted using historical bird data from the Waterfowl Breeding Population and Habitat Surveys of the Canadian Wildlife Service and the U.S. Fish and Wildlife Service (USFWS). These surveys have been continuous since the 1950s, and cover all major waterfowl regions in North America, including our study region. We employ historic climate data from the Canadian Climate Archives, matched by location to the waterfowl surveys. The analyses are conducted spatially at the USFWS stratum level, with six strata located in the Northwest Territories (strata 13 through 18, although 13 and 18 are quite small).[2] Downscaling analyses indicate that the USFWS strata boundaries, which are defined in part by waterfowl habitat quality, are an appropriate scale for the climate data (Chan-McLeod and Krcmar 2007).

Climate change scenarios

To identify potential shifts in waterfowl abundance due to climate change affecting the Northwest Territories, models relating bird parameters and environmental conditions are applied to 29 individual climate change scenarios for three different periods of time (Chan-McLeod and Krcmar 2007). Because of the many uncertainties associated with the initial conditions for various physical parameters, it is important to use climate data across a wide range of scenarios. The climate change scenarios are generated using the Pacific Climate Impacts Consortium (PCIC) Regional Analysis Tool.[3] This tool has analytical capabilities for downscaling global climate model data. The 29 individual climate scenarios are constructed using the results from seven climate models, or General Circulation Models (GCM), at seven different agencies – CGCM2, GFDLR30, ECHAM4, CSIROMMk2b, CCSRNIES, HADCM3, and NCARPCM. Scenarios have different inherent assumptions regarding population growth, economic growth, energy use, land use and so on, representing average as well as extreme ranges of projected changes for the study region. The averages of the 29 scenarios in each of the three time periods are used to illustrate the effects of climate change on bird communities.

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[2] A map of the various strata is found in Zimpfer et al. (2009, p.5). Only the very small stratum 13 and a large part of stratum 14 lie within the ISR region of Figure 2. Of these, Holman and Sachs Harbour lie outside the boundaries of the U.S. Fish and Wildlife Service's waterfowl breeding habitat surveys.

[3] This tool is found at http://pacificclimate.org/tools/regionalanalysis/ (viewed April 19, 2010).

The climate change scenarios are applied to regional normal values of the climate variables, based on their historical average for the period 1961-1990.[4] The climate change effects on waterfowl abundance are projected for the years 2020, 2050 and 2080, relative to regional normal values of waterfowl abundance based on averages for the same 1961-1990 period. Because any scenarios from a GCM model have equal probability of occurring, we simply present the mean waterfowl response over all projected future climate scenarios.

Climate impacts on waterfowl abundance

Mean climate change effects are projected for two types of waterfowl (ducks and geese) across geographic strata in the Northwest Territories. The effects of climate change, when averaged over the 29 scenarios in our model, vary depending on waterfowl type, geographic stratum and time period. We present our results for stratum 14, which we assume represents the impact on the ISR, and the entire NWT. Although both the Northwest Territories and stratum 14 are projected to experience significant climate change impacts on future abundance of waterfowl, impacts are much stronger for stratum 14 (as it lies in the northern portion of the NWT). Projected average annual changes in waterfowl abundance for stratum 14 and the entire NWT are presented in Table 1.

Climate impacts on waterfowl harvest

Assuming that harvest patterns do not change over time, we project climate-induced changes in the annual harvests for sport purposes in the Northwest Territories, as well as the changes in the annual subsistence harvest in the ISR. Actual and projected climate-induced

[4] Historical instrumental temperature records constructed by the Climate Research Unit at East Anglia University are in terms of a 1961-1990 climate average (see Jones et al. 2010).

changes in the harvest of waterfowl by sport hunters in the NWT are presented in Table 2, and the corresponding subsistence harvests in the ISR are provided in Table 3.

Significant climate-induced changes in harvests of waterfowl are projected for both sport hunting and subsistence purposes in the Northwest Territories. Relative to the observed 1991-1993 harvest, the mean annual sport harvest of waterfowl in the NWT is projected to increase by about 3.8%, 26.2% and 89.9% by 2020, 2050 and 2080, respectively (Table 2). Using the projected impact of climate in stratum 14, the mean annual subsistence harvest of waterfowl in the ISR is projected to increase by 27.2%, 90.6% and 268.1%, respectively, by 2020, 2050 and 2080, relative to the observed 1988-1997 harvests (Table 3).

It is important to note that the waterfowl harvest projections were made under the assumption of unchanged harvest patterns and trends, while studies based on surveys of hunters find a secular decline in waterfowl hunting in Canada (Boyd, et al. 2002). However, this applies only to non-subsistence hunting.

4. IMPACTS ON CONSUMPTION AND NUTRITIONAL VALUES

The Inuvialuit Harvest Study (IHS 2003) survey results do not permit analysis of the consumption and sharing/trade of waterfowl harvest. Although no data are available regarding the contribution to diets of waterfowl taken by sport hunters, we can safely assume that harvested birds have been widely used for human consumption. In addition to cultural and social values of traditional food, its economic value is significant.

Wein (1994) calculates the costs of a weekly food basket for northern communities, known as the Northern Food Basket, and compares this to the costs of purchasing the same basket in large centers to the south. The Northern Food Basket includes 46 foods that can usually be found in the north. In communities in the Northwest Territories, the average weekly food basket was priced at $182 (and ranged between $133 and $254), while the price of the same basket in Edmonton was $110.

What is the impact of subsistence hunting of waterfowl, particularly geese? Using published data for domesticated birds (USDA 2005), we estimate average yields of 0.540 kg and 1.122 kg for the meat and skin of a duck and goose, respectively. Assuming the average cost of beef in small northern communities is $14.00/kg (Wildlife Division-Government of the Northwest Territories 2004), the annual economic value of the waterfowl subsistence harvest for 1988-1997 varied between $89,000 and $202,000. Using projected changes in the harvests of geese and ducks by 2020, 2050 and 2080, we estimate the economic impacts of increased sport and subsistence harvests (Table 4).

For sport hunters in the Northwest Territories, the projected annual value of increased waterfowl harvest averages $491, $3,427 and $11,753, respectively, by 2020, 2050 and 2080. Although a low financial value, it is significant relative to the level of harvest for hunters with permits. The projected annual value of increased harvests by subsistence hunters in the ISR averages $38,868, $129,726 and $ 383,753 by 2020, 2050 and 2080, respectively. While the survey data (IHS 2003) do not provide household level data on expenditures, and Aboriginal hunters are unlikely to fulfill all of their protein requirements from migratory birds, it is clear that the projected benefits from climate change can be significant.

Two caveats need to be mentioned. First, the results depend on whether climate change occurs as projected and that the impacts on duck and geese populations are as anticipated here. Second, outcomes are sensitive to food replacement costs and dietary preferences, which vary over time and across communities, and this will affect how people adapt to changes in the availability of waterfowl for subsistence. Although only a relatively small portion of total dietary energy may come from traditional food, the nutritional benefits of this food can be substantial. Research findings across the Canadian Arctic consistently confirm that traditional food improves diet quality as shown by the lower fat and saturated fat content of the diet, and significant quantities of protein and iron.

Nutrient values vary across different bird parts, so we present the values for meat and skin of a roasted bird. Nutrient data presented here are either directly available from the sources referenced or estimated using several sources. We employ data from Belinsky and Kuhnlein (2000) regarding nutritional benefits of Canada goose as a template for our estimation and analysis of nutrient values for waterfowl. We estimate the composition of energy, protein and fat for wild duck, as well as nutrient values of fat, vitamins and other minerals by applying the ratio of these nutrients in wild and domesticated goose to wild duck (USDA 2005). The nutrient compositions of meat and skin of roasted Canada goose and wild duck are presented in Table 5, along with the composition of roasted beef suggested as a replacement.

In addition to financial impacts of replacing beef by waterfowl meat, there are nutritional effects. We project relative changes of the cumulative intake of energy, total and saturated fat, protein, and iron if beef is replaced by an equivalent amount of waterfowl meat. The waterfowl meat replacement would result in an energy decrease of 36.1%, while total fat and saturated fat would decrease by 75.6 % and 182.7%, respectively. At the same time, protein and iron intakes increase by 20.1% and 65.9%, respectively. It is likely that subsistence hunters will make adjustments in their mix of food purchases to account for the increase in wild duck and geese harvests, both on economic and nutritional grounds.

In addition to the economic and nutritional values of traditional food, however, wild duck and geese provide significant cultural and social benefits to Aboriginal people. However, only qualitative evaluations of these benefits are possible as quantification is beyond the scope of this study. No general conclusions can be drawn regarding the impacts of projected changes in waterfowl population on traditional food supply and further economic and nutritional consequences across various regions and communities. The consumption of migratory waterfowl varies by dietary preferences, customs regarding the sharing of wild meat, and seasonality.

5. DISCUSSION

Climate change is often projected to result in adverse effects on native communities in many countries. Contrariwise, in this study we find that climate change actually results in positive benefits, at least regarding the abundance and harvest of migratory waterfowl. Indeed, the climate change signal likely has its strongest effect on waterfowl abundance in the Northwest Territories that contain substantial areas of spring and summer breeding grounds. The projected increase in waterfowl populations over the NWT implies increased availability of birds for harvest. The assessed impacts of projected changes in waterfowl population on traditional food supply in the NWT, and the associated economic and nutritional consequences, are generally quite positive.

To take advantage of increasing waterfowl abundance, Aboriginal communities in Canada’s northwest could adopt several strategies. First, subsistence hunters can adjust harvest techniques to changing conditions, thereby increasing their harvest per unit of effort. This will enable higher overall harvests and greater substitution of bird meat for beef that needs to be transported a great distance (often by air) from southern parts of the country. Second, many more community members can be involved in the harvest of ducks and geese. This could provide recreational, nutritional, cultural and other benefits in addition to economic ones. Finally, the government can put in place policies that promote subsistence harvest and consumption of locally harvested food.

The extent to which increased abundance of migratory waterfowl can benefit subsistence hunters will depend on policies that affect hunting effort and success of hunters elsewhere in North America. It will also depend on the capacity of other regions where waterfowl reproduce to retain their productivity. For example, if climate change lowers the productivity of the pothole region of the Canadian prairies in waterfowl breeding, the north may simply benefit from a shift in breeding habitat. Overall migratory waterfowl numbers might decline, in which case hunting pressure (hunting policies) in other regions of Canada and the United States will affect the eventual availability of waterfowl in the North. In this regard, the secular trend towards less hunting (Boyd et al. 2002) may be a benefit that is just as important or more so for the North than the positive effects of climate change.

It is clear that to determine the impacts of declines in the demand for hunting permits and climate change on future waterfowl populations requires bioeconomic modeling that is beyond the scope of the current study (see van Kooten et al. 2010). Therefore, the results provided here are indicative only, but they do suggest that, regardless of the underlying cause, access to wild duck and geese harvests for subsistence purposes can have important consequences for northern Aboriginal peoples.

Acknowledgment
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Table 1. Projected Annual Changes (%) in Waterfowl Abundance in the Northwest Territories and Stratum 14

	Northwest Territories			Stratum 14		
	95% confidence interval			95% confidence interval		
Year	Mean	Upper	Lower	Mean	Upper	Lower
2020	3.8	8.3	-0.7	27.2	34.4	19.9
2050	26.2	37.5	14.9	90.7	113.2	68.1
2080	89.9	121.9	57.9	268.2	345.1	191.2

Table 2. Observed and Projected Sport harvests in the Northwest Territories

	Ducks			**Geese**			**Total**		
Item	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Observed 1991-1993	1249	1780	737	231	275	204	1480	2055	941
Projected by									
2020	1296	1927	731	240	298	202	1536	2225	934
2050	1576	2447	847	292	378	235	1868	2825	1082
2080	2372	3951	1164	439	610	322	2811	4561	1486

Table 3. Observed and Projected Subsistence harvest in the ISR

	Ducks			**Geese**			**Total**		
Item	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Observed 1991-1993	674	2190	224	8786	11776	5562	9460	13966	5786
Projected by									
2020	857	2943	269	11172	15827	6671	12029	18770	6939
2050	1285	4669	377	16751	25106	9350	18035	29776	9727
2080	2481	9748	652	32347	52419	16197	34828	62167	16849

Table 4. Annual Value of Waterfowl Harvested ($'000s)

Item	Northwest Territories			Stratum 14		
	Mean	Max	Min	Mean	Max	Min
Observed	13.071	17.777	8.776	143.11	201.53	89.06
Projected by						
2020	13.562	19.245	8.711	181.97	270.86	106.81
2050	16.498	24.436	10.091	272.83	429.67	149.72
2080	24.824	39.454	13.857	526.86	897.09	259.35

Table 5: Proximate Composition of Meat and Skin of Roasted Canada Goose, Wild Duck and Roasted Beef Rib (per 100g)

Group	Energy (kcal)	Total fat	Protein	Ash	Iron	Zinc	Calcium	Copper	Fatty acids, total		
									Saturated	Mono-unsaturated	Poly-unsaturated
		Grams									
Goose[a]	299	19.7	27.8	0.9	6.65	3.55	9.4	0.34	5.2	9.8	3.1
Duck[b]	176	11	28.8	1.4	4.68	1.05	5	0.3	3.7	4.7	1.5
Beef[b]	407	34.6	22.2	0.9	2.27	5.56	10	0.1	14.7	15.5	1.2

[a] Belinsky and Kuhnlein (2000)
[b]USDA (2005)

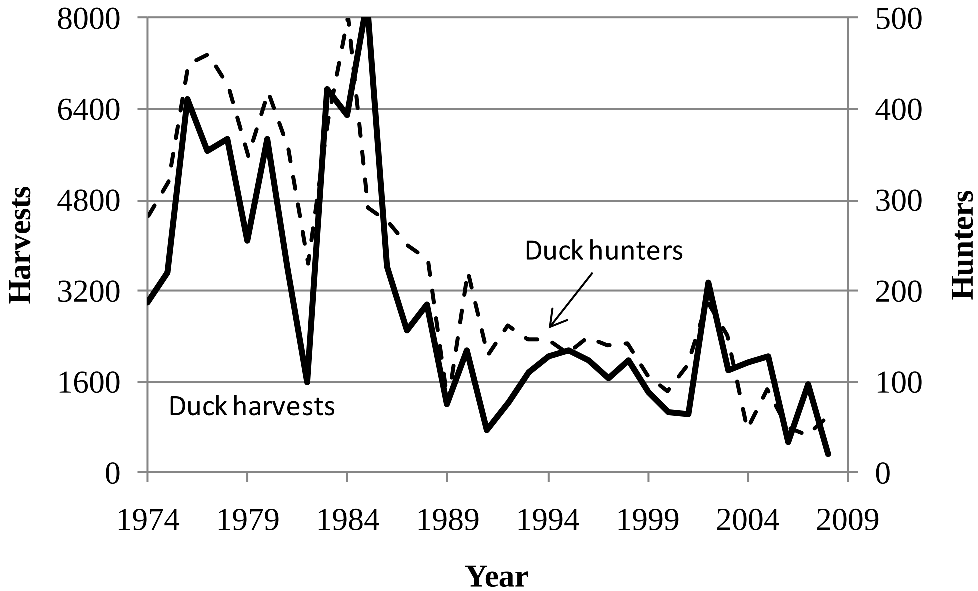

Figure 1(a). Duck harvests and number of successful duck hunters with permits, Northwest Territories, 1974-2008

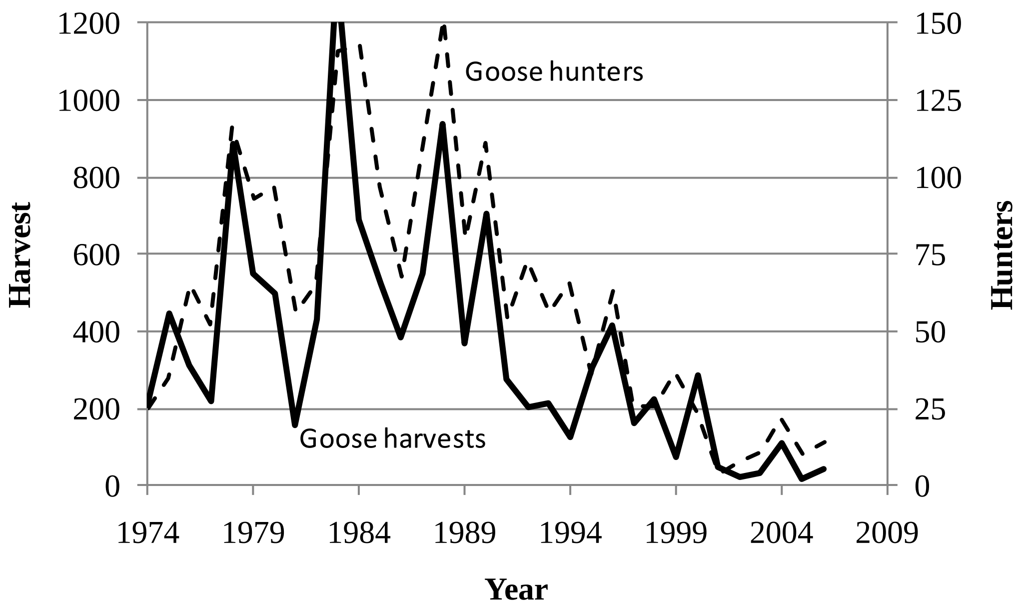

Figure 1(b). Goose harvests and number of successful goose hunters with permits, Northwest Territories, 1974-2006

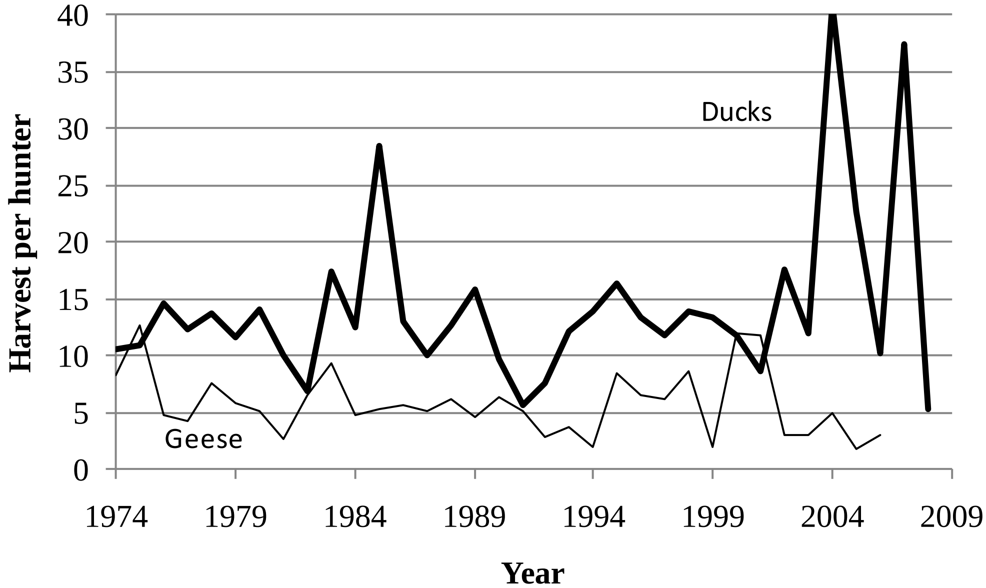

Figure 1(c). Average harvest per successful hunter, Northwest Territories, Ducks (1974-2008) and Geese (1974-2006)

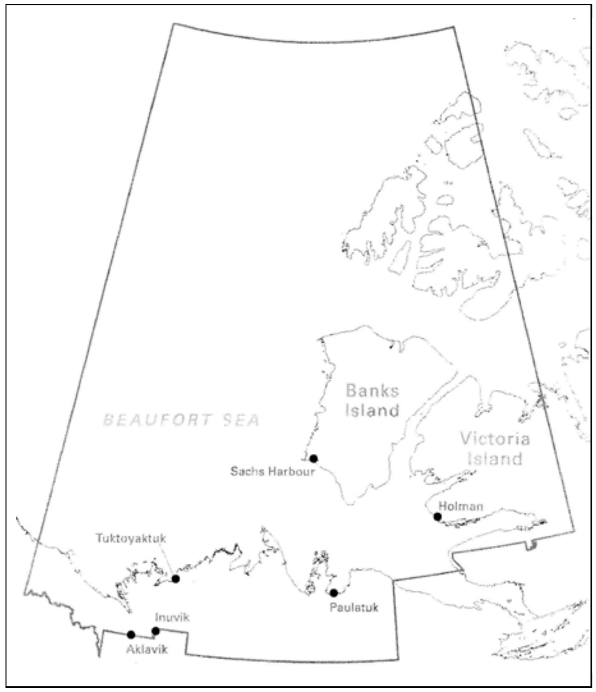

Figure 2. *Map of the Inuvialuit Settlement Region (ISR)*

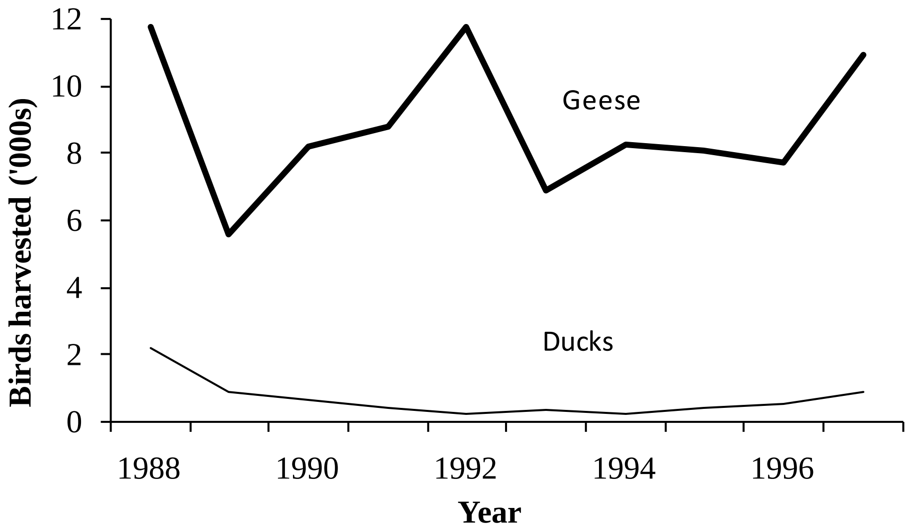

Figure 3(a). Duck and geese harvests by ISR members, 1988-1997

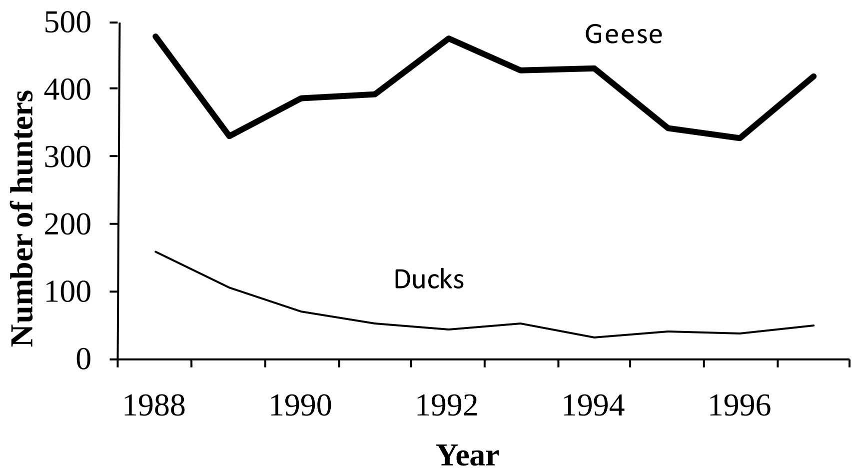

Figure 2(b). Number of ISR hunters of geese and ducks, 1988-1997

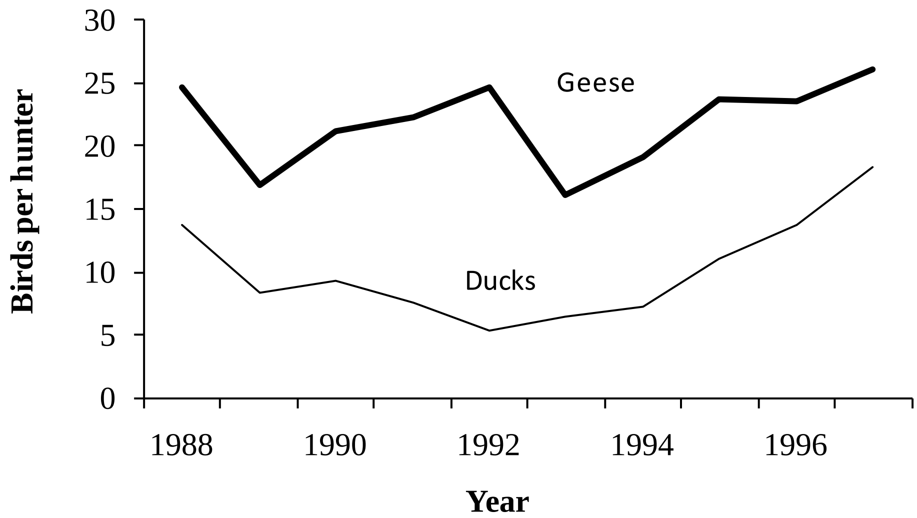

Figure 3(c). Average harvests of geese and ducks per ISR hunter, 1988-1997