The Use of Local Ecological Knowledge for Analyzing Changes in Muskox

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ABSTRACT

This report analyzed and synthesized local ecological knowledge data on muskox provided by harvesters from eight Arctic communities across the range of the Porcupine caribou herd, Mackenzie Delta, and adjacent marine areas during 1996-2015. This report assesses the annual variation in relative abundance, in comparison to previous years, of muskox (*Ovibos moschatus*) observed by harvesters, as well as other potential competing animals for similar resources (e.g., Porcupine caribou (*Rangifer tarandus granti*)) and potential predators (e.g., bears (*Ursus* spp.) and wolves (*Canis* spp.)) inhabiting the North Slope. Harvesters tended to report less than normal muskox abundance before 2004, but more harvesters started seeing more than normal than those in other years after this date. This increase in number of muskox observations was not related to other changes observed on the land, specifically more than normal observations of bears and wolves and less/same than normal observations of caribou.

INTRODUCTION

Community-based monitoring is becoming popular among natural resource managers, particularly in northern Canada where comprehensive claim settlements call for integration of local ecological knowledge (LEK) with other sources of knowledge (Usher 2000). LEK is a multigenerational knowledge accumulated through close and continuous contact with the environment (Usher 2000). LEK as defined above is thus not limited by age or heritage to aboriginal persons. Few community based monitoring programs are long-term, and thus, do not have LEK readily available for integration into research and monitoring. Arctic Borderlands Ecological Knowledge (ABEK) Coop is such an organization whose goals is to (1) monitor and assess ecosystem changes in the range of the Porcupine caribou herd and adjacent coastal and marine areas; (2) encourage use of both science-based studies and studies based on local and traditional knowledge in ecological monitoring and ecosystem management; (3) improve communications and understanding among governments, aboriginal and non-aboriginal communities, and scientists with regard to ecosystem knowledge and management; and (4) foster capacity-building and training opportunities in northern communities in the context of the above-listed goals (Arctic Borderlands Ecological Knowledge Coop 2016).

Here, this report assesses the annual variation in relative abundance, in comparison to previous years, of muskox (*Ovibos moschatus*) observed by harvesters during 1996-2015. The current population of muskox has grown from a group of 51, introduced to Barter Island, Alaska, in 1969 (Pederson et al. 1991; Parks Canada Agency 2003). The North Slope population was estimated at 400 animals in 2006 (Wildlife Management Advisory Council [North Slope] 2008). This population increase is likely to impact behavior of other potential competing animals for similar resources (e.g., Porcupine caribou (*Rangifer tarandus granti*)) and potential predators (e.g., bears (*Ursus* spp.) and wolves (*Canis* spp.)) inhabiting the North Slope (e.g., Medred 2012). Consequently, this report also assesses the annual variation in relative abundance of bull caribou, bears, and wolves by harvesters to determine whether these parameters influence muskox numbers.

METHODS

Survey design

Since 1996, Arctic Borderland Ecological Knowledge (ABEK) Coop has gathered local ecological knowledge by interviewing harvesters in different Arctic communities across the range of the Porcupine caribou herd, Mackenzie Delta, and adjacent marine areas (Figure 1). In the beginning, interviews focused on the communities of Aklavik and Fort McPherson, Northwest Territories and Old Crow, Yukon Territory. Today, standardized interviews are conducted across eight communities spanning the Northwest Territories, Yukon Territory, and Alaska.

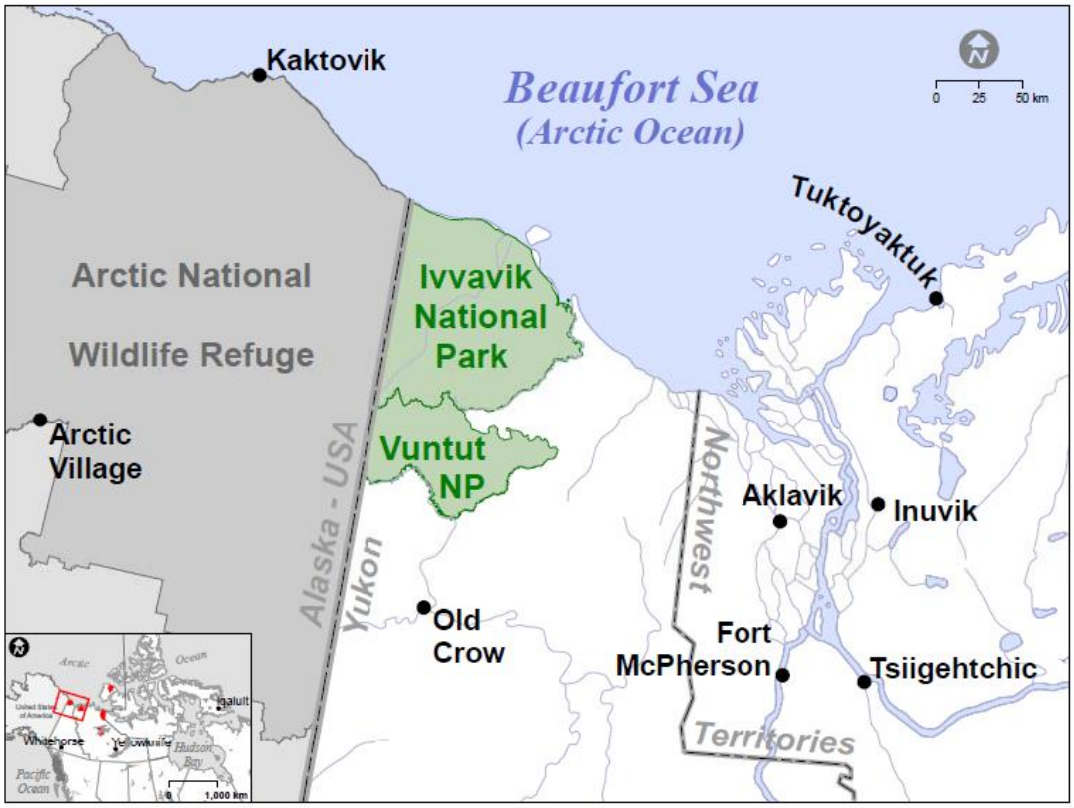


Figure 1. Map of the eight Arctic communities where the Arctic Borderlands Ecological Knowledge Coop gathers local ecological knowledge.

Each community had a locally trained monitor who administered the survey to harvesters (Table 1). The Coop trained the monitor, typically an individual recommended by the Renewable Resource Council and/or Hunters and Trappers Committee, to standardize data collection across the Arctic communities for spatial and temporal comparison. The selection of interviewees was deliberately nonrandom to focus on harvesters who had the most experience on the land during different seasons. Although details of all interviewees are recorded in a database, they remain anonymous when accessing this data to ensure confidentiality.

Survey questions

Although the Coop tried to keep the survey relatively consistent over the past years, interview questions were added or dropped (Arctic Borderlands Ecological Knowledge Coop 2016). Consequently, data for some questions were limited to a few years with a focus on relative abundance (less, same, or more) of muskox, caribou (primarily bulls), wolves, and bears for this report.

Table 1. Number of interviews across eight Arctic communities gathered by Arctic Borderlands Ecological Knowledge Coop during 1996-2015.

Year	Aklavik	Arctic Village	Fort MacPherson	Inuvik	Kaktovik	Old Crow	Tsiigehtchic	Tuktoyaktuk
1996	23		14			15		
1997	32		19			30		
1998	38		22			21		
1999	29		19			32		
2000	41	10	21			20		
2001	42	14	20		8	21		
2002	36	15	20			20		
2003	26	20	20	35		19	20	20
2004	40	20	20			20	20	16
2005	40	20	20	20		20		20
2006	32	30	20	30		20	20	20
2007	25	20	15	24		15	15	13
2008	19	18	15	21		13	15	
2009								
2010	31	14	20	17		16	20	20
2011	27	4	20	33		20	20	20
2012	40	19	20	39		17	20	20
2013	40	20	20	40		19	20	20
2014	40	20	20	21		20	20	20
2015	40		19	40		20		11

Statistical analyses

The Coop focused on harvesters who had the most experience on the land, and 62-98% of these harvesters annually hunted during 1996-2015 (n = 43-159; Figure 2). For each animal, we calculated a relative abundance index by multiplying the number of responses in each category and an arbitrary score of 1 (less), 2 (same), and 3 (more). This index was similar to Russell et al. (2013), but the difference with this index was that annual values were averaged by the total number of responses in that given year so values ranged between 1 and 3. Next, original pre-determined responses by harvesters were randomly sampled with replacement 1000 times to calculate bootstrapped 95% confidence limits in Excel software (Bowles 2014). If the assumption is that relative abundance do not differ amongst years, then these bootstrapped confidence limits should include 2 (same).

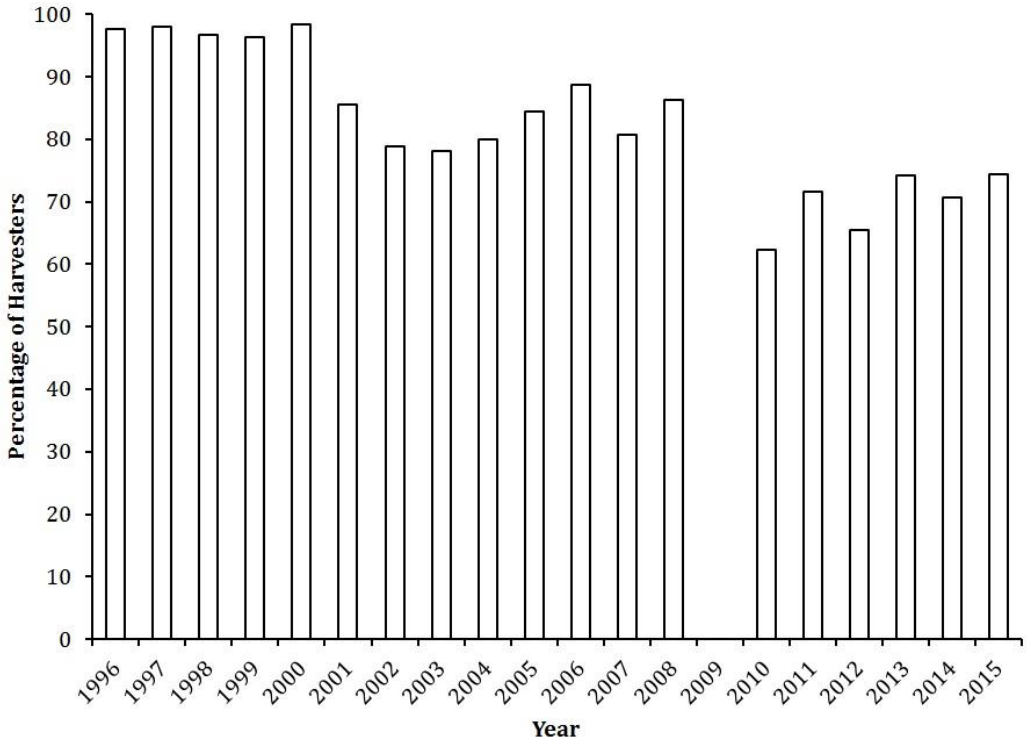
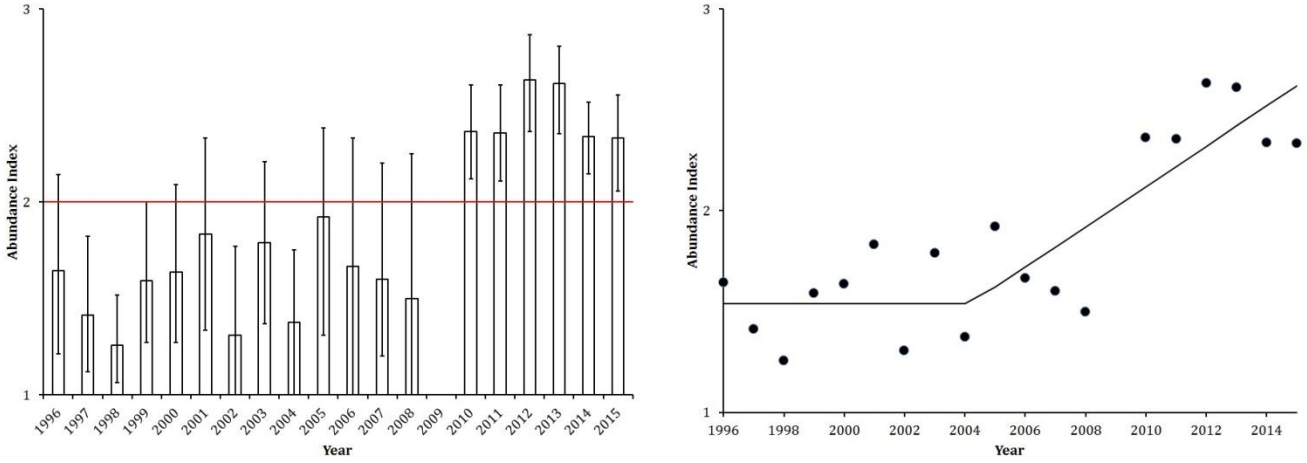


Figure 2. The percentage of harvesters who hunted during 1996-2015.

Unfortunately, questions like relative abundance of caribou, wolves, and bears were recently introduced to surveys in 2010 so only muskox had long-term data (≥10 years) to analyze trend in SegReg software (Oosterbaan 2016), where two segments may be separated by a breakpoint. Last, this relative abundance index of muskox was analyzed to determine whether observations fluctuated in response to other animals, specifically bull caribou, wolves, and bears observed in the fall, using Spearman's rank-order correlation in RCmdr software (Fox 2015). Statistical significance was set at $\alpha = 0.05$.

RESULTS

The number of annual surveys ranged between 52 and 179 during 1996-2015 (Table 1). No surveys were conducted in 2009 to complete a survey redesign in collaboration with program partners and decision making bodies (M.Y. Svoboda, personal communication). The number of harvesters that rated relative abundance of muskox varied amongst years (n = 6-62). Abundance was rated less in 4 of those years (21%), same in 9 years (42%), and more in 6 of 19 years (37%; Figure 3a). Segmented, linear regression indicated two segments in the data with a breakpoint at 2004 ($F_{3, 15} = 13.31$, $P < 0.001$, $R^2 = 0.88$; Figure 3b). Harvesters, on average, saw less muskox than normal during 1996-2004, but started observing more than normal over the past decade.



(a) Annual index with 95% confidence limits.

(b) Linear, segmented regression with a breakpoint at 2004.

Figure 3. Relative abundance index (1 = less, 2 = same, 3 = more) of muskox during 1996-2015.

The number of harvesters that rated relative abundance of bulls varied amongst seasons: spring (n = 57-88), summer (n = 25-70), fall (n = 68-112), and winter (n = 45-88). Harvesters often responded that relative abundance of bulls as less or as same than in other years for all seasons, except twice in fall when harvesters observed more bulls in fall 2013 and 2015 (Figure 4). There was no association between more muskox observed and the abundance of caribou bulls ($r_s = -0.20$, n = 6, P = 0.70).

The number of harvesters that rated relative abundance of bears varied amongst seasons: spring (n = 72-128), summer (n = 60-124), and fall (n = 61-131). Harvesters often responded that bear abundance was more than normal for all seasons except in summer and fall 2014 when abundance was thought to be the same as other years (Figure 5). There was no association between more muskox observed and the abundance of bears ($r_s = 0.43$, n = 6, P = 0.40).

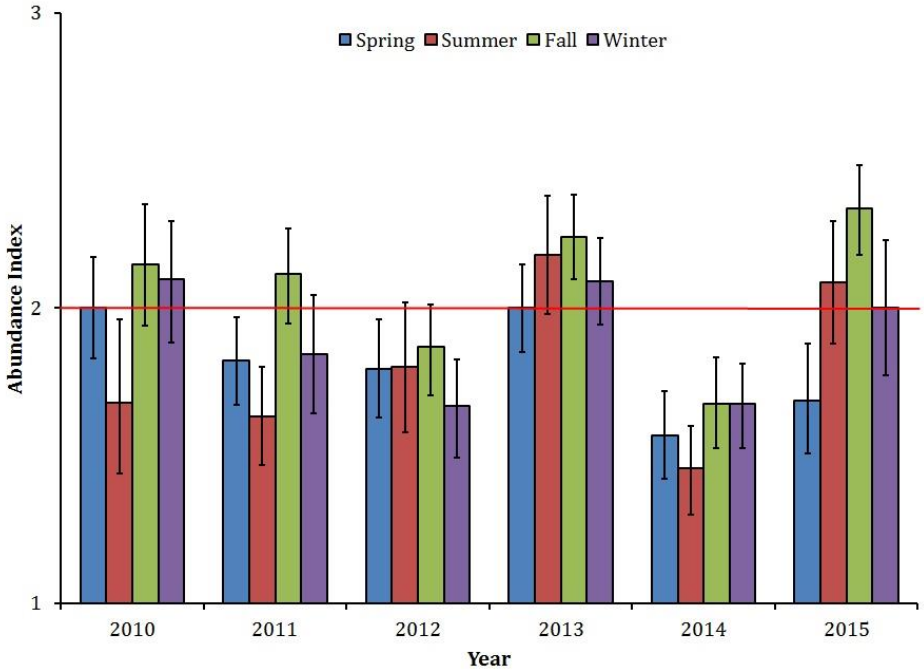


Figure 4. Seasonal abundance index (1 = less, 2 = same, 3 = more) of caribou bulls during 2010-2015. Harvesters responded that relative abundance was less/more than normal when bootstrapped 95% confidence limits did not include this threshold (red line).

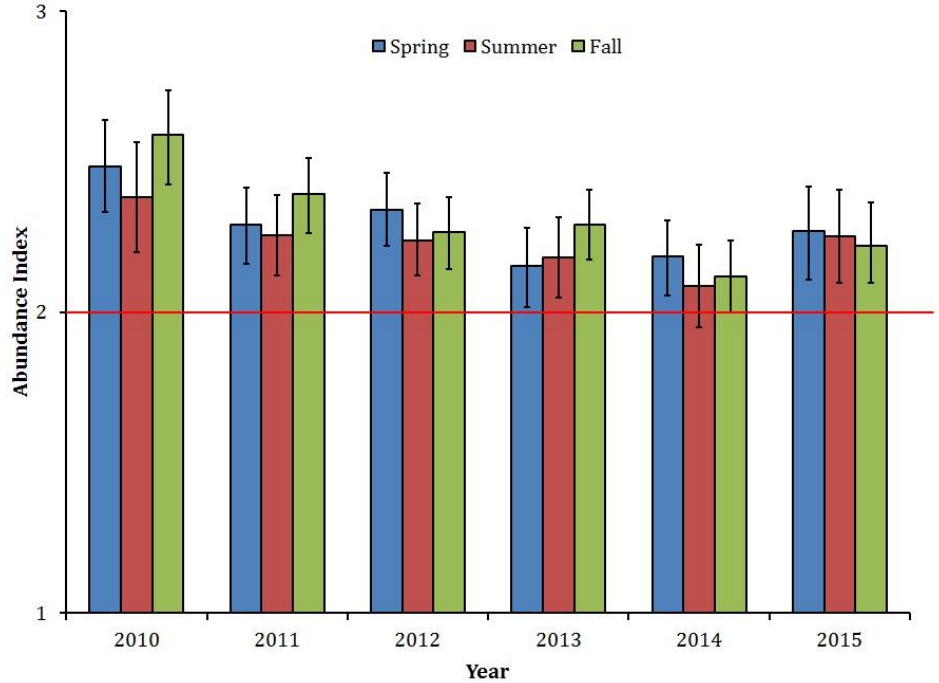


Figure 5. Seasonal abundance index (1 = less, 2 = same, 3 = more) of bears during 2010-2015. Harvesters responded that relative abundance was less/more than normal when bootstrapped 95% confidence limits did not include this threshold (red line).

The number of harvesters that rated relative abundance of wolves varied amongst seasons: spring (n = 65-103), summer (n = 48-93), fall (n = 73-110), and winter (n = 67-119). Harvesters often responded that wolf abundance was more than normal for all seasons except for summers in 2010, 2012, and 2014 when abundance was thought to be the same as other years (Figure 6). There was no association between more muskox observed and the abundance of wolves (r_s = 0.37, n = 6, P = 0.47).

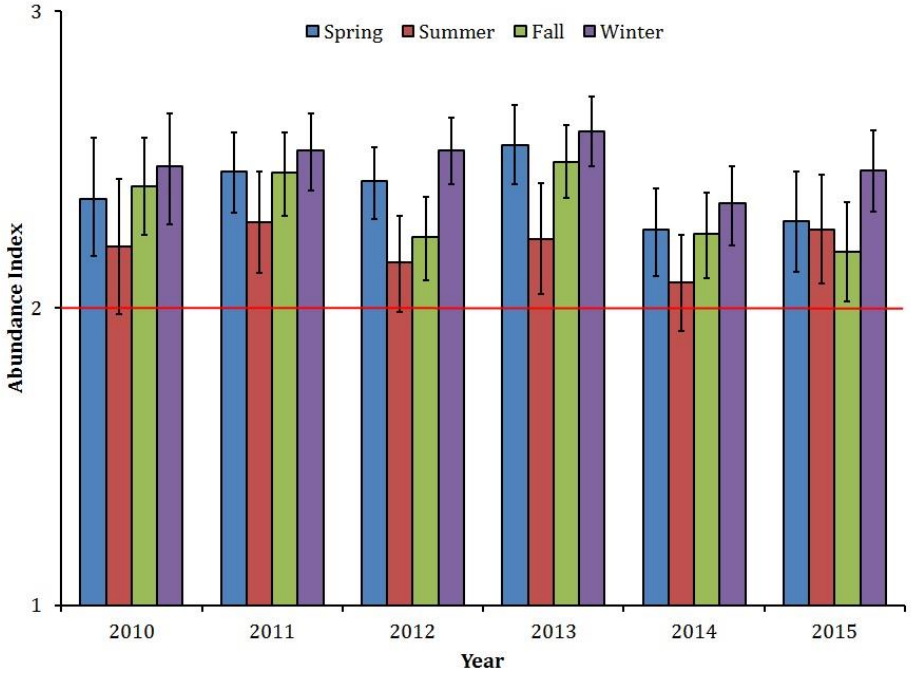


Figure 6. Seasonal abundance index (1 = less, 2 = same, 3 = more) of wolves during 2010-2015. Harvesters responded that relative abundance was less/more than normal when bootstrapped 95% confidence limits did not include this threshold (red line).

DISCUSSION

This report analyzed and synthesized 19-years of LEK data on muskox provided by harvesters from eight Arctic communities across the range of the Porcupine caribou herd, Mackenzie Delta, and adjacent marine areas. Muskox surveys are often costly for remote areas, requiring multi-agency cooperation to estimate populations. The use of confidence limits with LEK data allow biologists and managers to identify years when harvesters are seeing changes on the land (e.g., relative abundance of muskox), and can follow up these observations for further research. Here, harvesters tended to report less than normal muskox abundance before 2004, but more harvesters started seeing more than normal after this date.

This increase in number of muskox observations may coincide with other changes on the land. Here, harvesters also reported seeing more potential predators (e.g., bears and wolves) than normal, which feed on muskox (Medred 2012). This rise in muskox

observations is thought to potentially have detrimental effects on nearby caribou, where harvesters coincidently reported less to the same numbers as those observed in other years. However, these parameters were not associated with more muskox being reported, indicating that other factors (e.g., climate, habitat changes) may be attributed to these changes on the land.

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