Migration Trends for King and Common Eiders and Yellow-billed Loons past Point Barrow in a Rapidly Changing Environment

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Abstract

Most of the king (*Somateria spectabilis*) and common eiders (*S. mollissima v-nigra*) nesting in northern Alaska and northwestern Canada pass Point Barrow, Alaska, during spring and fall migrations. Yellow-billed loons (*Gavia adamsii*), a species of international conservation concern, also migrate past Point Barrow. Spring migration counts of eiders have been conducted at Point Barrow approximately every ten years since 1976. These counts indicate that both eider species experienced population declines of approximately 50% between 1976 and 1996, and that the declines had stabilized by 2004. Population estimates derived from migration counts have not been previously estimated for yellow-billed loons. We conducted spring counts of eiders and loons in 2015 and 2016 to obtain population indices to compare with eider counts from 1994, 1995, 2003, and 2004, and loon counts from 2003 and 2004. These data allowed us to evaluate current and long-term trends. We estimated (95% confidence intervals) that 796,419 (± 304,011) king and 96,775 (± 39,913) common eiders passed Point Barrow in 2015 and 322,381 (± 145,833) king and 130,390 (± 34,548) common eiders passed Point Barrow in 2016. Both king and common eider population indices increased from 1994 through 2016; however, the increase over time was not significant ($F < 5.07$, $P > 0.087$, df = 1). Our population indices for king eiders were very different between the two years of this study, possibly due to a very short and intense migration peak in 2016. This peak resulted in a population count that was biased low because sampling periods did not adequately capture the peak of migration. The numbers of common eiders were similar between the two years, and within range of counts conducted in 2003–2004. Photo analysis of flocks indicated that observer counts were on average 4% lower than photo counts (paired t-test; $|t| = 3.26$, df = 297, $P < 0.001$) for flocks of less than 1,400 individuals (observer count). Estimates of yellow-billed loon populations were highly variable and are biased low as numbers of loons passing Pt. Barrow were still high when our counts ended in late May. It is important that counts continue to be conducted for these species of conservation and subsistence importance. However, techniques need to be refined to reduce bias and variability and to address the increasing difficulty of conducting a count from the shorefast ice in spring.

Introduction

King (*Somateria spectabilis*) and common eiders (*S. mollissima v-nigra*) wintering in the Bering Sea and North Pacific Ocean migrate north to nesting areas in Russia, Alaska, and Canada. Most of the eiders nesting in Alaska and Canada pass by Point Barrow when entering and leaving the Beaufort Sea. At Point Barrow, the migration passes very close to shore and the spring passage can be spectacular. Woodby and Divoky (1982) estimated that 113,000 eiders passed in 30 minutes in the spring of 1976. Although the spring passage of eiders at Point Barrow has been described by researchers (Murdoch 1885, Brueggeman 1980), the actual magnitude of the spring migration has been estimated on only a few occasions (Woodby and Divoky 1982, Suydam et al. 1997, 2000b, Quakenbush et al. 2009).

In 2000, Suydam et al. (2000a) standardized the estimations of spring migration conducted at Barrow in 1953 (Thompson and Person 1963), 1970 (Johnson 1971), 1976 (Woodby and Divoky 1982), 1987 and 1994 (Suydam et al. 1997), and 1996 (Suydam et al. 2000a, b). They determined that the king eider population appeared to remain stable between 1953 and 1976 and then declined by 53% between 1976 and 1996. They also determined that the common eider population declined by 56% during the same time period (Suydam et al. 2000a). Migration counts were repeated in 2002–2004, at which time it appeared that the number of common eiders passing Point Barrow had increased since 1996, but only slightly, and that the number of king eiders may have increased, but not significantly and not back to the numbers seen in 1970 (Quakenbush et al 2009). The reasons for the apparent decline are poorly understood but may be related to climate change and anthropogenic disturbance. These factors are likely to affect survival through changes in the benthic invertebrate community, increased collisions with infrastructure, habitat loss, and northern expansion of competitors, parasites, and infectious diseases, (Kerr 2002, Lovvorn et al. 2003, Dunton et al. 2005, Grebmeier et al. 2006, Bluhm and Gradinger 2008).

Yellow-billed loons (*Gavia adamsii*) also migrate by Point Barrow from wintering areas along the coast of eastern Asia (Evers et al. 2013). Although there is no evidence of a long-term population decline in yellow-billed loons in northern Alaska (Earnst et al. 2006), the yellow-billed loon is an international species of concern, with the global population estimated at 16,650 to 21,000 birds. The International Union on Conservation of Nature (ICUN) has categorized the yellow-billed loon as "vulnerable" and several Russian Red Book Data books list the yellow-billed loon as a rare species of low population at risk. In 2009, the U.S. Fish and Wildlife Service listed the yellow-billed loon as a candidate species "warranted but precluded by other higher priority listing actions" for protection under the Endangered Species Act (ESA) because of life history, small global population, restricted distribution, habitat requirements, and subsistence use. When the ESA listing decision was reviewed in 2014, it was decided that the yellow-billed population did not warrant listing, although their vulnerability was recognized. Yellow-billed loons have been included in most migration counts since 2003, but the utility of a loon migration index count has not been assessed.

Eiders migrate up the open lead (open water separating shorefast ice from the free moving sea ice) that typically forms on the west side of Point Barrow in the spring before turning and heading east into the Beaufort Sea. Migration counts have been conducted from the lead edge by observers with binoculars counting the number of birds passing approximately every ten years since the 1990s. This allows an index of population size to be calculated and the trajectories of the populations of king and common eiders to be estimated. However, there are some assumptions that should be addressed: (1) counts of flocks may be biased depending on a number of factors including the number and size of flocks; (2) we assume that most eider flocks migrate up the lead and past the observation point and are available to be detected by observers; and (3) we assume that the proportion of the total migration following the lead has not changed over time. The first assumption has been addressed by using the same methodology through time. In this way, any bias in total population estimates would be as consistent as possible for each count, resulting in a reliable estimate of population trend. The second assumption was evaluated for fall migration (not spring) using radar to count birds (1997 and 2000). The data indicated that nearly all eiders encountered (i.e., those within the range of the radar) passed within 3 km of the survey location at the base of the Barrow Peninsula (see Day et al. 2004). Additionally, king eider satellite transmitter data indicated that individuals typically migrated past Pt. Barrow within 5 km of shore, and very few of the tracked eiders passed inland of the Pt. Barrow Spit (Phillips 2005, Quakenbush et al. 2009). However, these radar and satellite analyses were from summer and fall migrations and may not apply during spring migration when eiders experience very different conditions. Lastly, there is no way to go back in time and assess the third main assumption: no change in migratory routes over time.

The primary purpose of this study was to examine population trends of king and common eiders migrating past Point Barrow in the springs of 2015 and 2016 by continuing the standardized point-count methodology developed in prior surveys (Quakenbush et al. 2009). Additionally, using a pre-existing radar installation in Utqiagvik, we attempted to evaluate the proportion of migrating birds that passed between the lead/observation point and the city of Utqiagvik (formerly Barrow) and those that passed just south of Utqiagvik and were not observed. Finally, to inform future migration counts, we assessed observer bias through the comparison of observer counts and photographs of specific flocks.

In this report we (1) present estimates of the numbers of king and common eiders passing Point Barrow during the spring of 2016 and compare them to estimates derived from 1996, 2002–2004, and 2015 counts (Suydam et al. 2000a, Quakenbush et al. 2009); (2) present an estimate of the 2016 yellow-billed loon population in comparison to estimates from 2003–2004 (L.R. Quakenbush and R.S. Suydam, unpublished data) and 2015 (R.L. Bentzen, unpublished data); and (3) evaluate observer error through photographic and radar techniques. Although the Coastal Marine Institute did not fund the count conducted in 2015, the data have not been summarized or reported elsewhere and we include them here for comparison .

Methods

Observer Locations

Counts were primarily conducted at a site close to the edge of the shorefast ice northwest of Point Barrow. In 2015, the count occurred from 23 April to 31 May. We began the count at the lead edge from 23 April–15 May (North Perch, 71° 25'N, 156° 30'W; Figure 1, Figure 2). There were whaling camps established on either side of the counting site, and the one to the north landed a bowhead whale on 7 May. The remains of the whale attracted a considerable number of polar bears (up to 11 at one time) and, on 13 May, we moved south to a site slightly farther from the lead edge. Fortunately, the move occurred after peak migration and, although it was not as easy to determine sexes of birds flying past, it was still a relatively good location for counting (South Perch, 71° 22'N, 156° 36'W). Our crew and the whalers were forced to move to shore on 21 May after the sea ice degraded because of warm weather. Thus, the last week of the count was conducted from land at two sites south of Utqiagvik (Bluff, 71° 17'N, 156° 49'W; Gravel Pit, 71° 16'N, 156° 46'W). In 2016, the count occurred from 24 April to 1 June. We began the count from the edge of the shorefast ice from 24 April–11 May (71° 25'N, 156° 30'W; Figure 1). Because strong southwest winds were forecasted on 11 May and the lead edge was predicted to become very unsafe, our observers moved to the Gravel Pit from 11–17 May. However, conditions for observing eiders were not ideal at the Gravel Pit as the lead was far away; the crew moved to a point farther south which provided better counting opportunities from 18 May–1 June (Monument, 71° 09'N, 157° 03'W). Previous counts have also begun at the lead edge and moved on-land as ice conditions deteriorated.

The count locations and timing for the 2003 and 2004 yellow-billed loon data are detailed in Quakenbush et al. (2009).

Figure 1. Eider migration count locations, Alaska, 2015 and 2016.

Observations

We used the same methods to collect and analyze data as those used by Suydam et al. (1997) and Quakenbush et al. (2009) in order to directly compare estimates among years. Four observers, in teams of two, counted eiders and loons for up to 12 hours per day. Counts typically followed a pattern of two hours on, one hour off between 0500–1300 and 1700–0100 hours. Previous counts have not observed a diurnal pattern in migration and this observation pattern followed previous counts and allowed for snow machine travel back and forth to the counting location. Occasionally counts ended early due to the proximity of polar bears or high winds causing unsafe ice movement or break-up. We deferred to our local guides and the North Slope Borough Department of Wildlife Management on assessing when ice travel conditions were safe.

Figure 2. The count location at the edge of the shorefast ice, Point Barrow, Alaska, 2016. Photo credit: Mark Dodds.

For each counting period, we collected data on weather including percent cloud cover, the presence of fog and precipitation, air temperature, visibility, wind speed, and wind direction. For each flock sighted, we recorded time, direction of travel, species composition, number sighted, and the ratio of males to females for each species. To ensure that standardized counting protocols were used, all observers were trained by Dr. Robert Suydam (North Slope Borough) and other individuals who had assisted with earlier eider migration counts. In addition, early in the season, each observer estimated flock size independently and then arrived at a consensus estimate with the team. Flock size estimates between observers were generally within ±10% of each other. Discussion of estimates usually resulted in an explanation for discrepancies and convergence on a consensus estimate. Flocks could often be counted multiple times as they approached and moved past the perch, and if observer estimates were disparate another count was made. Flocks passing opposite to the expected direction of travel (i.e., not traveling south to north) were subtracted from the number of eiders flying in the expected direction during each 2-hour period. While we could estimate size of eider flocks, due to distance, we were often unable to identify all birds within a flock to species and sex. In such cases, the flock was categorized as ‘unidentified eiders.’ To estimate passage rates by species, we divided the number of unidentified eiders between king and common eiders based upon the species proportion that were identified during each 2-hour survey period. Occasionally, no flocks were identified to species within a count period, so we used the proportion of species derived from the next count period of the day to adjust our estimates.

In order to obtain correction factors for total flock size, sex ratio, species ratio, and to determine if subadults migrated with adults, we photographed a subset of flocks using a high-resolution camera with 400-mm telephoto lens (Figure 3). For larger flocks we attempted to take a photo encompassing the entire flock and then zoomed in and took multiple photos of portions of the flock that could later be 'stitched' together.

Figure 3. Example of a flock photo used in the photo analysis, Point Barrow, Alaska, 2016. Photo credit: WCS staff photo.

Population Estimation

To account for daily variation in our estimate of a total index of population size, we followed Quakenbush et al. (2009) and treated our sample as coming from a stratified design, where each day represents a separate stratum. Within each day, we used the observed ratio of king to common eiders to assign unidentified eiders to one or the other species. We assumed a 50:50 sex ratio for flocks where sex ratio was not determined. Within each day (*d*), the average number of eiders passing in a 2-hour period ($\bar{y}_d$) was estimated using all 2-hour periods sampled (2 hours being the standard observation increment). This average was then multiplied by the total number of 2-hour sampling periods that were possible within each day ($N_d = 12$). Following Thompson (2002; page 119), the index population total thus was defined as the sum of the daily totals:

$$Total = \sum_{d=1}^{L} N_d \bar{y}_d$$

where *L* is the total number of days sampled. The variance estimator for the population total accounts for the number of 2-hour periods sampled within each day (n_d) and the sampling variance within each day (s^2_d) and was defined as:

$$\mathrm{var}(Total) = \sum_{d=1}^{L} N_d (N_d - n_d)(s_d^2/n_d)$$

We used linear regression to estimate population trends between 1994–2016 using the population estimates for the years 1994–2004 presented in Quakenbush et al. 2009 (Table 1). We log-transformed the count data and estimated separate trends for king and common eiders.

Table 1. Estimated index of total number of king and common eiders passing and 95% confidence intervals from prior surveys. Calculations based on comparable time periods in spring 1994, 1996, 2003, and 2004 (Quakenbush et al. 2009).

	King Eiders		Common Eiders	
	Population Estimate	95% CI	Population Estimate	95% CI
1994[1]	345,489	147,877	74,651	22,317
1996[1]	330,218	70,725	72,606	13,606
2003[2]	356,293	75,598	114,998	28,566
2004[3]	591,961	172,011	110,561	32,087

[1]May 1-June 4
[2]April 26-June 5
[3]April 28-June 3

Photo Analysis

We used the count tool in Adobe Photoshop Professional and examined flock photos to obtain correction factors for total flock size, sex ratio, and species ratio and to determine if subadults migrated with adults. The process was time-consuming, particularly for large flocks where multiple photos were stitched together. We used paired t-tests to compare flock counts by observers with counts determined from photos. Similarly, we used paired t-tests to compare sex and species ratios derived from observers and photos.

Radar Analysis

In order to evaluate whether flocks seen on radar were included in those counted by observers or if they were outside observer detection, we used data recorded by the radar installation on the bank building in Utqiagvik run by the Sea Ice Group at the Geophysical Institute at UAF and available on the web (http://seaice.alaska.edu/gi). The goal was to determine the proportion of flocks not counted by observers.

Unfortunately, the radar installation was not operational 5–10 May 2016, which was peak migration. Additionally, due to sea ice conditions, the count location was more than 8 km from Utqiagvik in 2016 and outside the range of the radar. Regardless, we reviewed radar data from 11–24 May to determine if flocks were missed in late migration when the radar was working and we were counting from the Gravel Pit and Monument south of Utqiagvik (Figure 1).

Results

Observation Periods

In 2015, the spring migration count was conducted over 39 days, with 405 hours of recorded observation effort during which a total of 356,164 eiders were counted (Table 2). In 2016, the count was conducted over 38 days, with a total of 406 hours of recorded observation effort during which 224,532 eiders were recorded (Table 2). Most of the eiders counted were kings (Table 2). It is important to note that Table 2 presents the raw number of eiders counted by observers each year and is not a total index of eider populations.

Table 2. Raw count data for eiders on spring migration, Point Barrow, Alaska, 2015 and 2016. Unidentified eiders were assigned as king or common eiders based on the proportion of king and common eiders that were identified during each 2-hour survey period.

	2015	2016
King eiders	320,423	159,736
Common eiders	35,741	64,796
Total eiders	356,164	224,532

Eider migration peaked on 7–9 May in both years and most birds passed Point Barrow between 30 April 30 and 13 May (Figure 4). Flock size ranged from 1–10,800 in 2015, and 1–8,000 in 2016. We estimated (95% confidence intervals) that 796,419 (±304,011) king and 96,775 (±39,913) common eiders passed Point Barrow in 2015, and 322,381 (±145,833) king and 130,390 (±34,548) common eiders passed Point Barrow in 2016 (Figure 5).

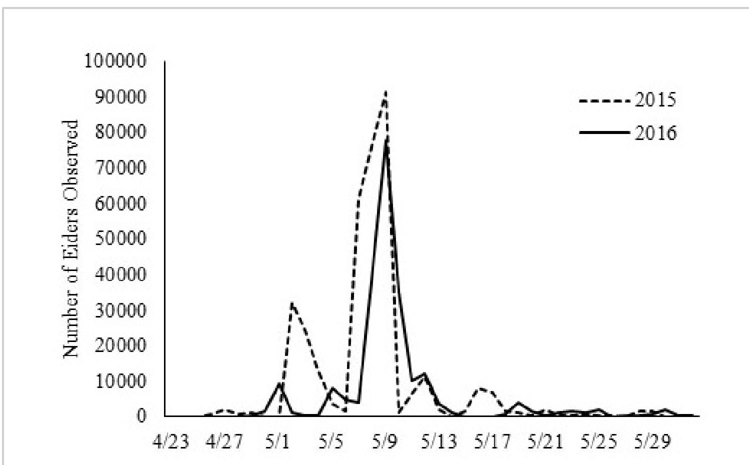

Figure 4. Raw number of eiders counted during spring migration, Point Barrow, Alaska, 2015 and 2016. Unidentified eiders were assigned as king or common eiders based on the proportion of king and common eiders that were identified during each 2-hour survey period.

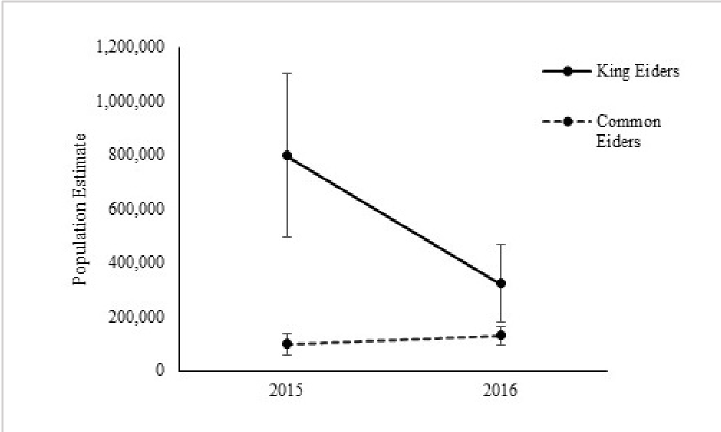

Figure 5. Total eider index ± 95% confidence intervals for king and common eiders passing Point Barrow, Alaska on spring migration, 2015–2016.

Numbers of migrating birds varied throughout the day; for example on 8 May 2016, 36,510 eiders were counted during six 2-hour periods throughout the day but 76% of the morning count (0500–1300 hours) passed in the last half hour (Figure 6).

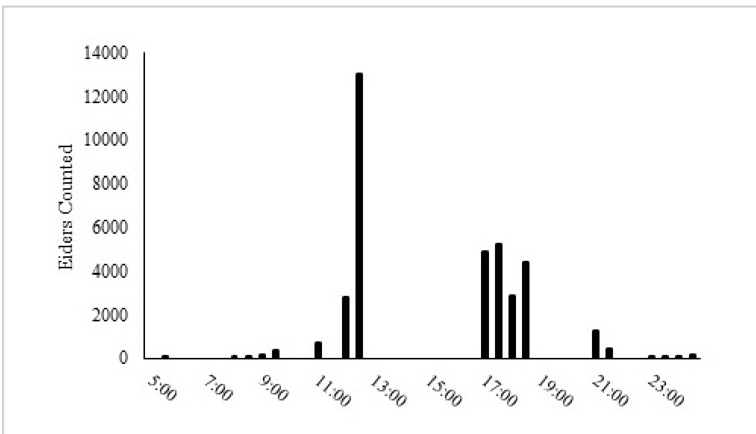

Figure 6. Number of eiders observed passing Point Barrow, Alaska, on spring migration throughout the day on 8 May 2016. Eiders were counted 0500–0700, 0800–1000, 1100–1300, 1700–1900, 2000–2200, and 2300–0100 hours.

Population Trajectory

There was no trend from 1994–2016 for king eider population indices ($F = 0.99$, $R^2 = 0.2$, $P = 0.37$, df = 1; Figure 7); the rate of increase was 0.018 (%/year) but 95% confidence intervals included zero (95% CI = -0.033–0.069). However, if we do not include data from 2016, the rate of increase for king eiders was 18.63, a significant increase from 1994 and 2015 (95% CI = 1.85–35.81; $F = 12.45$, $R^2 = 0.81$, $P = 0.04$, df = 1).

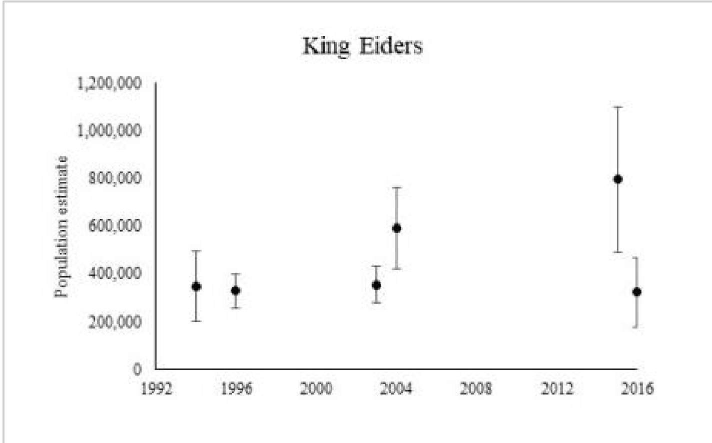

Figure 7. King eider population indices and 95% confidence intervals of king eiders on spring migration past Point Barrow, Alaska. Estimates from 1994–2005 are from Quakenbush et al. 2009.

Indices for common eider populations were stable 1994 through 2016, (F = 5.067, R^2= 0.56, P = 0.087, df = 1; Figure 8). The rate of increase for common eiders was 0.019 (95% CI = -0.005–0.043).

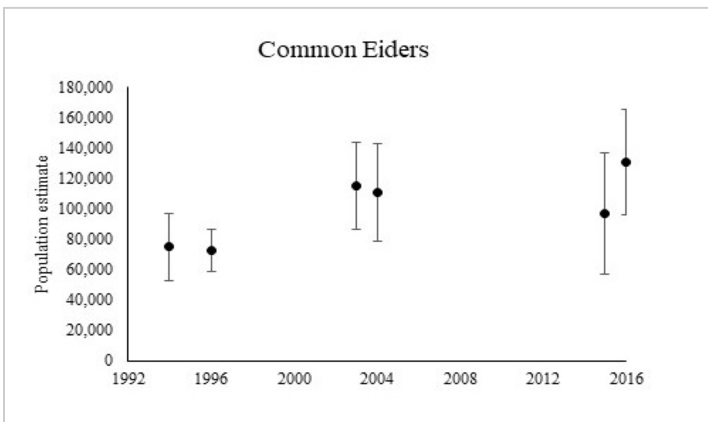

Figure 8. Common eider population indices and 95% confidence intervals of common eiders on spring migration past Point Barrow, Alaska. Estimates from 1994–2005 are from Quakenbush et al. 2009.

Photo Analysis

We used a subsample of 298 flocks with counts from both observer and photos, which ranged in size from 1 to 1,400 individuals (observer count). Our photo analyses indicated that flock counts by observers were significantly lower than counts derived from photos (paired t-test; |t| = 3.26, df = 297, P < 0.001). The average ratio of total flock size as counted by observers versus total flock size determined from photos was 0.96 and ranged from 0 to 2.13. Sex ratio also varied between counts by observers and photos of the same flocks; observers counted significantly fewer females than were determined from photos (paired t-test; |t| = 7.72, df = 171, P < 0.001). Species ratios (common to king eiders) did not vary between counts by observers and photos for mixed-species flocks (paired t-test; $|t| = 0.69$, df = 58, $P = 0.25$). Eight subadult male king eiders were counted in photos that were not identified by observers.

Radar Analysis

We were unable to detect any flocks in the radar data 11–24 May 2016, despite having observations of flocks passing during these dates.

Yellow-billed Loons

We counted 679 yellow-billed loons in 2016 and estimate (95% confidence intervals) that 1386 (± 340) yellow-billed loons passed Point Barrow during May 2016. Loons were first observed on migration 11 May and were still being observed when our counting ended on 1 June 2016 (Figure 9). For comparison, 184 yellow-billed loons were observed in 2003, 1,134 in 2004, and 85 in 2015 (Figure 9). These observations resulted in estimates of 686 (± 683) yellow-billed loons passing Point Barrow in 2003, 4,218 (± 1,972) in 2004, and 173 (± 86) in 2015.

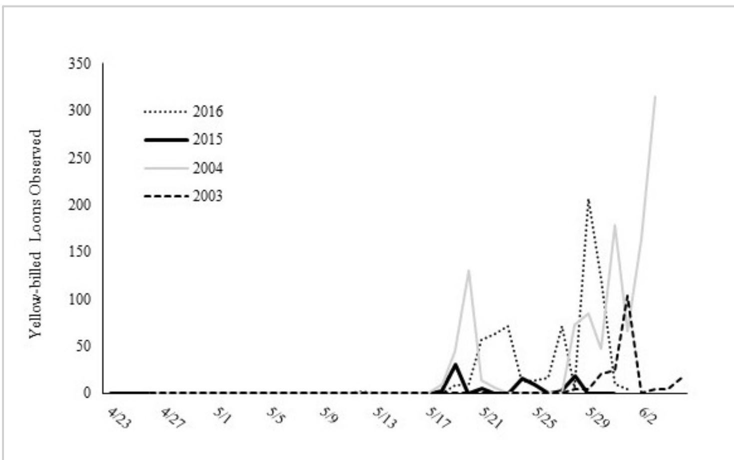

Figure 9. Number of yellow-billed loons observed on spring migration past Point Barrow, Alaska, 2003, 2004, 2015, and 2016.

Discussion

Eider population sizes are a result of survival and reproductive success, and the impacts of predicted changes in climate on life history parameters are poorly understood. With recent rapid climatic changes, it is unclear how arctic-nesting bird populations will respond, so it is important to estimate and monitor population sizes over time. For example, winter conditions can influence timing of spring migration. In the Baltic Sea, both the North Atlantic Oscillation NAO) and, particularly, the timing of ice break-up result in earlier spring migration of common eiders (Lehikoinen et al. 2006). In some populations, mild winters result in earlier egg laying in the breeding season (D'Alba et al. 2010), which may result in increased reproductive success. However, in some areas, such as La Pérouse Bay, Canada, breeding populations of common eiders have declined in recent years due to complex interactions between predators, increased abundance of snow geese (*Chen caerulescens*), and climate (Iles et al. 2013). The factors influencing eider populations related to climate are complex and still unclear. For example, the effects of the NAO at distinct wintering grounds may impact individual eiders differently depending on where they overwinter, and some birds are affected through changes in the food web (Guéry et al. 2017). In the Chukchi Sea, common, king, spectacled (*S. fischeri*), and Steller's (*Polysticta stelleri*) eiders stage in, and migrate through, leads in the sea ice along northwestern Alaska before passing Point Barrow in spring. However, eiders' access to prey and the locations of profitable foraging areas vary widely and climatic changes may increase unpredictability of critical food resources (Lovvorn et al. 2015).

Population Indices and Trajectory

The king and common eider populations that migrate past Point Barrow in spring appear to be stable to slightly increasing 1994–2016. This is supported by aerial surveys of the Arctic Coastal Plain of Alaska, which indicated that the king eider population was increasing between 2003–2012 (+2.4% per year; Platte and Stehn 2013). Similarly, annual aerial surveys of the coastline of the Arctic Coastal Plain (1999–2009) showed an overall annual increase of 3.0% per year of indicated breeding common eider pairs (Dau and Bollinger 2009). This survey period covers the early portion of the period for which we calculated a slight, but insignificant, increase in the number of common eiders passing Point Barrow (1992–2016) and supports our conclusion that the population decline that occurred between 1976 and 1996 has slowed and possibly reversed.

Although common eiders breeding in southwestern Alaska do not migrate past Point Barrow, or breed in the Arctic, they likely experience similar wintering conditions and may show similar long-term population patterns. Similar to patterns observed in the Point Barrow migration counts, aerial surveys of common eiders on the Yukon-Kuskokwim Delta showed a stable trend during 2003–2012 (Platte and Stehn 2013) after declines of up to 90% from 1957 to 1992 (Stehn et al. 1993; Hodges et al. 1996).

Eiders breeding in eastern North America and Greenland likely have different population patterns than those wintering around the Bering Sea as they experience much higher hunting pressures (Merkel 2004, 2010), devastating avian cholera outbreaks (Descamps et al. 2012), loss of colonies due to polar bear predation (Iverson et al. 2014, Prop et al. 2015), and they winter in separate ocean systems. Common eiders breeding in eastern Canada have increased at some colonies and decreased at others (Chaulk et al. 2005, Chaulk 2009, Hipfner et al. 2002, Falardeau et al. 2003, Black et al. 2012, Maftei et al. 2015, Pratte et al. 2016). Common eiders breeding in western Greenland declined precipitously from 1960–1965 to 1998–2001 (Merkel 2004) followed by a sharp increase in breeding numbers from the late 1990s to the late 2000s, possibly due to harvest reductions in Greenland that began in 2001 (Burnham et al. 2012, Merkel 2010). This is a similar pattern to that observed in Alaska, but likely due to different factors. It is difficult to determine patterns in population dynamics and sort out influencing factors because long-term datasets across the circumpolar north are lacking, and localized studies show mixed results.

Our indices of the population of king eiders migrating past Point Barrow were very different (>50% difference) for 2015 and 2016 (Figure 3). Because of this discrepancy, there is some argument for removing the 2016 count from the analysis of population trajectory. If we do not include data from 2016, the king eider population may have actually increased from 1993–2012. We do not believe that the difference in count estimates for king eiders indicated that the population declined by 50% between the two years. Instead, the difference is likely due to the non-normal distribution of the data and the early deterioration of the shorefast ice in 2016. Because eiders pass by in large pulses, with counts ranging from zero to >90,000 on any given day, adequately capturing variability can be difficult. In fact, previous counts also found very high inter-annual variability; the estimates of the numbers of king eiders in 2003 and 2004 (Quakenbush et al. 2009) varied between years (304,966 ± 76,254 in 2003; 591,961 ± 172,011 in 2004) and are within the same ranges as we found 12 years later (Figure 5).

The 2016 count may be biased low as most of the population passed Point Barrow in two days. The population estimate is based on the average of six count periods within each day; if only a few birds pass during five periods and thousands pass during one, that variation will be captured in our estimates of population size and variance. However, if the large pulse of birds passed during a time we were not counting, the population estimate will be biased low, as will the variance. For example, on 8 May 2016, 76% of the eiders counted in the morning period (0500–1300 hours) passed Point Barrow during the last half hour (Figure 6). Based on the average of the last half hour of the morning count and the first half hour of the evening count, we may have missed as many as 71,444 eiders during the 4 hours (1300–1700 hours) when we weren't counting. Unfortunately, we were unable to extend the count that day or add an additional period between 1300 and 1700 hours for logistical reasons. However, we observed larger flocks than we had seen at any other time during the two years of the count while snow machining back to Utqiagvik that afternoon. The result was that, despite obviously being the peak in migration, our daily count total was only 37,994 eiders. It is possible the very contracted migration period in 2016 was due to sustained north and east winds holding the eiders back at a staging area south of Point Barrow (Oppel et al. 2009) for an extended period of time. When the wind let up, there was a mass migration in a very short period of time. Eider migration is related to wind speed and direction (Woodby and Divoky 1982, Day et al. 2004, Quakenbush et al. 2009). Ice conditions were also different between the two years (Figure 10). In 2015, we remained on the shorefast ice, relatively near the lead edge, until 22 May, resulting in coverage of most of the migratory period from a good vantage point. Unfortunately, in 2016, due to degrading ice conditions, we could only remain at the lead edge until 11 May; it is unknown whether our early departure resulted in counts being biased low. In 2003 and 2004, observers remained on the ice until 27 May.

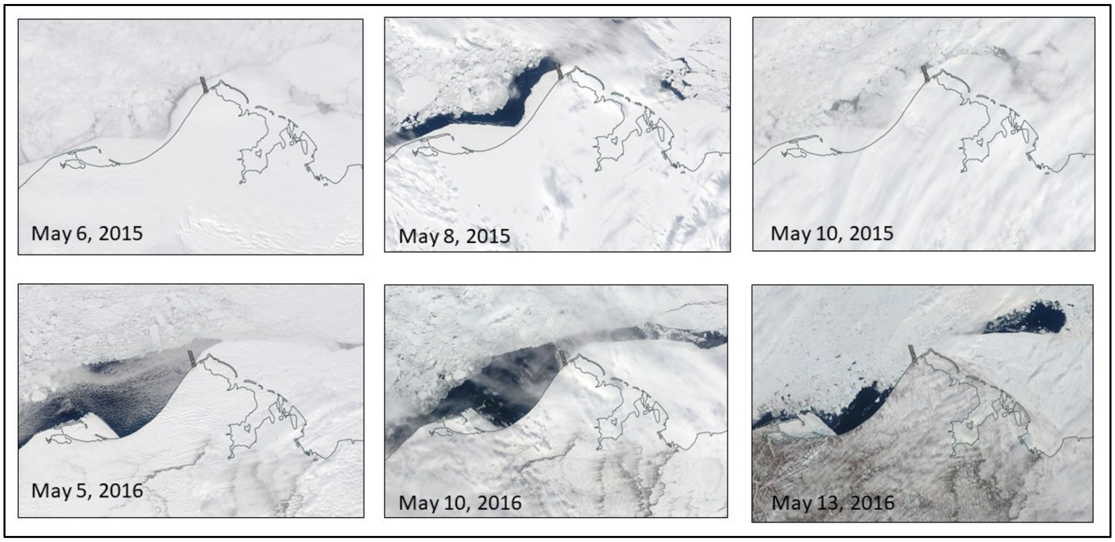

Figure 10. Ice cover just before, during, and after peak migration in 2015 and 2016. Ice cover data from NASA, 2016.

Photo Analysis

We found that observers underestimated flock size by 4% for flocks of less than 1,400 individuals and that negative bias likely increased with flock size. These negative observer biases are known when comparing photograph counts to observer counts (see Udevitz et al. 2005). Due to known observer biases, it is likely that population estimates from the 1950s through the most current count are biased low, not high. It is unknown if this bias remained constant over the years. Photo analysis also revealed that observers underestimated the number of females in a flock; however, this does not influence estimates of population size. In contrast, misidentifying the species would impact population estimates, but observers correctly distinguished adult male king and common eiders. With respect to age class, eight subadult male king eiders were counted in photos that were not identified by observers, confirming that some subadults migrate with adults past Point Barrow in spring. The presence of subadult male eiders in the spring migration has been observed since the early 2000s and confirmed with satellite telemetry (Bentzen and Powell 2015). Brown-colored eiders (either females or subadults) have also been observed near Point Barrow throughout the winter in recent years, and it is suspected that these are subadults. Subadults are known to winter farther north than adults and to be less winter-site faithful (Bentzen and Powell 2015). This tendency towards a shorter migration may be becoming more prevalent as sea ice conditions change.

Radar Analysis

Prior to initiating this project, we reviewed a 3-day animation of radar data from the Sea Ice Group (from April 2014) wherein it appeared that flocks of birds could be seen migrating north along the lead. In that year, the lead was very close to Utqiagvik (after a huge piece of shorefast ice broke off with a number of whalers on it) and fairly open and not cluttered with ice. However, we could not identify birds on the radar images collected in 2016. The radar settings may have changed slightly, or ice conditions could have been optimal (e.g., open lead with few icebergs) in 2014. We could not detect eiders migrating over ice-filled waters using this radar installation and were, therefore, unable to determine the proportion of flocks that escaped detection by our observers on the perch.

Yellow-billed Loons

Based on aerial surveys, there are an estimated 3,369 yellow-billed loons breeding on the North Slope of Alaska (Earnst et al. 2005). Our population indices fluctuated from only 173 in 2015 to 4,218 in 2004, and numbers observed were still high in all years when the count ended (Figure 9). There were some unidentified loons observed each year, but they were more likely to be red-throated (*G. stellata*) or Pacific (*G. pacifica*) loons than the very large and distinctive yellow-billed loon, so we did not include them in our population estimates. Ten unidentified loons were observed in 2003, 850 in 2004, 370 in 2015, and 12 in 2016. Of these, it is possible that the 2015 yellow-billed loon estimate is very low because of not including the unidentified loons in our analyses. In addition, we do not believe the eider migration count is well designed to determine population size or trajectory for yellow-billed loons. The eider count was designed to cover the spring migration period of eiders and ended by 1 June. However, the number of yellow-billed loons migrating past Point Barrow is still high in early June, resulting in a truncated count for this species. Also, it is not clear that loons follow the lead past Point Barrow as eiders do, and a significant proportion of the population may fly inland south of our observation areas. We had hoped this project would supply important information on the population size and status of the yellow-billed loons that migrate across the Beaufort Sea, but we conclude that using eider migration counts at Point Barrow is not an appropriate technique. Furthermore, loon counts during the eider survey would not be consistent with a loon-specific survey and could not be directly compared. More information on the timing and routes of loon migration is necessary to design an on-land count during migration to derive population estimates.

Recommendations

- Continue the eider migration count every five years. The length of this dataset is impressive and allows us to calculate an index of population trajectory that has been confirmed by other metrics such as aerial breeding ground surveys. It is also important to conduct surveys in pairs (at least two years in a row) as any single year may be impacted by weather and other factors.
- Conduct summer/fall counts for king eiders. Given the difficulties of the spring count largely due to uncertain ice conditions, we need to have a summer/fall count as well, to capture the migration as king eiders return to the Bering and Beaufort Seas after breeding. Sea ice conditions are projected to continue to deteriorate and become more unpredictable and more difficult to travel through as the amount of multi-year ice decreases. We may not be able to continue the spring count from the ice edge in the future. Fall and summer counts have been conducted since summer 1994 and provide reliable population estimates for king eiders (see

Quakenbush et al. 2009). The drawback to a summer/fall count is that they occur over a longer time frame, about July 1 through the mid-October, and are thus more expensive to implement. However, they are safer, do not rely on sea ice conditions, and since the migration is longer and has a less variable distributions, it is easier to sample, resulting in a lower bias. Common eiders migrate later than king eiders (Quakenbush et al. 2009) and summer/fall counts prior to 2002 included the entire migration period (October and early November). Additionally, since common eiders migrate later, females and hatch-year birds cannot be easily identified through visual counts.

- Use adaptive sampling. We need to be prepared to increase the number or duration of sampling periods when the peak of migration occurs. As we have shown, the bulk of migration can occur in just a few hours and if that period isn't sampled our population estimate will be biased low. Unfortunately, as adaptive sampling was not done in the past, it may make comparisons with earlier counts difficult.

Conclusion

King and common eider populations have stabilized since the 50% declines seen between the 1970s and the 1990s and may be rebounding slightly. This pattern is supported by aerial surveys on the Arctic Coastal Plain of Alaska. Eiders are an important subsistence resource for local residents of the Alaskan and Canadian Arctic, and common eiders, in particular, are of high conservation concern due to predicted increases in storm surges and rising sea levels impacting their breeding areas. Information on the status of their populations is vital for state, local, and federal managers, and for the indigenous communities across the western Arctic. The marine and coastal environments used by these species are at risk due to climate change (e.g., increased storm surges) and potentially affected by offshore oil and gas exploration. We conclude that, while the populations have not continued their decline, future monitoring is important as the Arctic warms and human activities increase.

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Study Products

Publications

Bentzen, R.L., A.N. Powell, and R. Suydam. In Prep. Migration trends for king and common eiders past Point Barrow.

Presentations

Bentzen, R.L., A.N. Powell, and R Suydam. Migration trends for king and common eiders past Point Barrow, in a rapidly changing environment, 2015–2016. 2017 Coastal Marine Institute Annual Research Review, Anchorage, AK, January 2017. (oral presentation)

Bentzen, R.L., A.N. Powell, and R. Suydam. Migration trends for king and common eiders past Point Barrow, Alaska. 6th International Sea Duck Conference, Tiburon, CA, February 2017. (oral presentation)

Bentzen, R.L., A.N. Powell, and R. Suydam. Migration trends for king and common eiders past Point Barrow, in a rapidly changing environment, 2015–2016. 2018 Coastal Marine Institute Annual Research Review, Anchorage, AK, January 2018. (oral presentation)

Bentzen, R.L., A.N. Powell, and R. Suydam. Migration trends for king and common eiders past Point Barrow, in a rapidly changing environment, 2015–2016. North Slope Borough Department of Wildlife Management, Utqiagvik, AK, March 2018. (agency presentation)

Bentzen, R.L. Migration trends and nesting ecology of king and common eiders in northern Alaska. Tuzzy Consortium Library, Utqiagvik, AK, March 2018. (community presentation)

Bentzen, R.L. Eiders in Alaska. Barrow High School, Utqiagvik, AK, March 2018. (high school lecture)

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