ARCTIC BORDERLANDS ECOLOGICAL KNOWLEDGE SOCIETY: COMMUNITY-BASED BIRD MONITORING PRELIMINARY REPORT, 2009-2015

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Abstract

Local and traditional ecological knowledge can provide valuable information on trends in wildlife populations, changes in environmental conditions, and the health of ecosystems. The Arctic Borderlands Ecological Knowledge Society (ABEKS) has performed interviews in communities in the Northwest Territories, Yukon, and Alaska for nearly two decades, collecting information from local experts on wildlife populations, berry production, weather, harvest success, and other factors. This report presents a summary of knowledge compiled between 2010 and 2015 on populations of birds within the region, including waterfowl, shorebirds, birds of prey, songbirds, and other bird groups. There were some indications of earlier arrival by waterfowl, songbirds, and other birds in some years, but little change in departure times. There were also indications of local scale changes in migration timing in some bird groups (e.g. gulls), and in some communities (e.g. Old Crow, Yukon; Fort McPherson, NWT). As well, there were individual comments from multiple communities and in multiple years suggesting the migration routes of some bird groups are changing. While some bird groups were reported to not be changing in abundance, responses indicated a possible decline in duck, shorebird, owl, and Common Nighthawk (*Chordeiles minor*) numbers, and an increase in swan and eagle numbers throughout the region. However, there was also considerable annual, species-level, and community-level variation in all groups, possibly reflecting local-scale variation in weather and seasonal conditions; in landscape-scale variation in changes to habitat, food availability, or other environmental factors; and opposing trends in population numbers among species within bird groups. Overall, there were many consistencies between trends reported by respondents and other sources of data on population status

and trends, suggesting that the local knowledge provided by the ABEKS bird questions may help in informing or supplementing existing bird population databases. As well, the addition of focused questions on a few target species (either possible indicator species, or species of conservation and management concern) would further strengthen the ability of the ABEKS database to provide long-term ecological monitoring for species and populations of interest, and to give early warning of population and environmental changes within the region.

Introduction

The information within this report is from the Arctic Borderlands Ecological Knowledge Society (ABEKS), which has performed interviews in northern communities for nearly 20 years. The goal of ABEKS is to compile data from local experts who live, hunt, and fish within the range of the Porcupine Caribou herd, and adjacent areas in Northwest Territories, Yukon, and Alaska. Experts provide information on wildlife, fish, berries, weather, and other environmental factors.

The interview data in this report focuses on bird knowledge collected from 2010-2015. The information shared through interviews conducted by ABEKS helps fill a scientific knowledge gap on northern bird species and captures indicators that show trends in populations and migration timing. Indicators such as animal abundances and arrival times can be used to identify climatic trends and other environmental changes observed over time. It will also provide valuable information on the health of the traditional economy, which includes the amount of traditional food sources available and whether traditional needs are being met.

Methods

Communities included in the bird data analysis are Aklavik (Gwich'in and Inuvialuit), Fort McPherson (Gwich'in), Inuvik (Gwich'in and Inuvialuit), Tsiigehtchic (Gwich'in), and Tuktoyaktuk(Inuvialuit), NT; Arctic Village, Alaska (Gwich'in); and Old Crow, Yukon (Gwich'in). Every year a community monitor chosen by a local community council or organization conducts interviews in their community. The community monitor and local renewable resource council then identify 20 local experts within the community, and the local experts are interviewed between January and February. The interview responses are anonymous and entered in the ABEKS database each year.

The interview questions concerning birds are divided into nine different sections. The sections touch on abundances of game birds, non-game waterbirds, birds of prey, and other types of birds. The questions also cover whether game birds were hunted, the number of people a person provides birds for, and whether the needs for game birds were met. In all questions, interviewees are given the opportunity to provide additional information, note unusual observations, and give comments.

Answers to interview questions from years 2010-2015 were made available from the ABEKS database. Relative indices of abundance and timing were calculated for data from 2010-2015, while community-level responses and comments were analysed from 2010-2014.

Migration Timing and Routes

Questions on timing of arrival and departure were presented for three bird groups (waterfowl, songbirds, other birds). The questions were phrased as "Did birds arrive or leave at the normal time this year?", with possible answers being arrived or departed "noticeably early", "noticeably late", or "no change from usual". Respondents were encouraged to provide information on individual species, where possible, and on unusual observations, patterns, or trends. Information on changes in migration routes and patterns was derived from additional comments made by respondents. Between 65 and 168 respondents provided answers regarding migration timing of bird groups (Table 1).

Table 1. Total number of respondents providing information on arrival and departure times for waterfowl, songbirds, and other birds (excludes "don't know" responses).

		2010	2011	2012	2013	2014	2015
Arrival time	**Waterfowl**	109	134	162	168	150	119
	Songbirds	104	138	165	166	158	121
	Other birds	67	128	147	148	142	116
Departure time	**Waterfowl**	101	131	162	149	150	122
	Songbirds	98	133	159	144	156	122
	Other birds	65	126	147	128	139	119

Abundances of Birds

To collect information on abundance of birds, questions were presented in four categories, each broken down into sub-groups or species. The categories and sub-categories were 1) game birds (sub-categories: dabbling ducks, sea ducks/diving ducks, geese, ptarmigan/grouse, sandhill cranes, and other); 2) non-game waterbirds (sub-categories: loons, swans, shorebirds, other); 3) birds of prey (sub-categories: falcons, eagles, hawks, owls), and 4) other birds (sub-categories: woodpeckers, nighthawks, kingfishers, other). Questions about abundance of birds were phrased as "Based on your observations in the past year, are there more, the same or fewer [bird group/species] than usual?" As with timing of migration questions, respondents were encouraged to provide additional information on individual species, unusual observations, or any other patterns or trends they had noticed. Between 33 and 172 respondents provided answers regarding abundance of groups or species (Table 2).

Table 2. Total number of respondents providing information on abundance for game birds, non-game waterbirds, birds of prey, and other birds (excludes "don't know" responses).

		2010	2011	2012	2013	2014	2015
Game birds:	Geese	127	133	149	162	147	110
	Sea Diving Ducks	105	101	87	104	99	87
	Dabbling Ducks	125	125	135	150	141	109
	Ptarmigan/Grouse	122	126	136	156	143	108
	Sandhill Cranes	102	118	100	118	114	99
Non-game water birds:	Loons	125	123	144	158	138	100
	Swans	129	133	152	171	145	110
	Shorebirds	113	122	122	137	121	88
Birds of prey:	Hawks	113	117	124	124	108	95
	Eagles	131	134	159	172	153	118
	Falcons	94	89	92	91	88	81
	Owls	116	119	130	129	125	95
Other birds:	Nighthawks	61	41	34	40	42	33
	Kingfishers	53	66	72	81	58	59
	Woodpeckers	87	72	90	84	82	57

Harvesting

Information on harvesting of birds was collected through three questions: 1) did you hunt for game birds this year?; 2) did you meet your needs for game birds this year?; and 3) how many people are you providing birds for this year? Respondents were only asked questions 2 and 3 if they had said yes to question 1.

Analysis

For region-wide abundance and timing analyses, relative abundance indices were calculated for each bird group or species between 2010-2015 by multiplying the number of responses in each category and an arbitrary score of 1 (less), 2 (same), and 3 (more). This index was based on the procedure used by Russell et al. (2013), but in this case 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 respondents 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 or timing does not differ amongst years, then these bootstrapped confidence limits should include 2 (same). Bootstrapped data summaries were provided by Linh Nguyen to ABEKS for this report.

For community-level analyses from 2010-2014, the percentages of respondents in each of the response categories were calculated (e.g. percentage of respondents who said “noticeably early”, “noticeably late”, or “no change” for each bird group). Respondents who answered with ‘don’t know’ were excluded from the analysis.

Interview comments from 2010-2014 were examined for patterns and recurring similarities regarding species, bird groups, or timing of migration/breeding. These comments are summarized within the relevant bird group sections in the results, below.

Results

Migration Timing and Routes

Arrival Time

Respondents reported that waterfowl were arriving earlier than usual in 3 out of 6 years (2010, 2011, and 2015), and later than usual in 2014 (Figure 1). In Old Crow, respondents said that waterfowl were arriving earlier than normal in 3 of the 5 surveys (2009-2010: 63% of 16 respondents, 2010-2011: 53% of 19 respondents, 2012-13: 90% of 19 respondents).

While in most years, respondents said that songbirds were arriving at the normal time, in 2011 and 2015 songbirds were reported as arriving earlier than usual (Figure 1). In three years of the survey, Old Crow respondents said that songbirds were arriving early (2009-10: 63% of 16 respondents; 2010-11: 60% of 20; 2012-13: 63% of 19). In contrast, in two years of the survey, Fort McPherson respondents said that songbirds were arriving late (2012-13: 67% of 18 respondents; 2013-14: 50% of 20).

Respondents reported that “other birds” (non-waterfowl and non-songbirds) were arriving earlier than usual in 3 out of 6 years (2010, 2012, and 2015; Figure 1). In three years, respondents in Old Crow reported that other birds were arriving earlier than usual (2009-10: 79% of 14 respondents; 2010-11: 45% of 20; 2012-13: 68% of 19).

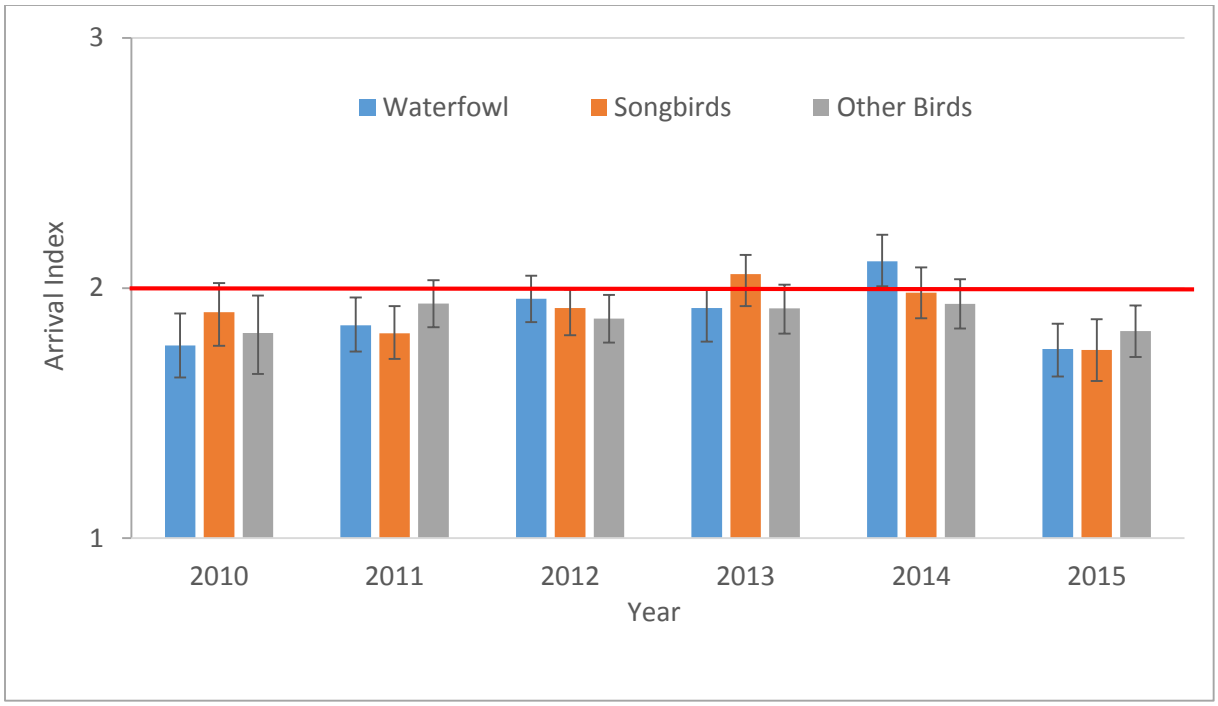

Figure 1. Arrival time index (1 = earlier, 2 = same time as usual, 3 = later) of songbirds, waterfowl, and other birds, across all communities, from 2010-2015. Respondents reported that relative timing of arrival was earlier/later than normal when bootstrapped 95% confidence limits did not include this threshold (red line).

Departure Time

Most respondents across communities reported no change in waterfowl departure time except in 2012, when waterfowl were reported to be departing earlier than usual (Figure 2). In 2011-12, more than half of both Gwitch'in and Inuvialuit speaking respondents in Inuvik reported that waterfowl were departing early (Gwitch'in: 53% of 17 respondents; Inuvialuit: 58% of 19 respondents). In Fort McPherson, the majority of respondents in 2010-11 and 2012-13 reported that waterfowl were departing early, while in 2013-14 47% of 19 respondents reported waterfowl departing early and 37% said waterfowl were departing late.

When all communities were grouped, respondents in 2010, 2012, 2014, and 2015 said that songbirds were departing earlier than usual (Figure 2). As well, from 2010 through 2014, respondents in Fort McPherson said that songbirds were departing early (2010-11: 65% of 20 respondents; 2011-12: 60% of 20; 2012-13: 65% of 20; 2013-14: 65% of 20). In 2009-10, respondents in both Old Crow and Tuktoyaktuk said that songbirds were departing early (Old Crow: 56% of 16 respondents; Tuktoyaktuk: 57% of 7). However, in 2012-13, 84% of 19 respondents in Old Crow said that songbirds were departing late.

Overall, most respondents reported that other birds were departing at a normal time (Figure 2). However, in 2010-11 and 2012-13, most respondents in Fort McPherson said that other birds were

departing early (2010-11: 67% of 15 respondents; 2012-2013: 64% of 19). In Old Crow in 2012-13, most respondents said that other birds were departing late (58% of 19 respondents), while in 2013-14, most respondents in Old Crow said that other birds were departing early (58% of 19). There were also many comments from multiple communities regarding departure times of gulls, suggesting that gulls were staying later into fall and winter than previously.

Figure 2. Departure time index (1 = earlier, 2 = same time as usual, 3 = later) of songbirds, waterfowl, and other birds, across all communities, from 2010-2015. Respondents reported that relative timing of departure was earlier/later than normal when bootstrapped 95% confidence limits did not include this threshold (red line).

Waterfowl Arrival and Departure Comments

In 2009-10, there was 1 comment from Arctic Village about ducks and geese arriving early, 1 comment from Arctic Village about swans arriving late, and 1 from Inuvik about geese leaving sooner. In 2010-11, there was 1 comment from Tsiigehtchic that Snow Geese were arriving two weeks early, 1 comment from Old Crow that black ducks were arriving late, 1 comment from Aklavik that Black Geese left early, 1 comment from Aklavik that Snow Geese left late and 1 from Old Crow that loons left late. In 2011-12, a comment from Tuktoyaktuk noted Geese and all other birds were two weeks early, 1 comment from

Arctic Village reported early arrival of ducks, and 1 comment from Arctic Village and Inuvik noted that ducks came early and left late. Other comments from 2011-12 were as follows: in Inuvik 2 comments stated ducks and geese left early, in Arctic Village one comment noted geese and ducks did not stay long, arriving at the same time and leaving early, and in Fort McPherson and Tuktoyaktuk there was a comment each that geese and waterfowl stayed late. In 2012-13, there was one comment from Old Crow reporting the early arrival of black ducks and 1 comment each that ducks came late in Arctic Village and Fort McPherson. In 2013-14, there were 2 comments from Arctic Village and 1 from Fort McPherson that ducks left late. One other comment in 2013-14 from Tsiigehtchic noted geese arrived late.

Songbird Arrival and Departure Time Comments

In 2009-10, there was one comment from Old Crow that songbirds were arriving early. In 2010-11, there was 1 comment from Old Crow that swallows and robins arrived early, and 1 comment from Old Crow that swallows stayed late. In 2011-12, there was 1 comment from Old Crow that swallows left in late August. In 2012-13, there was 1 comment from Fort McPherson that songbirds arrived late. In 2013-14, there was 1 comment from Inuvik that Snowbirds [Snow Buntings] were early in the previous year and 1 comment from Aklavik that many songbirds arrived early.

Other Birds Arrival and Departure Comments

In 2009-10, there was 1 comment each from Tuktoyaktuk, Old Crow, and Fort McPherson that birds were arriving earlier, 2 comments from Old Crow and 1 from Aklavik that birds were arriving later, 2 comments from Old Crow that birds were leaving earlier, and 1 comment from Tuktoyaktuk that birds were leaving 3-4 weeks later. In 2010-11, there was 1 comment from Inuvik that birds were coming earlier and leaving later and 2 comments from Fort McPherson that all birds left early. In 2011-12, there was 1 comment from Old Crow and Tsiigehtchic that birds arrived early. A trend in 2011-12 was 11 comments that birds were departing late (3 from Tsiigehtchic, 2 from Tuktoyaktuk, 2 from Old Crow, 2 from Arctic Village, and 1 each from Inuvik and Aklavik). In 2012-13, 3 comments from Old Crow reported birds arriving early, 1 comment from Fort McPherson said birds were arriving late, 2 comments from Old Crow and Aklavik reported birds leaving earlier, and 1 from Tsiigehtchic said birds were leaving early. In 2013-14, there was 1 comment from Aklavik that birds were coming early, 1 comment from Fort McPherson noted birds came late, 2 comments from Fort McPherson said birds left early, and 1 comment from Arctic Village said birds left later.

Comments on timing of Gulls

In 2009-10, there was one comment from Tuktoyaktuk that some gulls were now staying until October. In 2010-11, there were no comments about gulls. In 2011-12, there were two comments from Inuvik that gulls were arriving early and staying later and 1 comment form Tsiigehtchic that gulls were leaving later. In 2011-12, there were several comments that gulls were leaving later: 2 each from Aklavik, Inuvik and Old Crow and 1 each from Tsiigehtchic, Tuktoyaktuk, and Fort McPherson. In 2012-13, there were no comments about gulls. In 2013-14, there was 1 comment from Tsiigehtchic that gulls were departing later.

Comments on timing of Birds of Prey

In 2009-10 and 2010-11, there were no comments on arrival or departure of birds of prey. In 2011-12, there was 1 comment from Inuvik that eagles had been arriving earlier and leaving later, and 1 comment from Inuvik and Old Crow that eagles were leaving later. In 2012-13, there was one comment from Inuvik that eagles were leaving earlier. In 2013-14, there were 8 comments from Tsiigehtchic that eagles were staying later.

Migration Route Changes

Throughout all years and communities there were 17 comments that migration routes of birds were changing.

In 2009-10, 4 comments were from Tsiigehtchic, Aklavik, Old Crow, and Tuktoyaktuk. Examples of comments in 2009-10 are as follows:

> Geese & swans have different route – Tsiigehtchic
> Travel in different direction – Aklavik
> Canada geese do not know where they go – Old Crow
> Migration routes changed, less seen flying by Tuk for instance – Tuktoyaktuk

In 2010-11, there were 2 comments on migration route changes. The comments were from Aklavik and Tuktoyaktuk and are very similar to the 2009-10 comments from that community.

In 2011-12 there were 4 comments on migration route changes, one from Aklavik and three from Tuktoyaktuk. The Tuktoyaktuk comments centered around changing geese migration routes; for example one comment was "Geese had a different route last year." In 2012-13 there were 4 comments, which were from Old Crow, Tsiigehtchic (one Inuvialuit and one Gwitch'in speaker), and Inuvik. For example a comment from Inuvik was, "Fewer birds flying by the camp than usual, maybe found a new route to fly by." Another example from Old Crow in 2012-13 is, "The migration pattern was all mixed up."

In 2013-14, there were three comments about changing migration routes. Both comments from Inuvik and Aklavik were about changing geese migration patterns. The Arctic Village comment was, "Birds are moving somewhere else. moving with other birds. animals go same route every year. same with fish and birds."

Abundances of Birds

Game Birds

Geese

In most years, respondents reported no change in the abundance of geese (Figure 3). However, in 2013 and 2015, reported seeing more geese than usual.

On a community level, in both Fort McPherson and Tsiigehtchic in 2009-10, most respondents said there were fewer geese (Fort McPherson: 70% of 20 respondents; Tsiigehtchic: 56% of 18 respondents). In Arctic Village in 2010-11 and 2013-14, most respondents said there were fewer geese (2010-11: 75% of 4 respondents; 2013-14: 58% of 19). In Inuvik, in 2011-12, most Gwitch'in speakers reported seeing fewer geese (71% of 17), and in 2013-14, both Gwitch'in and Inuvialuit speakers reported seeing fewer geese (Gwitch'in: 50% of 8; Inuvialuit: 70% of 10).

Conversely, in Tuktoyaktuk in 2009-10 and 2013-14, most respondents reported seeing more geese (2009-10: 58% of 19; 2013-14: 63% of 19), andin Old Crow in 2010-11, most respondents reported seeing more geese (73% of 15).

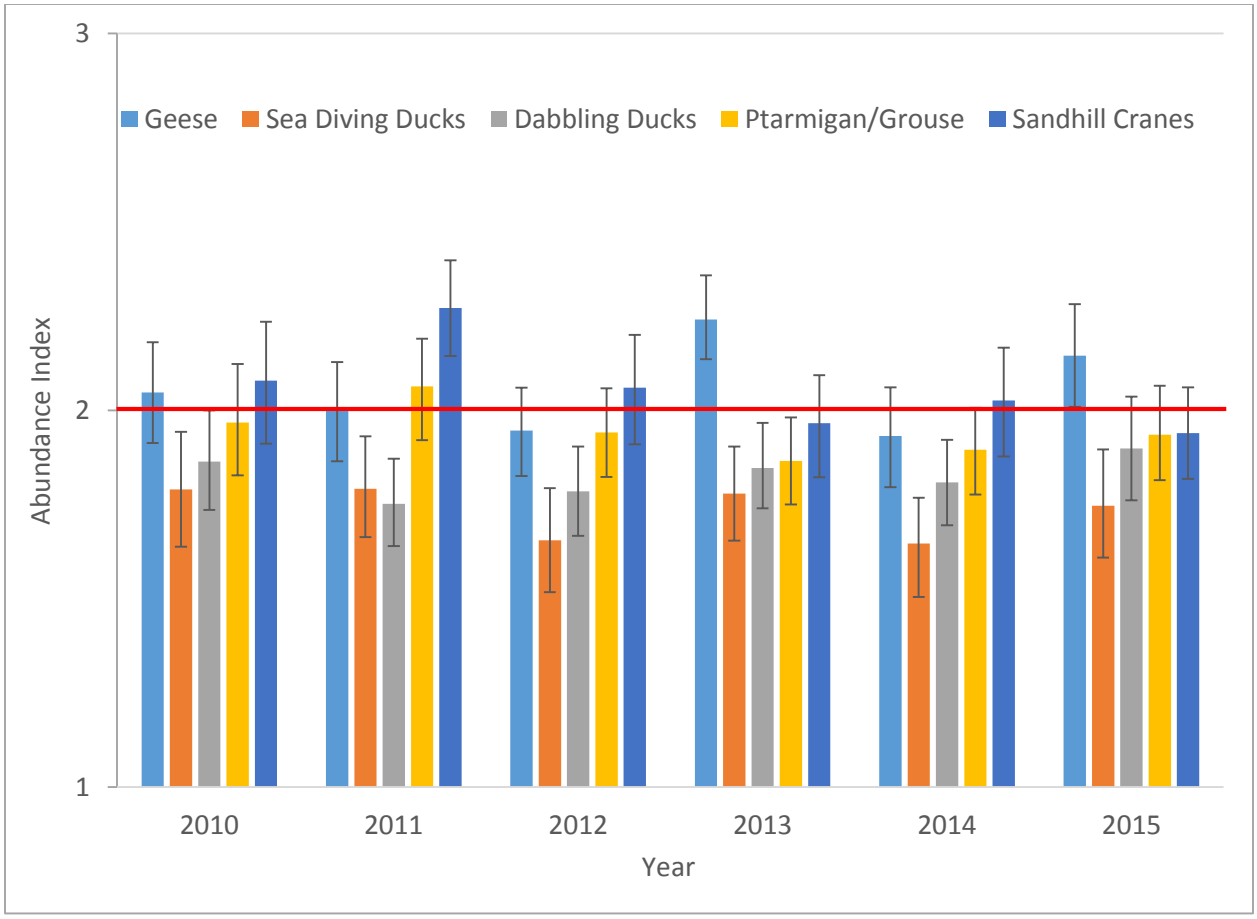

Figure 3. Abundance index (1 = fewer, 2 = same time as usual, 3 = more) for game birds, across all communities, from 2010-2015. Respondents reported that relative abundance was less/more than normal when bootstrapped 95% confidence limits did not include this threshold (red line).

Comments on Abundance of Geese

In 2009-10, there was 1 comment each from Old Crow, Arctic Village, and Aklavik that the abundance of geese had increased. Conversely, in 2009-10 there were 2 comments from Fort McPherson and 1 from Tsiigehtchic that the abundance of geese had declined. In 2010-11, there was 1 comment each from Tuktoyaktuk and Old Crow that there were more Canada Geese. In 2011-12, there was one comment

from Old Crow about fewer geese. In 2012-13, there was 1 comment from Inuvik about more "blue geese" [snow geese] and 1 from Fort McPherson about more geese in the Peel than the Mackenzie River. In 2013-14, there was 1 comment from Tsiigehtchic that there were more blue geese, also 1 comment that stated there were fewer geese in that year.

Sea and Diving Ducks

In all years of the survey, when communities were grouped, respondents reporting seeing fewer sea and diving ducks (Figure 3).

On a community level, in Old Crow in 2009-10 and 2013-14, most respondents reported seeing fewer sea and diving ducks (2009-10: 54% of 13; 2013-14: 80% of 15). In Tsiigehtchic in 2009-10, 2010-11, and 2011-12, most respondents reported seeing fewer sea and diving ducks (2009-10: 72% of 18; 2010-11: 67% of 18; 2011-12: 79% of 14). In Inuvik in 2010-11, 2011-12, and 2013-14, most respondents (Gwitch'in speakers for all years except 2013-14 which was Inuvialuit speakers) reported seeing fewer sea and diving ducks (2010-11: 64% of 11; 2011-12: 75% of 8; 2012-13: 89% of 9; 2013-14: 83% of 6). In Fort McPherson in 2011-12 and 2013-14, most respondents reported seeing fewer sea and diving ducks (2011-12: 75% of 4; 2013-14: 69% of 16).

In Tuktoyaktuk in 2009-10 and 2010-11, respondents reported seeing more sea and diving ducks (2009-10: 50% of 20; 2010-11: 65% of 17).

Comments on Abundance of Sea and Diving Ducks

In 2009-10, there was 1 comment from Old Crow stating there were more White-winged Scoters along the river. In 2010-11, there was 1 comment from Old Crow stating there were 'not much' White-winged Scoters. In 2011-12, there was 1 comment from Arctic Village of seeing a White-winged Scoter where it had never been around before. In 2012-13, there was 1 comment from Tuktoyaktuk that 'Eider ducks do not come around often anymore' and 1 comment from Inuvik that 'a couple eider ducks' were seen. In 2013-14, 2 comments from Inuvik reported sightings of Eider ducks. In 2013-14, 1 comment from Fort McPherson reported seeing 'black ducks that are usually around the coast', and 1 comment from Old Crow that reported seeing a lot of Common Mergansers.

Dabbling Ducks

In all years except 2010 and 2015, respondents reported seeing fewer dabbling ducks than usual (Figure 3).

On a community level in Aklavik in 2009-10, most Gwitch'in speakers reported seeing less dabbling ducks (60% of 9). In Fort McPherson in 2009-10, 2010-11, and 2011-12, most respondents reported seeing fewer dabbling ducks (2009-10: 65% of 20; 2010-11: 68% of 19; 2011-12: 55% of 20). In Tsiigehtchic in 2009-10 and 2011-12, most respondents reported seeing fewer dabbling ducks (2009-10: 72% of 18; 2011-12: 56% of 16). In Inuvik in 2011-12 and 2012-13 most Gwitch'in speaking respondents reported seeing fewer dabbling ducks (2011-12: 83% of 18; 2012-13: 65% of 17).

Comments on Abundance of Dabbling Ducks

In 2009-10, there were no comments about dabbling ducks. In 2010-11, there was 1 comment from Aklavik stating there were many dabbling ducks in the spring yet none in the fall, and 1 comment each from Aklavik, Tsiigehtchic and Fort McPherson of seeing less ducks. In 2011-12, there was 1 comment from Arctic Village about more ducks. Conversely, in 2011-12 there were 2 comments from Arctic Village about fewer ducks and 1 from Fort McPherson about fewer ducks. In 2012-13, there was 1 comment from Old Crow of "lots of white and dark colored ducks", and 1 comment each from Inuvik, Fort McPherson, and Tsiigehtchic of fewer ducks. In 2013-14, there were a few comments stating that there were fewer ducks (2 comments from Arctic Village, 1 comment each from Tsiigehtchic and Old Crow).

Ptarmigan and Grouse

In most years, respondents reported no change in the abundance of ptarmigan and grouse, except in 2013, when respondents reported seeing fewer ptarmigan and grouse (Figure 3).

On a community level in Old Crow in 2009-10 and 2010-11, most respondents reported seeing more ptarmigan & grouse (2009-10: 92% of 13; 73% of 15). In Tuktoyaktuk in 2010-11, most respondents reported seeing more ptarmigan & grouse (53% of 19). In Fort McPherson in 2011-12, respondents reported seeing more ptarmigan & grouse (50% of 20). In Arctic Village in 2013-14, most respondents reported seeing more ptarmigan & grouse (55% of 19).

In Tsiigehtchic in 2009-10, most respondents reported seeing fewer ptarmigan & grouse (56% of 16). In Inuvik in 2010-11, Gwitch'in speaking respondents reported seeing fewer ptarmigan & grouse (50% of 12).

Comments on Abundance of Ptarmigan & Grouse

In 2009-10, there was 1 comment from Tuktoyaktuk that stated that more Spruce Grouse were "coming lower on the treeline". In 2010-11, there was 1 comment from Aklavik that there were "Spruce Hens in Delta – unusual" and 1 comment from Arctic Village that "grouse are coming back". In 2011-12, there was 1 comment from Arctic Village that more grouse were seen and 1 from Arctic Village that hardly any ptarmigan were seen in the previous year. In 2012-13, there was 1 comment from Tsiigehtchic that "spruce chicken is not around as much as they used to be". In 2013-14, there were 2 comments from Arctic Village that have been more grouse.

Sandhill Cranes

Overall, the majority of respondents reported seeing the same abundance of Sandhill Cranes in all years except 2011 when respondents reported seeing more cranes than usual (Figure 3).

On a community level in Old Crow in 2009-10, most respondents reported seeing more Sandhill Cranes (92% of 14). In Tuktoyaktuk in 2009-10, 2010-11, and 2013-14, most respondents reported seeing more Sandhill Cranes (2009-10: 56% of 18; 2010-11: 59% of 17; 2013-14: 65% of 20). In Tsiigehtchic in 2010-11 and 2013-14, most respondents reported seeing more Sandhill Cranes (2010-11: 63% of 19; 2013-14:

68% of 19). In Fort McPherson in 2012-13, respondents reported seeing more Sandhill Cranes (50% of 18).

On a community level in Fort McPherson in 2013-14, most respondents reported seeing fewer Sandhill Cranes (56% of 18). In Old Crow in 2013-14, most respondents reported seeing fewer Sandhill Cranes (59% of 17).

Comments on Abundance of Sandhill Cranes

Overall there was only one comment concerning cranes: in 2012-13, a respondent from Fort McPherson reporting that there were more cranes.

Non-Game Waterbirds

Loons

In most years, respondents reported no change in the abundance of loons (Figure 4). However, in 2015, respondents reported seeing more loons than usual.

On a community level, in Aklavik in 2009-10, most respondents reported seeing more loons (80% of 10 respondents), while in Old Crow in 2013-14, most respondents reported seeing fewer loons (60% of 20).

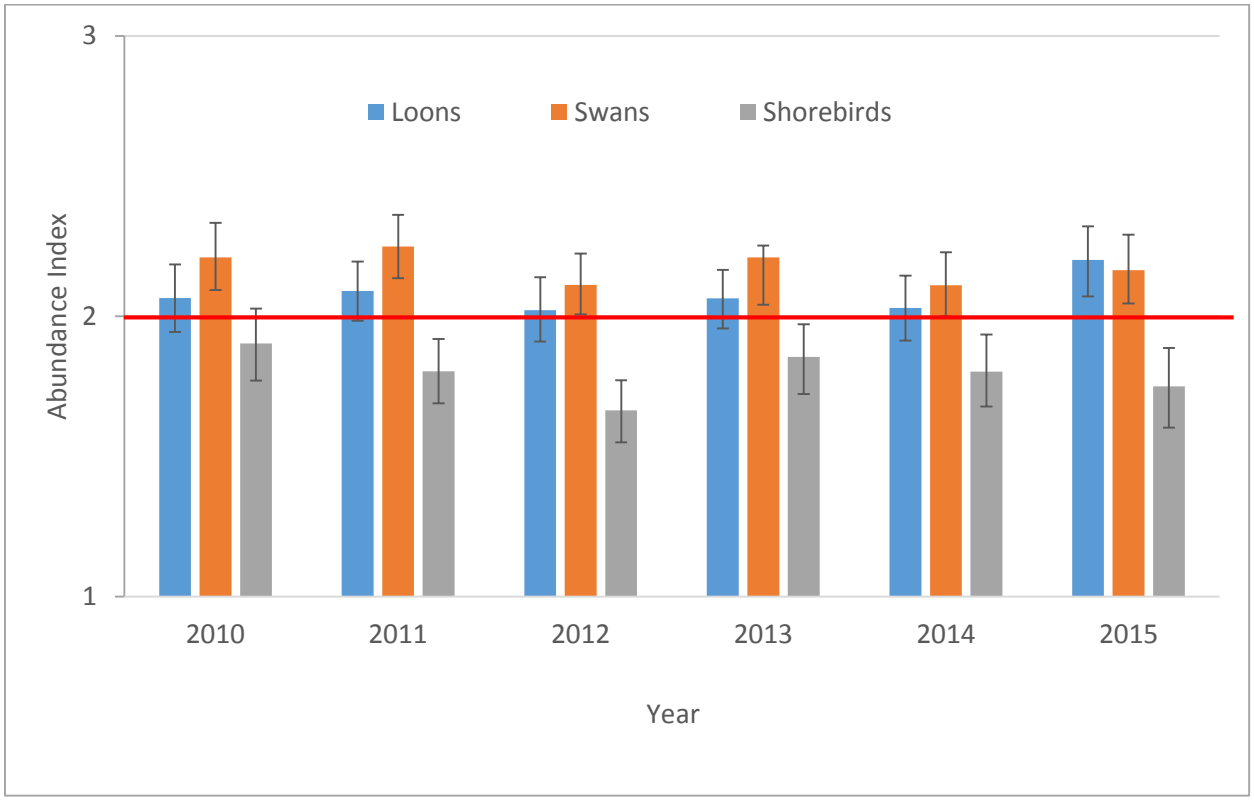

Figure 4. Abundance index (1 = fewer, 2 = same time as usual, 3 = more) for non-game waterbirds, across all communities, from 2010-2015. Respondents reported that relative abundance was less/more than normal when bootstrapped 95% confidence limits did not include this threshold (red line).

Comments on Abundance of Loons

In 2009-10, there was 1 comment in Old Crow that "there are lots of loons at my fishing spot; many get caught". Conversely, in 2009-10, there was 1 comment from Aklavik noting that there have been fewer loons in the spring. In 2010-11, there were no comments about loons. In 2011-12, in Arctic Village, 1 comment reported fewer loons and 1 comment reported more loons. In 2012-13, 1 comment from Arctic Village reported that there were very few loons. In 2013-14, in Arctic Village 1 comment from Arctic Village reported seeing very few loons.

Swans

In all years except 2014, respondents reported more swans (Figure 4).

On a community level in Tuktoyaktuk in 2009-10, most respondents report seeing more swans (65% of 20). In Inuvik in 2010-11 and 2012-13, Inuvialuit speakers in both years report seeing more swans (2010-11: 72% of 18; 2012-13: 60% of 19).

Comments on Abundance of Swans

In 2012-13, there was 1 comment from Arctic Village that very few swans were seen. In 2013-14, there was 1 comment each from Tsiigehtchic and Arctic Village that there were fewer swans seen.

Shorebirds

In all years except 2010, most respondents reported seeing fewer shorebirds than usual (Figure 4).

On a community level in Fort McPherson in 2009-10, 2010-11, 2011-12, and 2013-14, respondents report seeing fewer shorebirds (2009-10: 88% of 17; 2010-11: 72% of 18; 2011-12: 63% of 16; 2013-14: 77% of 17). In Arctic Village in 2011-12 and 2012-13, respondents report seeing fewer shorebirds (2011-12: 60% of 10; 2012-13: 50% of 14). In Inuvik in 2011-12, 2012-13, and 2013-14, Gwitch'in speaking respondents (except 2013-14 which were Inuvialuit speaking) report seeing fewer shorebirds (2011-12: 80% of 15; 2012-13: 53% of 15; 2013-14: 50% of 6). In Tsiigehtchic in 2012-13 and 2013-14, most respondents report seeing fewer shorebirds (2012-13: 58% of 19; 2013-14: 61% of 18). In Old Crow in 2013-14, most respondents report seeing fewer shorebirds (56% of 18).

Comments on Abundance of Shorebirds

In 2009-10, there was 1 comment from Tuktoyaktuk about seeing an Eskimo Curlew around Nanusuak. In 2009-10, there was 1 comment in Old Crow that stated 'Less shorebirds in Old Crow Flats where there used to be 1000s'. In 2012-13, there were 3 comments about seeing shorebirds in Tuktoyaktuk, 1 comment about seeing Wilson's Phalarope in Arctic Village, and 1 comment from Arctic Village of changing shorebird population structures in Arctic Village.

Gulls and Terns

Gulls and terns were not included as a specific category within the non-game waterbirds. However, there were many write-in comments regarding changes in the abundances of these species.

In 2009-10, there was 1 comment from Old Crow on seeing many gulls in the Old Crow Flats. Conversely, in 2009-10, there were 3 comments from Old Crow that fewer gulls were being seen. In 2010-11, there were 2 comments from Old Crow that fewer gulls were being seen, and 1 comment specifically stating gulls were not seen at all the past summer. In 2011-12, there were 2 comments from Old Crow that reported fewer sightings of gulls and 1 comment from Aklavik that reported fewer sightings of gulls. In 2012-13, there was 1 comment each from Inuvik and Old Crow of seeing more gulls. Conversely, in 2012-13 in Old Crow, 1 comment noted there were fewer gulls, and in Fort McPherson 1 comment noted there were fewer Arctic Terns. In 2013-14, there was one comment from Arctic Village that reported more Arctic Terns and 1 comment from Fort McPherson that there were fewer gulls.

Birds of Prey

Hawks

In 2010, 2012, and 2014, respondents reported seeing fewer hawks than usual, while in 2011, 2013, and 2015, respondents reported no change in hawk abundance (Figure 5).

On a community level in Fort McPherson in 2009-10, 2010-11, 2011-12, 2012-13, and 2013-14, respondents report seeing fewer hawks (2009-10: 75% of 16; 2010-11: 63% of 19; 2011-12: 53% of 17; 2012-13: 50% of 14; 2013-14: 62% of 13). In Arctic Village in 2012-13, most respondents report seeing fewer hawks (77% of 13).

Comments on Abundance of Hawks

In 2009-10, there was 1 comment from Old Crow that there were “more Red-tailed Hawks”. In 2010-11, 2011-12 and 2012-13, there were no comments on the abundance of hawks. In 2013-14, there was 1 comment from Tuktoyaktuk that they were “getting more pigeon hawks”.

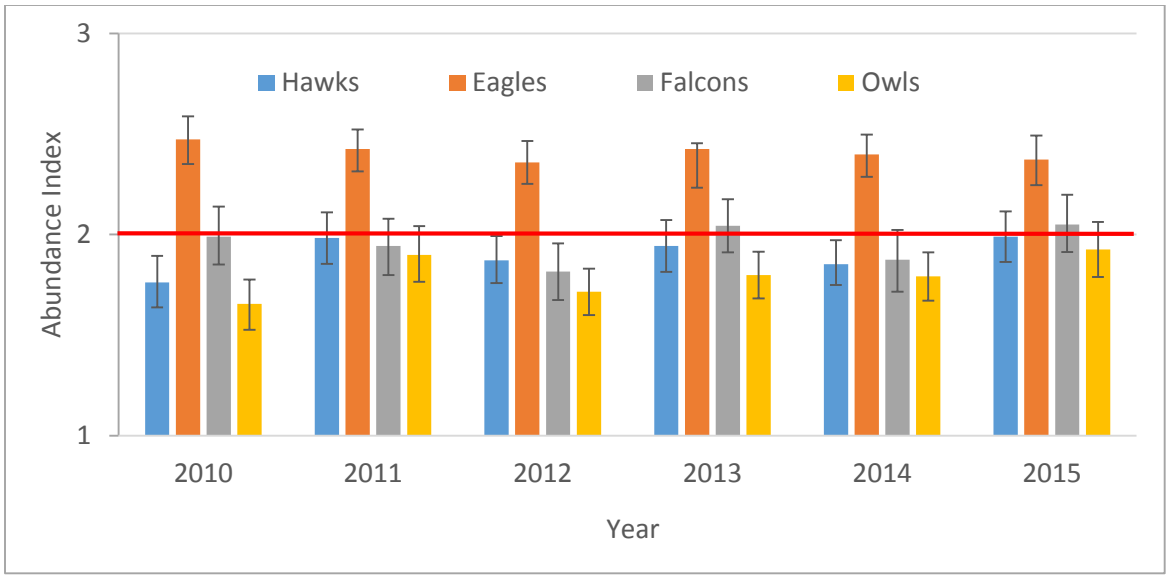

Figure 5. Abundance index (1 = fewer, 2 = same time as usual, 3 = more) for birds of prey, across all communities, from 2010-2015. Respondents reported that relative abundance was less/more than normal when bootstrapped 95% confidence limits did not include this threshold (red line).

Eagles

In all years, the majority of respondents reported seeing more eagles (Figure 5).

There was a similar pattern in each of the communities, with most communities, in most years reporting seeing more eagles. In Fort McPherson in 2009-10, 2011-12, and 2012-13, respondents reported seeing more eagles (2009-10: 75% of 20; 2011-12: 45% of 20; 2012-13: 45% of 20). In Old Crow in 2009-10 and 2012-13, most respondents report seeing more eagles (2009-10: 73% of 15; 2012-13: 61% of 18). In Tsiigehtchic in 2009-10, 2010-11, 2011-12, and 2013-14, most respondents report seeing more eagles (2009-10: 53% of 19; 2010-11: 53% of 19; 2011-12: 55% of 20; 2013-14: 60% of 20). In Tuktoyaktuk in 2009-10, 2010-11, 2011-12, 2012-13, and 2013-14, most respondents report seeing more eagles (2009-10: 70% of 20; 2010-11: 85% of 20; 2011-12: 72% of 18; 2012-13: 74% of 19; 2013-14: 79% of 19). In Inuvik in 2009-10, 2012-13, and 2013-14, most respondents report seeing more eagles (2009-10: Inuvialuit speaking - 71% of 17; 2012-13: Gwitch'in - 65% of 20, Inuvialuit: 72% of 18; 2013-14: Gwitch'in – 78% of 9). In Aklavik in 2010-11 and 2011-12, most Gwitch'in speaking respondents report seeing more eagles (2010-11: 83% of 6; 2011-12: 80% of 15).

Comments on Abundance of Eagles

In 2009-10, there was 1 comment from Aklavik that there are more Golden Eagles present when caribou calving starts. In 2010-11 and 2011-12, there were no comments about eagles. In 2012-13, there was 1 comment from Fort McPherson that there are "more eagles spread out in country". In 2013-14, there was 1 comment from Fort McPherson that there were fewer eagles.

Falcons

In all years the majority of respondents reported the same abundance of falcons (Figure 5). However, in 2012, respondents reported seeing fewer falcons than usual.

On a community level in Inuvik in 2011-12, most Gwitch'in speaking respondents reported seeing fewer falcons (59% of 17). In Arctic Village in 2012-13, most respondents reported seeing fewer falcons (75% of 4). In Fort McPherson in 2013-14, most respondents reported seeing fewer falcons (71% of 7).

Comments on Abundance of Falcons

In 2009-10, there was 1 comment in Old Crow that there are more Peregrine Falcons. In 2010-11 and 2011-12, there were no comments about falcons. In 2012-13, there was 1 comment from Tuktoyaktuk that there are more Peregrine Falcons in the winter. In 2013-14, there were no comments about falcons.

Owls

In most years (2010, 2012, 2013, and 2014), respondents reported seeing fewer owls than usual (Figure 5).

At the community level, in all years in Fort McPherson, most respondents reported seeing fewer owls (2009-10: 82% of 17; 2010-11: 80% of 20; 2011-12: 68% of 19; 2012-13: 72% of 18; 2013-14: 88% of 16). In Aklavik in 2009-10, Gwitch'in speaking respondents reported seeing fewer owls (70% of 10). In Arctic Village in 2009-10 and 2012-13, most respondents reported seeing fewer owls (2009-10: 70% of 10; 2012-13: 62% of 13). In Inuvik in 2009-10 and 2010-11, most Inuvialuit respondents reported seeing fewer owls (2009-10: 65% of 17; 2010-11: 75% of 12). In Old Crow in 2013-14, respondents reported seeing fewer owls (2013-14: 50% of 16).

Comments on Abundance of Owls

In 2009-10, there were 2 comments from Arctic Village of seeing owls in the fall. In 2010-11, there were 2 comments from Old Crow of seeing more white owls. In 2011-12, there was 1 comment from Aklavik about seeing more owls, 1 from Aklavik about seeing more white owls, and 1 comment from Old Crow about a "White owl seem old age". In 2013-14, there was 1 comment about seeing a Snowy Owl on the ice road from Aklavik to Inuvik, and 1 comment from Arctic Village of seeing fewer owls.

Other birds (Nighthawks, Kingfishers, Woodpeckers, Songbirds, etc.)

Nighthawks

In all years except 2015, respondents reported seeing fewer nighthawks than usual (Figure 6).

On a community level in Fort McPherson in 2009-10, 2010-11, and 2013-14, most respondents reported seeing fewer nighthawks (2009-10: 100% of 10; 2010-11: 82% of 11; 2013-14: 100% of 9). In Tsiigehtchic in 2011-12 most respondents reported seeing fewer nighthawks (67% of 6).

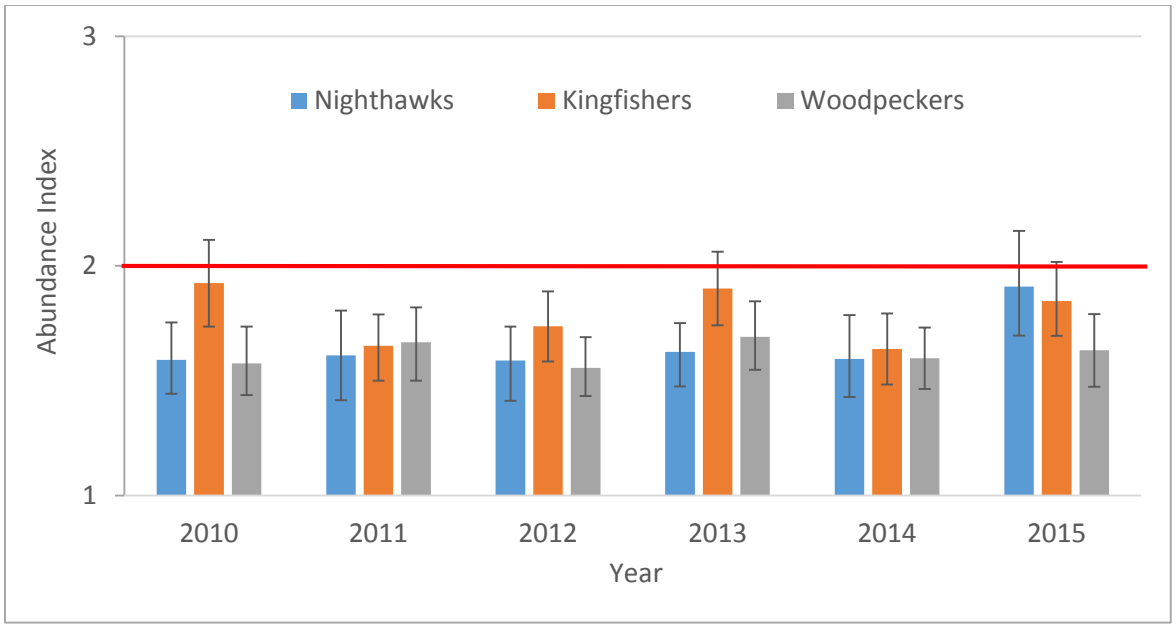

Figure 6. Abundance index (1 = fewer, 2 = same time as usual, 3 = more) for other land birds, across all communities, from 2010-2015. Respondents reported that relative abundance was less/more than normal when bootstrapped 95% confidence limits did not include this threshold (red line).

Comments on Abundance of Nighthawks

There was only one comment in all years about nighthawks: in 2012-13, a respondent from Inuvik commented that they had not seen any nighthawks in years.

Kingfishers

In half of the years of the survey (2011, 2012, and 2014), respondents reported seeing fewer kingfishers than usual (Figure 6).

On a community level in Fort McPherson in 2010-11, 2011-12, and 2013-14, most respondents reported seeing fewer Kingfishers (2010-11: 72% of 18; 2011-12: 71% of 14; 2013-14: 100% of 11). In Inuvik in 2011-12, most Gwitch'in speaking respondents reported seeing fewer kingfishers (75% of 8).

Comments on Abundance of Kingfishers

There were only two comments in all years about kingfishers. In 2009-10, a respondent from Fort McPherson stated "never seen kingfisher for a long time - saw one at 8 miles 10 years ago". In 2013-14, a respondent from Old Crow said "never seen kingfisher in 20 years".

Woodpeckers

In all years, respondents reported seeing fewer woodpeckers (Figure 6).

On a community level in Aklavik in 2009-10 and 2010-11, most Gwitch'in and Inuvialuit respondents reported seeing fewer woodpeckers (2009-10: 75% of 8; 2010-11: 57% of 7). In Aklavik in 2011-12, most Gwitch'in speaking residents reported seeing fewer woodpeckers (100% of 2). In Fort McPherson in 2009-10, 2010-11, 2011-12, 2013-14, most residents reported seeing fewer woodpeckers (2009-10: 95% of 20; 2010-11: 74% of 19; 2011-12: 63% of 16; 2012-13: 63% of 16; 2013-14: 88% of 16). In Inuvik in 2009-10, 2010-11, 2011-12, most Inuvialuit speakers reported seeing fewer woodpeckers (2009-10: 59% of 17; 2010-11: 80% of 5; 2011-12: 67% of 9). In Inuvik in 2011-12, most Gwitch'in speakers reported seeing fewer woodpeckers (63% of 16). In Arctic Village in 2011-12, 2012-13, and 2013-14, respondents reported seeing fewer woodpeckers (2011-12: 63% of 16; 2012-13: 73% of 11; 2013-14: 50% of 12).

Comments on Abundance of Woodpeckers

In 2012-13, there were 2 comments from Inuvik on woodpeckers: 1 comment remarked that woodpeckers had not been heard for 2 years and another noted a general decrease in woodpecker numbers. In 2013-14, there were 2 comments from Old Crow that reported woodpeckers were starting to reappear.

Songbirds and Other Birds

Blackbirds

Across all communities and years there were 26 comments about blackbirds. In 2009-10, there were four comments about blackbirds; for example, in Aklavik a comment was, "Black bird – haven't seen for a long time." In 2010-11, there were seven comments about blackbirds; for example in Arctic Village a comment was, "Not very many birds around these days. Even black birds are rare." In 2011-12, there were three comments about blackbirds; for example, in Fort McPherson one comment was, "A few really black birds." In 2012-13, there were six comments about black birds; for example, in Inuvik one comment was, "I saw 1000 black birds with a red spot on their wings." In 2013-14, there were six comments about black birds; for example, one comment from Fort McPherson was "Noisy black birds."

Blue Birds

Across all years there were five comments about seeing birds blue in color. The comments were from Aklavik, Tuktoyaktuk and Inuvik. For example, in 2009-10 a comment from Aklavik was, "Blue jays, don't usually see in area." Another comment from 2011-12 from Aklavik was "There was blue jays this summer on the Peel River."

Robins

Across all years and communities there were 13 comments about robins. In 2009-10 there were 5 comments about robins; for example in Aklavik a comment was, "Lots of robins." In 2010-11 there were 2 comments about robins; for example in Arctic Village a comment was, "Used to be a lot of robins at camp site but not last year. That is unusual." In 2011-12, there were 4 comments about robins, as an example in Inuvik a comment was, "I've noticed that there was more robins last year, more Robins than usual." In 2012-13 there was one comment about robins, which was from Fort McPherson and was, "Grey bird looks like a robin." In 2013-14 there was one comment about robins, which was from Old Crow and was, "A Robin in Old Crow after January."

Red Birds

Across all communities and years there were 12 comments about red birds. In 2009-10, there were 2 comments about red birds from Arctic Village and Old Crow; for example from Arctic Village a comment was, "Red bird that is unusual." In 2010-11, there were four comments about red birds; for example one comment from Old Crow was, "Red colour (sparrow-type bird)". In 2011-12, there were two comments about red birds; for example from Tsiigehtchic a comment was, "Red bird size of Whiskeyjack." In 2012-13, there was one comment from Old Crow about red birds which was, "Red colour with black wings." In 2013-14, there were three comments about red birds; for example in Tsiigehtchic a comment was, "Small red birds."

Jays

Across all years and communities there were 14 comments about jays. In 2009-10 there were 2 comments about jays, as an example from Aklavik one comment was, "Some strange bird look like whiskeyjack." In 2010-11 there was only one comment about Jays from Fort McPherson which was "Magpies at 8 miles." In 2011-12 there were 3 comments about jays, as an example from Aklavik a comment was, "Black whisky jakes 2 of them. Unusual." In 2012-13 there were 5 comments about jays, 2 comments from Inuvik and 2 from Tsiigehtchic were about increasing numbers of magpies. In 2013-14 there were three comments about jays, as an example in Fort McPherson a comment was, "One Magpie."

Yellow Birds

Across all communities and years there were 28 comments about seeing yellow birds, with 16 of these comments coming from Tuktoyaktuk, and 10 of those 16 comments in 2013-14. In 2009-10 there were 2 comments about seeing yellow birds, as an example one comment from Tuktoyaktuk was, "Little yellow bird – never seen before." In 2010-11 there were 4 comments about yellow birds, as an example one comment from Tuktoyaktuk was, "Yellow Canaries." In 2011-12 there was one comment about yellow birds which from Tuktoyaktuk and was, "Yellow bird and a blue turquoise bird." In 2012-13 there were 6 comments about yellow birds, as an example one comment from Artic Village was, "Little yellow bird flying around the neighbor. never see it before. looks like chickadee." In 2013-14 there were 2 comments from Aklavik and Old Crow about yellow birds and 10 from Tuktoyaktuk from Inuvialuit speakers about small yellow birds, comments from Tuktoyaktuk included: "Odd little yellow bird. Seeing more of them", "Small yellow or green warbler."

Hummingbirds

Across all years and communities there were 14 comments about hummingbirds. In 2009-10 there were four comments from Tsiigehtchic, Tuktoyaktuk, and Fort McPherson concerning hummingbirds. In 2011-12 there were five comments from Fort McPherson, Inuvik, and Old Crow concerning hummbingbirds. One comment in Old Crow stated "Humming bird showed up in July. 3rd sighting." In 2012-13 there were three comments about hummingbirds in Tsiigehtchic, Tuktoyaktuk, and Inuvik. One comment from Inuvik was "Seen a humming bird." In 2013-14 there were 2 comments from Tsiigehtchic and Inuvik concerning hummingbirds.

Rainbirds

Across all years there were four comments about Rainbirds in Old Crow. In 2009-10 one comment stated that Rainbirds were seen in Old Crow in November, December, and January. In 2012-13 a comment stated a Rainbird was seen in Old Crow in December.

Unidentified/Different Birds

Across all communities and all years there were 67 comments about seeing different or unidentified birds.

In 2009-10, there were 13 comments about seeing different birds; for example in Tuktoyaktuk a comment was: “Some kind, small green/lime bird around tree line – just like a canary.”

In 2010-11 there were 10 comments about seeing different birds; for example in Inuvik a comment was: “Never seen these birds here before, can’t tell us what they are.”

In 2011-12 there were 16 comments about seeing different birds; two examples of comments are: from Fort McPherson, “Seen Egret in 2011 around middle Peel”, and from Tuktoyaktuk, “A bird not from around here. From around the Illusion Islands (Bird Book) a little black bird. Second year in a row he has seen”.

In 2012-13 there were 16 comments about seeing different birds. Three examples of comments are:

> Different kind of bird it comes and go. this one eat spruce trees, i see it bother the tree a lot. kind of grayish. swallow like. – Arctic Village
>
> Coast birds are around here, lots in the Delta and they are big black birds, they are fish eaters. They are usually in the coast, lots on the Mackenzie River. - Inuvik
>
> Saw a bird. It looked like a "fruit loop" bird. Big beak, almost same size as its body. Saw it coming back on the ice road, it flew across the river. Like a cockatoo. Maybe someone’s pet flew away - Tuktoyaktuk

In 2013-14 there were 12 comments about different birds. Three examples of comments are:

> Lots of birds I have not seen before Looks like red crossbill similar to that – Arctic Village
>
> More small song birds. They seem to be multiplying as years and warmer weather is coming. – Arctic Village
>
> Pine grosbeaks small flock – Old Crow

General Comments on Abundance of Birds

Comments on general increases in abundance

In 2009-10, 2010-11, and 2012-12 there were no general comments on increasing numbers of birds. In 2012-13 there were 4 comments from Arctic Village that reported increasing numbers of birds, and 1

comment from Inuvik that stated “more different kinds of birds.” In 2013-14 there was 1 comment from Tsiigehtchic that noted there were “just more number of birds.”

Comments on general decreases in abundance

In 2009-10, there were 6 comments on decreasing numbers of birds: 4 from Arctic Village, and 1 each from Fort McPherson and Tsiigehtchic. One comment from Arctic Village stated “When we were children, birds were in abundance, there was lots of noise in the woods”.

In 2010-11 there were 9 comments in total on decreasing number of birds, with 5 from Fort McPherson, and 1 comment each from Inuvik, Tuktoyaktuk, Old Crow, and Tsiigehtchic. Examples of comments in 2010-11 from Fort McPherson are: “Too quiet in spring & summer” and “fewer birds both water and land”.

In 2011-12, there were 13 comments on decreasing number of birds, including 5 from Arctic Village, 5 from Inuvik, and 1 each from Aklavik, Old Crow, and Fort McPherson. Examples of 2011-12 comments include: from Arctic Village, “My Father use to say it was so noisy”, and from Inuvik, “there seems to be less of all birds”.

In 2012-13, there were 12 comments on deceasing number of birds, with 3 from Arctic Village, 3 from Tsiigehtchic, and 2 each from Aklavik, Inuvik, and Fort McPherson. Examples of comments in 2012-13 include: from Arctic Village, “Less everything is less, hardly any birds around”; from Tsiigehtchic, “hardly any around these days”; and from Inuvik, “Hardly any birds. Long ago you couldn't sleep because there were so many birds. Now it’s pretty lonesome out in the bush cause of no birds”.

In 2013-14, there were 10 comments about decreasing number of birds, including 4 from Arctic Village, 4 from Fort McPherson, and 1 each from Old Crow and Tsiigehtchic. Examples of comments in 2013-14 include: from Arctic Village, “Less birds all year, less lakes due to dry land and lakes are drying up fast”, and from Fort McPherson, “birds are scarce, never see no nests”.

Harvesting

Hunted Game Birds

There was little change in the number of individuals hunting game birds across the 5 years of the survey. The percentage of respondents who hunted game birds ranged from a low of ~63% in 2010-11 to a high of ~67% in 2012-13 (Figure 7). Note that this question was not asked in 2009-10.

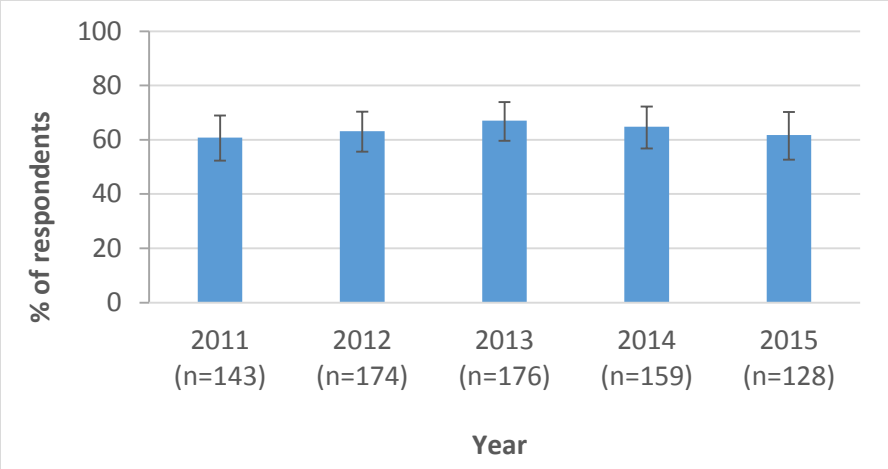

Figure 7. Percentage of respondents answering "yes" to the question "Did you hunt for game birds this year?" (with 95% confidence limits). Sample sizes are the total number of respondents answering either yes or no.

Number of People Providing Birds For

The majority of respondents in each year were providing for 0-5 other people (Figure 8), ranging from a low of ~45% of respondents providing for 0-5 people in 2011-12 to a high of ~60% in 2009-10. The next highest number of people provided for was from 6-10, ranging from a low of ~23% of respondents providing for 6-10 people in 2009-10 to a high of ~34% in 2011-2012. The last number of people provided for of any note was from 11-20, ranging from a low of ~8% of respondents to a high of 16%.

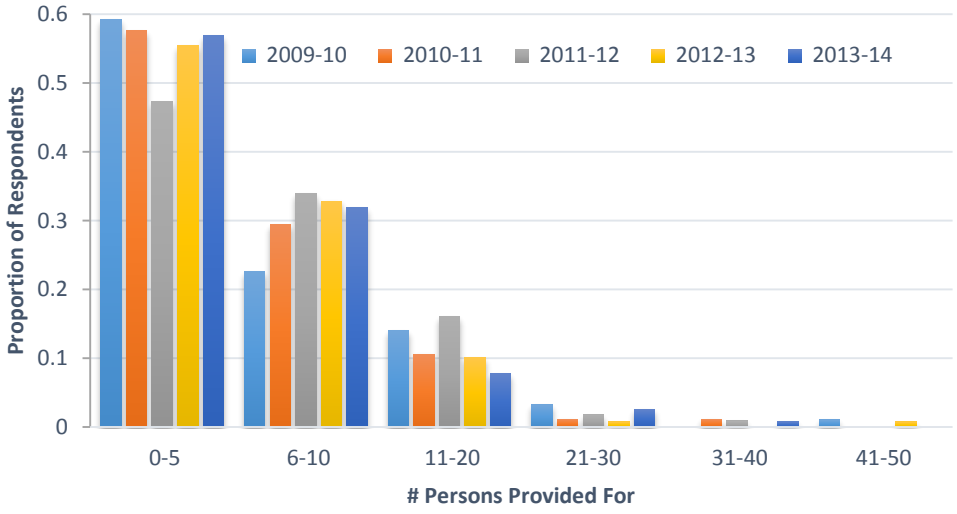

Figure 8. Responses to the question "How many people are you providing birds for this year?".

Needs Met

In all years, the majority of respondents (ranging from 62-77%) said that they met their needs while hunting game birds (Figure 9).

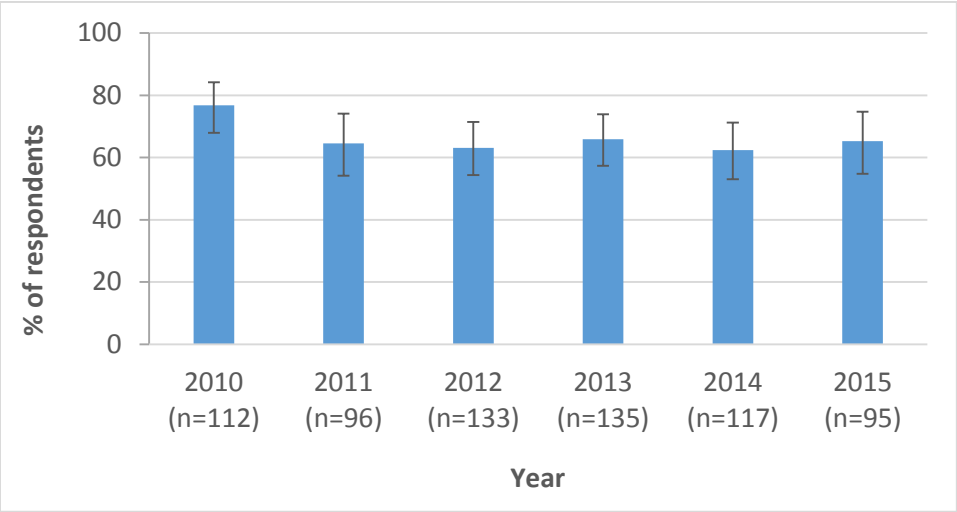

Figure 9. Percentage of respondents answering "yes" to the question "Did you meet your needs for game birds this year?" (with 95% confidence limits). Sample sizes are the total number of respondents answering either yes or no.

Discussion

Timing of Migration

While most respondents reported that arrival and departure dates were the same as usual for all three bird groups (waterfowl, songbirds, other birds), there was considerable interannual and intercommunity variation. Arrival times of migratory birds may be influenced by a variety of factors, such as conditions on the wintering grounds, and food availability and weather conditions on the migration route. For example, Pink-footed Geese (*Anser brachyrhynchus*) migrating to Svalbard may use spring conditions en-route as indicators of conditions further along, and thus are able to rapidly respond to spring advancement (Tombre et al. 2008). In the Arctic Borderlands survey region, local-scale weather and vegetation conditions may affect timing of advancement of individual groups of migrating birds; this may result in local variation in bird arrival timing, which may mask broader-scale population level changes in migration. As well, large-scale climate fluctuations, such as the North Atlantic Oscillation, may affect the timing of migration by Arctic-breeding birds (Rainio et al. 2006), which may also result in local-scale variation in arrival times, particularly across the latitudinal range of the Arctic Borderlands survey coverage region. Many comments suggested that arrival and departure times at local lakes, wetlands, and other areas seemed to be influenced by local conditions. For example, comments included "Ducks arrive[d] late because of late spring", "We had a late Fall season so the ducks stayed later than usual", and "Too warm, Ducks left late". Conditions such as timing of ice break up, spring or fall temperature, snow cover, and other factors might vary considerably across the region, resulting in variation in local observations of species arrivals and departures. This local-scale variation may mask broader-scale population changes, but might also serve as an indicator of region-wide effects of climate change.

While in most years and communities, respondents said that waterfowl were arriving at the same time as usual, Old Crow respondents identified waterfowl as arriving earlier than usual in 3 years of the survey. This is consistent with the results of long-term monitoring in the Old Crow area. Mossop (2013) reported that timing of breeding by waterfowl on the Old Crow Flats Wetland has advanced by 10-14 days over the last 40 years. This is also consistent with broader-scale trends toward advances in migration and timing of breeding with a variety of bird groups (Pearce-Higgins and Green 2014). Advances in timing of breeding and shifts in migration timing may lead to mismatches between birds and their food sources, or increased competition and predation (Pearce-Higgins and Green 2014). Thus, monitoring of changes in timing of migration and breeding may be crucial in identifying possible negative effects on reproduction and survival of birds. Data provided by the ABEKS questionnaires may provide early indications of changes and mismatches that can then be studied more intensively.

There were numerous comments regarding the timing of departure of gulls. Many respondents said that gulls were remaining in the area much later into fall and winter than previously. For example, in 2011-12 respondents in 6 of the communities (Aklavik, Tuktoyaktuk, Tsiigehtchic, Fort McPherson, Inuvik, and Old Crow) said that gulls were still present in late August and even into December. There were similar comments in 2012-13 from Inuvik and Fort McPherson, and in 2013-14 from Aklavik, Tsiigehtchic, and Old Crow. The 2011-12 late departures do not seem to correspond with any changes in freeze-up in either the Porcupine River or the Old Crow River in fall 2011, which were both reported as being within 1-2 days of normal (Arctic Borderlands Ecological Knowledge Society 2014a, b). It is unclear what the cause of delayed departure is in these cases but in general, fall migration in gulls is influenced by a number of factors including body condition, sex, and age, as well as weather, food availability, and other environmental conditions in the region. Additionally, timing of events in one season (e.g. fall) may be influenced by carry-over effects of conditions earlier in the year (e.g. summer, and even spring) (Boulet and Norris 2006). Thus, changes in timing of fall migration may be indicative of other changes occurring in the region, and local knowledge provided by ABEKS may help in identification of longer-term shifts in gull migration itself, as well as in factors that affect timing of migration in gulls.

Abundances of Birds

Game Birds

Geese and ducks

There was variation in responses regarding the abundance of game waterfowl, both across years and across communities, as well as across the waterfowl categories. While most respondents in most years reported no change in the numbers of geese, there was an indication of possible declines in numbers of sea ducks, diving ducks, and dabbling ducks. These results are consistent with circumpolar studies of bird population trends that report recoveries in the numbers of some species of waterfowl and declines in others (Deinet et al. 2015). For example, Zöckler et al. (2012) report that among goose species, of 45 populations with known trends, 19 are increasing, 12 are decreasing and 14 are stable, while among eider species (a sea duck) and other ducks, most populations with known trends are either stable or decreasing, with only 3 out of 61 populations increasing. In many cases, trends suggesting increases in waterfowl are driven by large population growth in geese, such as Greater White-fronted Goose (*Anser albifrons*) and Lesser Snow Goose (*Chen caerulescens caerulescens*) (Deinet et al. 2015).

Some duck species that have been reported to be in decline either globally or regionally include Greater Scaup (*Aythya marila*), Northern Pintail (*Anas acuta*), American Wigeon (*Anas americana*), Long-tailed

Duck (*Clangula hyemalis*), King Eider (*Somateria spectabilis*) and Common Eider (*Somateria mollissima*) (Deinet et al. 2015). While these species were not named directly in the questions in the survey, respondents mentioned some of them in their comments. For example, a respondent in Fort McPherson in 2010-11 said that there are not as many ducks such as pintails as in the past, and a respondent in Inuvik in 2012-13 said that there are "less and less smaller ducks, e.g. wigeons, scooters [scoters], and golden eyes." There were also a few general comments that there are fewer ducks, or that ducks are declining.

However, in the case of eiders, there appeared to be some regional variation in reports of abundance. In Arctic Village in 2009-10 and in Tuktoyaktuk in 2012-13, some respondents commented that there appeared to be fewer eiders, while in Inuvik and Aklavik in 2013-14, respondents reported seeing more eiders (the respondent from Arctic Village specified King Eiders as being more abundant than usual). Also, respondents in both Inuvik and Arctic Village reported unusual sightings of eiders (in locations in which they are not usually observed). This suggests that while some duck populations are declining, there may be increases in the abundance of eider ducks. This is consistent with reports from around the circumpolar north of recoveries in eider populations following changes in harvest regulations and other conservation measures (Deinet et al. 2015). Community-level data on eider populations in the Arctic Borderlands region may help in determining local-scale population trends in eiders, as well as in possible changes in regional distribution and habitat use as populations respond to recovery efforts elsewhere in their range, and to climate change (for example, see Gilchrist et al. 2005).

There were also comments suggesting a possible increase in the abundance of mergansers (*Mergus* sp.) in the Arctic Borderlands region. For example, in Old Crow in 4 out of 5 years, respondents commented that there were more mergansers. While there have been increases in Common Merganser (*M. merganser*) populations reported in other parts of the circumpolar north (BirdLife International 2016), North American populations of mergansers have been reported to be relatively stable (US Fish and Wildlife Service 2015). However, local changes in the abundance of mergansers in the Arctic Borderlands region may be indicative of climate change-related shifts in population distribution in the north. For example, range expansion has been reported for both Common Mergansers and Red-breasted Mergansers (*M. serrator*) in Finland (Brommer 2004).

Ptarmigan and Grouse

While there was no indication of large-scale changes in the abundance of ptarmigan and grouse, responses suggested considerable annual and community-level variation in abundance. In several communities, in several years, respondents reported increases in the number of ptarmigan and/or grouse, while two communities in two separate years, respondents reported seeing fewer ptarmigan and grouse. Comments also suggested local and short-term changes in distribution and behaviour of ptarmigan and grouse, with comments about Spruce Grouse (*Falcipennis canadensis*) in particular being observed in different habitats or locations than in other years. Because ptarmigan and grouse are resident year-round, annual variation in abundance and distribution may reflect responses to local environmental conditions, such as snow cover, food availability, and predator abundance.

Sandhill Cranes

While at a regional scale, most survey respondents reported that the abundance of sandhill cranes was not changing, there were indications of possible local-scale declines, particularly in Old Crow and Fort

McPherson. This may reflect local population fluctuations in cranes or shifts in distribution. Elsewhere in North America, sandhill cranes appear to be either stable (Canadian Wildlife Service 2015) or increasing in abundance (Sauer et al. 2014). Datasets such as the Breeding Bird Survey that are used to determine population status and trends in cranes may be of limited coverage and therefore reliability in northern parts of the species' range. Thus, local ecological knowledge provided by the ABEKS questionnaire may be crucial in identifying population changes at the northern edge of the species' range.

Non-Game Waterbirds

Loons

Based on the questionnaire responses, populations of loons appear to be relatively stable throughout the Arctic Borderlands region, with the majority of respondents reporting no change in loon abundance across the 6 years of the survey. This is consistent with other loon status reports, which show populations as stable throughout the Americas (Deinet et al. 2015). However, some reports suggest that populations of Red-throated Loon (*Gavia stellata*) may be declining in Alaska and other parts of their North American range (Wetlands International 2012) and thus have been placed on the North American Bird Conservation Initiative's (NABCI) State of the Birds Watch List for species considered at risk of becoming threatened or endangered without conservation action (Rosenberg et al. 2014). This highlights the need in surveys of local ecological knowledge for species-specific questions, where possible, in order to gain information on trends in individual species considered at risk. In the ABEKS questionnaires, it is possible that changes in populations of Red-throated Loon may be overlooked because questions focus on loons as a group. There are numerous reports in the eBird database of Red-throated Loon sightings throughout the Arctic Borderlands region (eBird 2016) and, thus, it may be worthwhile to formulate survey questions specific to Red-throated Loon in the ABEKS questionnaires. These questions could be accompanied by photographs and other material to help with distinction between Red-throated Loon and other species in the survey areas and to ensure correct identification by respondents. This may provide better information on the status of, and trends in, Red-throated Loons in the region.

Swans

While Tundra Swans (*Cygnus columbianus*) are declining in some European and Asian portions of their range (Deinet et al. 2015), they appear to be stable or increasing across their range in North America, including in the Arctic Borderlands region (USFWS 2015), as supported by the ABEKS questionnaire data. However, given their large numbers and identifiability, as well as the location of key breeding grounds within the Arctic Borderlands survey region, it is likely that ABEKS questionnaire data will be valuable in providing information on Tundra Swan population status and trends in future.

Shorebirds

Respondents indicated a decline in the abundance of shorebirds over the 6 years of the survey. This is consistent with worldwide reports of shorebird declines (Zöckler et al. 2012; Deinet et al. 2015). In the Arctic, shorebirds appear to be declining more rapidly than other bird groups (Zöckler et al. 2012), with overall declines of 60% and 10 species considered to be in severe decline (NABCI 2012). As well, several species occurring within the Arctic Borderlands region are included in NABCI's State of the Birds Watch

List as being of high conservation priority (Rosenberg et al. 2014). The reasons for shorebird declines are not well-understood, but because many Arctic breeding species migrate long distances to Central and South America, it is possible that causes of declines are occurring outside of the Arctic (Zöckler et al. 2012).

In the ABEKS questionnaire, shorebirds are grouped together and, thus, it may be difficult to extract information on trends for individual species of interest. It may be useful to identify a subset of shorebird species of highest concern, or of greatest potential as indicators for the group, in order to tailor a set of questions designed to provide information that can be used in long-term monitoring. In addition to helping inform conservation and management planning within the Arctic Borderlands region, shorebirds are considered to be good indicators of the health and functioning of inland and coastal wetlands (Zöckler et al. 2012), and so may be good candidates for more intensive local ecological knowledge data collection. Species that may be suitable include some of those from NABCI's Watch List (Rosenberg et al. 2014), such as the Semi-palmated Sandpiper (*Calidris pusilla*), which is also listed as "Near Threatened" by the International Union for the Conservation of Nature (BirdLife International 2012) or Whimbrel (*Numenius phaeopus*).

Birds of Prey

Eagles

While most other birds of prey were reported as being stable in abundance (or possibly declining, in the case of owls regionally and in some communities), eagles were consistently reported as being more abundant than in the past across all years and communities. This is consistent with North American-wide datasets showing rangewide increases in Bald Eagle (*Haliaeetus leucocephalus*) numbers over the last three decades (e.g. Wright and Schempf 2008; Sauer et al. 2014), which are generally attributed to banning of DDT and other pesticides. Golden Eagles (*Aquila chrysaetos*) are also considered to be stable or increasing throughout their range (Sauer et al. 2014). However, in the ABEKS questionnaire, "eagles" are grouped together under one category and so it is unclear whether respondents are referring to Bald Eagles, or to Golden Eagles, or both. Many respondents mentioned Golden Eagles in their comments, and expressed concerns about the effects of Golden Eagle increases on caribou calves. Thus, it may be useful to tailor a subset of questions related to the two eagle species, separately. Given the differences in life history, diet, and possible conservation issues between Bald and Golden Eagles, having a better understanding of population trends for each may help in monitoring of ecosystem changes in the region.

Other birds

Common Nighthawk

In most years, respondents reported seeing fewer Common Nighthawks (*Chordeiles minor*) than usual. Further monitoring of nighthawks, possibly with targeted questions in the ABEKS questionnaire, may be warranted as this species is undergoing significant population declines and is listed as Threatened under the Species At Risk Act (Environment Canada 2016). Current data on the status of nighthawks in Canada does not include good coverage of the Arctic Borderlands region. However, ABEKS responses, as well as reports of nighthawk sightings in eBird (Harding 1973; Schreven and Schreven 2015) suggest that

nighthawks occur and breed in the region. Understanding of population status, trends, ecology, and life history at the edge of species' range can provide crucial information on broader species trends and can assist in recovery and management plans.

Kingfishers

While there was regional and annual variation in responses regarding the abundance of kingfishers, in Fort McPherson in all years the majority of respondents said there were fewer kingfishers. Belted Kingfisher (*Megaceryle alcyon*) is listed as "least concern" by the IUCN but it is also considered a priority candidate species for consideration by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; Environment Canada 2014). It is also considered a priority species under several Bird Conservation Region Strategies, but none that encompass the ABEKS region (Environment Canada 2014). Monitoring of local changes in kingfisher populations within the ABEKS region may provide information that can be used to inform species assessments and in management plans for other Bird Conservation Regions. The source of much of the information on kingfisher declines comes from the Breeding Bird Survey, which does not have good coverage in the northern parts of the kingfisher's range. Additionally, the suggestion that kingfishers may be declining locally in Fort McPherson may warrant targeted surveys to determine the causes of local population changes. In general, kingfishers are vulnerable to loss of nest sites through destruction of river banks, gravel pits, shoreline erosion, and human disturbance (Environment Canada 2014) and so it is possible that there are local changes occurring in the Fort McPherson area that are affecting kingfishers within that community.

Woodpeckers

Most respondents said that there were fewer woodpeckers, both across years and within many communities. However, because woodpeckers are treated as a group in the interviews, it is difficult to determine which species of woodpecker may be in decline. There are a few woodpecker sightings reported in the eBird database in the Arctic Borderlands region (eBird 2016), which could be used as a supplement to the direct local knowledge provided by the ABEKS questionnaires. For example, there is one sighting of a Downy Woodpecker (*Picoides pubescens*) in Ivvavik National Park in 2012, one sighting of a Hairy Woodpecker (*Picoides villosus*) about 80km east of Tsiigehtchic in 1972, and one Hairy Woodpecker in the Arctic National Wildlife Refuge in 2009. There are also quite a few records of American Three-toed Woodpeckers in eBird, primarily near Inuvik but also in other areas of the Arctic Borderlands region. This suggests that it might be worthwhile to create a targeted subset of questions related to one or two woodpecker species, particularly those that might serve as indicators of climate-related habitat change (advancing treeline, insect outbreaks, changes in forest fire frequency and intensity, etc.).

Songbirds

While there were many comments provided regarding abundance of, and trends in, songbirds, the ABEKS questionnaire abundance section does not include specific songbird questions. Songbirds are mentioned with "other birds" but are not specifically included in the sub-categories within the "other birds" group and are only mentioned if a respondent chooses to include them as an additional item under "other". The large number of comments received regarding songbirds indicates that there is considerable local knowledge about both songbirds as a group, and about individual species, but this is not easily captured in the current questionnaire design. In many cases, respondents gave a description of the bird, or used a local term to describe it, and so it is not immediately clear to which species the

respondent is referring, or whether these are referring to the same species across communities. Having a subset of questions relating to specific songbird species, or groups (e.g. “swallows”, “blackbirds”, etc.) accompanied by reference photographs and other material that are standardized across communities, will help in identification of commonalities among songbird observations.

Because “songbirds” are a large and diverse group, with a variety of life histories, habitat requirements, migration strategies, and conservation issues, the current questionnaire format likely masks any real trends occurring in individual songbird species or groups. For example, some groups (e.g. aerial insectivores such as swallows) are in severe declines throughout North America while others are increasing. If all songbirds are grouped together, then respondents will not be able to easily give information in trends occurring within subgroups. Much of the data on songbird trends in other parts of North America relies heavily on scientific surveys (e.g. formal transect or point count surveys, Breeding Bird Surveys, etc.) and citizen science projects (e.g. Christmas Bird Count), but these kinds of data sources either do not provide sufficient coverage of northern areas, or are costly and logistically difficult to carry out. Thus, local knowledge on songbirds may be crucial in identifying trends occurring at the northern edges of the range of many of these species.

Knowledge from ABEKS could be used to help in the assessment of the status of Snow Buntings (*Plectrophenax nivalis*). Snow Buntings appear to be in severe decline but the data on Snow Bunting abundance that is used to assess population trends is considered to be somewhat unreliable and does not adequately cover Snow Bunting range (Deinet et al. 2015). For example, assessments of Snow Bunting abundance rely heavily on data from Christmas Bird Counts, which provide limited or no coverage in the northern part of this species’ range, including the area encompassing the Arctic Borderlands region. It has been suggested that what has been identified as declines in populations of Snow Buntings is actually reflective of northern range contraction, with buntings wintering farther north in their range than they have historically, and thus disappearing from counts conducted in the southern portions of their range (Deinet et al. 2015). This hypothesis is supported in the ABEKS data by many comments from respondents about Snow Buntings (or “snowbirds”) increasing in abundance, or arriving earlier in the spring. This highlights the need for incorporation of local knowledge about northern populations of species into assessments of status and trends in order to fully understand changes in species abundance.

Methodology and questionnaire design

There were many consistencies between trends reported by questionnaire respondents and other sources of data on population status and trends, suggesting that the local ecological knowledge provided by the ABEKS bird questions may help in informing or supplementing existing bird population databases. It may also be helpful in identifying population changes at local scales, before they are observable at larger scales.

However, given the likely differences in local climate, weather, disturbance, and other conditions across the communities in the region, there were also some differences in trends reported among communities, which may mask broader-scale, region-wide changes in populations. In many cases, the scale at which respondents answered questions and observed changes in populations may differ from the scale (either temporal or spatial) at which species-level changes in abundance or timing of migration are occurring. Thus, when using local ecological knowledge and traditional ecological knowledge in monitoring population trends, it is important to ensure that the sources of data (whether traditional or

scientific) are at similar scales (Gagnon and Berteaux 2009). Also, while local ecological knowledge may be able to identify very coarse and large-scale changes in population size or distribution, it is possible that it will need to be supplemented with intensive field-based surveys in order to provide the qualitative details required for population management (Gilchrist et al. 2005).

When compiling traditional and local ecological knowledge across a region, there must be consistency and standardization among respondents, years, and communities. Specifically, it is important to clarify and standardize how questions regarding trends are phrased, such as the time scale of reference for assessments of "more than usual", "same as usual", and "fewer than usual" in relation to bird abundance. The questions in the ABEKS questionnaire are phrased as "Based on your observations in the past year, are there more, the same or fewer [birds] than usual?" and so it is important to consider what is considered "usual" for the respondent. A similar problem arises with the wording of the question related to timing of arrivals and departures. This question is phrased as "Did birds arrive or leave at the normal time this year?", and so there may be variation among respondents in the scale of reference they use to assess what is "normal". Depending on the respondent's age and experience, they may be comparing the past year's observations to their knowledge over the course of several decades, or over just a few years. This means that answers are not necessarily comparable among respondents, depending on how they interpret the question and assess what they consider "usual" or "normal". Using interviews rather than questionnaires for some key species or bird groups may provide information that will be more easily comparable to other datasets, or that may allow respondents to fully elaborate on their observations. An alternative is to rephrase questions so that there is a specified time scale for response, or in which the respondent can specify the time scale to which they are referring. Either of these modifications to the ABEKS bird question methodology would in turn allow for better integration with large-scale datasets, and for communities to identify local-scale trends which they may wish to use to develop further monitoring, management, or recovery projects.

In using local knowledge from the ABEKS interviews to understand population change and trends, it is important to be able to match species discussed in the interviews with those in other databases. Thus, having an understanding of local and traditional names for bird species and groups will help in correctly and efficiently linking data from interviews with data from other sources. This highlights the need for preservation and documentation of languages and dialects. Dictionaries, databases, and other resources that provide translations of traditional and local names for wildlife species, places, and other factors are crucial in order to fully understand and apply local and traditional knowledge in wildlife monitoring, conservation, and management. Additionally, it is necessary to be able to standardize responses across communities in order to identify commonalities and patterns. For example, a term used to describe a species in one language or dialect may differ from that used in another language or dialect. If these differences are not recognized and documented, then important similarities in observations may go unnoticed during data analysis. Using standardized photographs and other materials as references during interviews, and documenting local names and terminology, will help to ensure that respondents are referring to the same species and will better enable identification of trends and patterns.

Combining of species into broad bird groups, such as "songbirds", "dabblingducks", and others may mask changes occurring among individual species within those groups. For example, in the case of both songbirds and dabbling ducks, there is a large array of species, with much variation in life history, migration strategy, breeding requirements, habitat associations, diet, and other factors. Some species

within these groups may be undergoing significant declines, while others may be increasing, and in both cases may be of conservation concern. By asking respondents about trends in abundance or timing of a group, changes in one direction by one set of species within that group may essentially cancel out changes in the other direction by different species within that group, leading to the appearance of no change for the group as a whole. Therefore, it is critical to identify a few species for which a subset of questions could be formulated. These species could be either possible indicators of broader ecosystem changes, or species of particular conservation or management concern. Some possible candidates would be Bald Eagles, Golden Eagles, Long-tailed ducks, eiders, swallows, American Three-toed Woodpecker, semi-palmated sandpiper, and others. Selection of these focal species could be based on level of conservation or management concern; traditional or cultural importance; ease of identification, extent of geographic range in the Arctic Borderlands region; or other factors.

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