Fall Izembek Brant Aerial Survey, Alaska, 2017

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Heather M. Wilson
U.S. Fish and Wildlife Service, Migratory Bird Management, 1011 E. Tudor Road, Anchorage, AK, 99503. heather_wilson@fws.gov.

SUMMARY

This report presents results of the annual Fall Izembek Brant Survey, conducted in the Izembek Complex of southwest Alaska (1976-2017). The 2017 Fall Izembek Brant population index was 154,811 (95% CI: 148,742-160,879) birds; calculated as the average of five repeated surveys of the Izembek Complex flown on 2, 3, 9 (morning and afternoon), and 10 October (146,525, 158,397, 163,647, 160,353, 145,134; CV: 5%). Annual indices for Canada geese, emperor geese, and Steller’s eiders were 31,190 (CV: 17%), 2,171 (CV: 27%), and 4,845 (CV: 28%) respectively. The fall population growth rate for Pacific brant indicated a slight long-term increase (1976-2017; 1.005, 95% CI: 1.002-1.009), while long-term trends for other species indicated declines (e.g., Canada geese: 0.992, 95% CI: 0.985-0.999, emperor geese: 0.967, CI: 0.958-0.978, and Steller’s eiders: 0.948, 95% CI: 0.937-0.959). The most recent 10-yr growth rate for brant (2008-2017) was 1.025 (95% CI: 0.999-1.051).

Key words: aerial survey, Pacific brant, waterbirds, southwest Alaska.

INTRODUCTION

Between September and November each year, nearly the entire world population of Pacific brant (Branta bernicla) stages at Izembek Lagoon and surrounding estuaries (hereafter: Izembek Complex; Reed et al. 1998, Ward et al. 2005). The Izembek Complex is a unique area of protected brackish waters, supporting one of the world’s largest eelgrass beds and a diverse array of wildlife. Fall-staging brant have been counted in the Izembek Complex since 1975 (USFWS, unpubl. data), with more standardized surveying beginning in 1976.

The primary objective of the Fall Izembek Brant Survey is to provide an annual index of abundance for the entire post-breeding Pacific brant population, while secondarily, providing annual fall population indices for Canada geese (Branta hutchinsii taverneri and B.h. minima),
emperor geese (*Anser canagicus*), and Steller’s eiders (*Polysticta stelleri*). Ancillary counts of other waterbird species observed during the survey are also reported each year to provide presence/absence and relative abundance information. Abundance and distribution of each species at Izembek varies seasonally, as well as locally; with birds shifting daily within, and among, Izembek Complex lagoon segments, due to tides, winds, predators, and hunting pressure. To help account for sampling error among these surveys of dense, multi-species aggregations within the Izembek Complex, a minimum of two replicate fall surveys (long-term average [1976-2017] = 4 surveys, range: 1-7 surveys; Appendices 1-2) are conducted each year, and the average of survey counts is used as the annual population index for each of the primary species in the survey (i.e., brant, Canada, and emperor geese, as well as Steller’s eiders). The coefficient of variation among repeated surveys is presented as a minimum estimate of variance among counts.

Given virtually all of the Pacific brant population stages within the Izembek Complex between late September and early November each year (Reed et al. 1989, Ward et al. 2005), the Fall Izembek Brant Survey (Wilson 2017a) is believed to provide a comparative overall population measure to the Pacific Flyway - Winter Brant Survey (Stehn et al. 2010, Olson 2018). The Pacific Flyway - Winter Brant Survey combines mid-winter counts from Baja Mexico (Palacios and Ávila 2019), California, Oregon, Washington, British Columbia, and Alaska (Wilson 2019) to create a composite ‘total’ population index (Pacific Flyway Council 2018, Olson 2018). Together, the Fall Izembek Brant Survey and Pacific Flyway - Winter Brant Survey represent the highest-ranked priorities for population assessment of Pacific Brant by the Pacific Flyway Council (2018; see also Stehn et al. 2010).

**METHODS**

**Field Methods**

The 2017 Fall Izembek Brant Survey was flown using a USFWS Cessna 206 (N9623R) aircraft equipped with amphibious floats, at a ground speed of 167-200 km/hr (90-110 kts) and an altitude of 45 m (150 ft) above ground level (as measured with a radar altimeter in the aircraft). The survey included the traditional Izembek Complex segments 60-68, 80-81, and 84-85 (Fig. 1), which correspond to Izembek Lagoon, Bechevin and Morzhovoi Bays, and northern Cold Bay [including Kinzarof Lagoon]. These segments were surveyed in their entirety, by following a historical survey route and monitoring real-time aircraft tracks to ensure repeated coverage of the survey area. All flights were conducted with <20 knots of wind. The left-seat pilot-observer and right-seat observer counted birds on their respective side of the aircraft, and input voice-recorded observations of birds (species and flock sizes) into independent portable computers. Geographic coordinates of bird observations were automatically recorded and linked to the position of the aircraft track using global positioning systems (GPS) and a custom computer program (RECORD; Jack Hodges, USFWS-MBM, Juneau). Although Pacific brant, Canada geese, emperor geese, and Steller’s eiders were the primary species of interest, other waterbird species were also recorded during the survey (Appendix 3).

In 2017, we included a right-rear seat observer-trainee in our first three replicates, in order to provide survey training. On the final two replicates of the survey, we transitioned the newer observer (with three years training experience on the survey) to the operational right-front seat
data collection position. However, this observer continued to be assisted by a more experienced observer (WWL) present in the right-rear seat. Our goal was to augment the learning experience for the new observer by providing open communication with the experienced observer, while striving to maintain consistency in the count methods. We denote this ‘combined’ observer as “TKZ / WWL” in Table 1.

History of the Survey

Aerial counts of fall brant at Izembek National Wildlife Refuge (IZNWR) have been conducted from 1976 to the present (Appendices 1-2). The survey effort was initiated by IZNWR, and was conducted almost exclusively by the refuge in the 1970’s and early 1980’s. By the mid-1980’s, responsibility for the counts became a joint effort between IZNWR and Migratory Bird Management - Alaska (MBM). In 1984 and 1992, two special survey ‘workshops’, led by MBM – Alaska were conducted. These workshops encompassed 8-30 within-year repeated surveys and were flown by a variety of crews and aircraft, with the goal of better understanding variation in counts among crews (Conant et al. 1984, 1992). Key recommendations from these workshops included incorporating aerial photography into the survey, continuing with repeated within-year counts, and providing additional observer training to help standardize effort. By the early 1990’s, MBM – Alaska had taken the lead on the fall aerial Izembek brant counts, typically completing them at the culmination of the Fall Emperor Goose Survey (1981-2015; Wilson 2017b), which terminated in Izembek each year. In 2016, the Fall Emperor Goose Survey was discontinued, and the ocular Fall Izembek Aerial Brant Survey (Wilson 2017a) became a stand-alone effort. In 2017, increased observer training, a commitment to five repeated ocular surveys per year, and an exploratory photographic Fall Brant Aerial Survey (Fischer and Flint 2017), were added to the survey effort.

Historical Data

In compiling historical Izembek brant counts, I included only surveys that were flown between 23 September and 31 October (a period that encompassed >90% of the brant counts during the September – November ‘fall’ window). I also limited surveys to those flown with two observers. I included all within-year survey counts that met these criteria, regardless of any previous designation as outliers, which occasionally resulted in different annual averages than had previously been reported. No fall Izembek Survey was flown in 1978, and only one complete survey was flown in 1976 and 1981 (Appendix 1), so averages and variances could not be calculated for those years. For years with 2+ surveys, I used the average of within-year survey counts as the annual population index for each of the primary species in the survey (i.e., brant, Canada, and emperor geese, and Steller’s eiders) and provided coefficient of variation among repeated surveys as a minimum estimate of variance among counts. In 11 years of the survey (1977, 1982, 1984, 1986, 1992, 1996, 2006-2007, 2011, and 2013-2014), there were missing segment data for one or more of the repeated within-year surveys; typically in areas outside the primary Izembek Lagoon staging area (i.e, Bechevin and Morzhovoi Bays, Segments 66-71, 78-81, and/or 82-86). To account for these intermittent missing segments in Izembek Complex totals, I imputed missing segment totals based on the average of the other within-year replicate surveys of those segments (e.g., in 1977, the average of segments 66-86 from the 10/4 & 24 surveys [8,625] was added to the missing segments 66-86 on the 9/23 survey). Further details
related to imputed data are provided in Appendix 2. Imputation methods applied to brant data were also applied to the three other primary species of interest; Canada geese, emperor geese, and Steller’s eiders.

**Analyses**

Annual population indices and associated 95% confidence intervals for the four primary species of interest were calculated as the average of within-year repeated surveys. Deterministic log-linear population growth rate estimates were calculated as approximate measures of population trend. I recognize that these do not incorporate within-year sampling error (i.e., variation among within-year replicate counts), into estimates of variance, and thus, likely underestimate the variance in growth rate. As of 2019, a broad-scale data standardization and archiving effort in the R environment (R Core Team 2013) was in development for all MBM-Alaska surveys. Upon completion of this process, I expect annual estimates and population trends to differ slightly from those presented here.

**RESULTS AND DISCUSSION**

My crew and I completed a total of five surveys of the Izembek Complex in 2017 (2, 3, 9 [morning and afternoon], and 10 October, Table 1). Survey conditions for all surveys were good to excellent, with broken ceilings of 2,500 feet or greater and west/southwest winds between 5 and 15 kts. Intermittent glare was a factor on the final two surveys (9 October afternoon and 10 October). Tide stage varied among surveys (Appendix 1).

**Table 1.** Summary of 2017 Fall Izembek Complex survey data for four primary species of interest. 2017 observers: Left front (Heather Wilson; HMW) and right-front (Bill Larned [WWL] and Tamara Zeller [TKZ]).

<table>
<thead>
<tr>
<th>Surveys</th>
<th>Observer(s)</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pacific Brant</td>
</tr>
<tr>
<td>1: Oct 2</td>
<td>HMW / WWL</td>
<td>146,525</td>
</tr>
<tr>
<td>2: Oct 3</td>
<td>HMW / WWL</td>
<td>158,397</td>
</tr>
<tr>
<td>3: Oct 9 (Morning)</td>
<td>HMW / WWL</td>
<td>163,647</td>
</tr>
<tr>
<td>4: Oct 9 (Afternoon)</td>
<td>HMW / (TKZ / WWL)</td>
<td>160,353</td>
</tr>
<tr>
<td>5: Oct 10</td>
<td>HMW / (TKZ / WWL)</td>
<td>145,134</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>154,811</strong></td>
</tr>
<tr>
<td><strong>CV</strong></td>
<td></td>
<td>5%</td>
</tr>
</tbody>
</table>
Pacific Brant

The 2017 index for Pacific brant was 154,811 (Tables 1-2, Appendices 2-3). Total counts were similar between replicate surveys (CV: 5%), but distributions among segments varied (Appendix 3). Some of the variation in distributions was likely due to brant response to tide; whereby eelgrass beds in the center of the lagoon become inaccessible to grazing at high tide. The long-term (1976-2017; Table 3), deterministic log-linear fall population growth rate of Pacific brant indicated a slightly increasing trend: 1.005, 95% CI: 1.002-1.009, $R^2$: 0.17, Fig. 2), while the most recent 10-year (2008-2017) growth rate (1.025, 95% CI: 0.999-1.051, $R^2$: 0.31) suggested a positive trend, but with confidence intervals that overlapped one.

Canada Goose

The 2017 Canada goose index was 31,190 (Tables 1 and 2, and Appendix 3). The long-term (1976-2017; Table 2, Fig. 3) fall population growth rate of Canada geese suggested a declining trend (0.992, 95% CI: 0.985-0.999, $R^2$: 0.09), while the most recent 10-year (2008-2017) growth rate (1.039, 95% CI: 0.967-1.011, $R^2$: 0.12), indicated no significant population change.

Emperor Goose

The 2017 emperor goose index was 2,171 (Tables 1 and 2, and Appendix 3). The long-term (1976-2017; Table 2, Fig. 3) fall population growth rate of emperor geese at Izembek Complex indicated significant decline (0.967, 95% CI: 0.958-0.978, $R^2$: 0.53), despite no significant trend over the most recent 10-years (2008-2017; annual growth rate: 0.983, 95% CI: 0.863-1.103, $R^2$: 0.10). However, the Izembek Complex typically represents only 3% of the total fall emperor geese staging on the Alaska Peninsula, with the largest aggregations of emperor geese occurring northeast of Izembek, in the estuaries of Cinder River (20%), Port Heiden (15%), Seal Islands (20%), and Nelson Lagoon/Port Moller (20%; Wilson 2017b).

Steller’s Eider

The 2017 index for Steller’s eiders was 4,845 (Tables 1 and 2, Appendix 3). The long-term (1976-2017; Table 2, Fig. 3) fall population growth rate of Steller’s eiders at Izembek Complex indicated a decreasing trend (rate: 0.948, 95% CI: 0.937-0.959, $R^2$: 0.70), while the most recent 10-year growth rate indicated no significant trend (2008-2017; rate: 0.959, 95% CI: 0.891-1.027, $R^2$: 0.15). Over the long-term (1979-2015; MBM data - Fall Emperor Goose Survey) Izembek Complex has represented ~25% of the total fall Steller’s eiders staging on the Alaska Peninsula, with the largest aggregations of Steller’s eiders typically occurring at Nelson Lagoon/Port Moller (53%), followed by Port Heiden (12%), and the Seal Islands (14%). As such, changes in the numbers of Steller’s Eiders at Izembek may represent changes in distribution, as opposed to real changes in overall population size.

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service.
ACKNOWLEDGMENTS

I thank Bill Larned for serving as right-front observer on Oct. 2, 3, and 9 (morning) surveys, and for providing mentorship and training for new right-front observers in 2017. I thank Tamara Zeller for serving as right-front observer on the Oct. 9 afternoon and Oct. 10 surveys. I gratefully acknowledge Izembek NWR for their continued support of the survey through lodging, vehicles, hangar space, and other logistics. I thank Michael Swaim for his assistance in creating survey preparation materials (e.g., navigation and hazard maps, as well as help in creating a report map figure), and David Safine for providing a helpful review of the report.

2017 Fall Izembek Brant Survey Crew, from left to right: Bill Larned (right-front observer), Tamara Zeller (new right-front observer), and Heather Wilson (left-front pilot-observer).

REFERENCES


Division of Migratory Bird Management, Vancouver, Washington.


Figure 1. Map of the Fall Izembek Brant Survey area in southwest Alaska, encompassing segments 60-85 of the historic fall survey of the Alaska Peninsula. Bold-font segments indicate those consistently included in the Fall Izembek Brant Survey (1976-2017). The airplane symbol denotes the survey base of operations, Cold Bay, Alaska.

Fall Izembek Brant Survey Segments

**Izembek Lagoon (60-65):**
60: Moffet Bay
61: Strawberry Point to Round Is. (incl. Neuman Is.)
62: Round Is. to Tern Is.
63: Tern Is. to Banding Islands west of Grant Point
64: Applegate Cove
65: Norma Bay
66: Outer coast shoreline Izembek to Bechevin

**Bechevin Bay (67-69):**
67: Hook Bay
68: Catherine’s Cove
69: Bechevin Channel

**Morzhovoi Bay (79-81):**
79 (not included in survey),
80: Big, Middle, and Little Lagoons,
81: NE Morzhovoi coast to Little John Lagoon

**Cold Bay (82-85):**
84: Cold Bay Dock to Kinzarof
85: Kinzarof Lagoon
82-83 and 86-87 (not included in survey).
Figure 2. Observed Pacific brant annual indices (± 95% confidence intervals from variation among within-year repeated surveys) and log-linear growth rates (long-term and 10-yr), from the Fall Izembek Brant Survey, Alaska, 1976-2017.
**Figure 3.** Canada goose, emperor goose, and Steller’s eiders annual indices (± SE among replicate surveys) and log-linear growth rates, from the Fall Izembek Brant Survey, Alaska, 1976-2017.
Table 2. Annual population indices for Pacific brant, Canada geese, emperor geese, and Steller’s eiders, on the Fall Izembek Brant Survey, Alaska, 1976-2017. This table has been updated from Wilson (2017), with annual, species-specific indices that are the average of all within-year replicate surveys from 23 Sept. – 31 Oct. each year, for all species (see Appendices 1-2 for details of within year replicate surveys). Historically, annual indices of species other than brant reflected only a single Izembek Complex total from the Fall Emperor Goose Survey.

<table>
<thead>
<tr>
<th>YEAR</th>
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<th>EMPEROR GOOSE</th>
<th>STELLERS EIDER</th>
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<td>37,558</td>
<td>8,155</td>
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<td>1977</td>
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<td>20,972</td>
<td>8,469</td>
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<td>3,459</td>
<td>40,709</td>
<td>1,927</td>
<td>4,458</td>
<td>426</td>
<td>18,944</td>
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<tr>
<td>10-YR AVE (2009-2017)</td>
<td>161,044</td>
<td>6,552</td>
<td>35,522</td>
<td>3,618</td>
<td>3,244</td>
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<td>LOG-LINEAR TREND 10-YRS (2009-2017)</td>
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<td>1.039</td>
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<td>0.983</td>
<td>0.061</td>
<td>0.959</td>
<td>0.035</td>
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<td>LOG-LINEAR TREND LONG TERM (1976-2017)</td>
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<td>0.002</td>
<td>0.992</td>
<td>0.004</td>
<td>0.967</td>
<td>0.005</td>
<td>0.948</td>
<td>0.006</td>
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### Appendix 1. Fall Izembek Brant Survey 1976-2017: annual dates of all surveys, crews, and aircraft from 23 September - 31 October each year.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>REPS</th>
<th>DATES</th>
<th>PILOT OBSERVER</th>
<th>OTHER OBSERVER(S)</th>
<th>AIRCRAFT</th>
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<tbody>
<tr>
<td>1976</td>
<td>1</td>
<td>10/16-17</td>
<td>Sarvis, Arneson</td>
<td>Arneson/Kurhajec</td>
<td>PA-18</td>
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<td>1977</td>
<td>3</td>
<td>9/23, 10/4, 10/24</td>
<td>Sarvis</td>
<td></td>
<td>PA-18</td>
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<tr>
<td>1978</td>
<td>2</td>
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<tr>
<td>1979</td>
<td>0</td>
<td>10/3, 10/23</td>
<td>Sarvis/Conant</td>
<td>Petersen/Gill/Dean</td>
<td>PA-18</td>
</tr>
<tr>
<td>1980</td>
<td>2</td>
<td>9/30, 10/29</td>
<td>Sarvis</td>
<td>Nunn</td>
<td>PA-18</td>
</tr>
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<td>1981</td>
<td>1</td>
<td>10/8</td>
<td>Sarvis</td>
<td>Nunn</td>
<td>PA-18</td>
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<td>2</td>
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<td>Sarvis/King</td>
<td>Dau/Bollinger</td>
<td>PA-18, C-185</td>
</tr>
<tr>
<td>1983</td>
<td>2</td>
<td>9/22, 10/3</td>
<td>Sarvis</td>
<td>Dau</td>
<td>PA-18</td>
</tr>
<tr>
<td>1984</td>
<td>30</td>
<td>10/6-11, 10/14-16</td>
<td>Sarvis/King/Hodges/Conant</td>
<td>Dau/Lensik/J.King/Rothe/Dirkson/</td>
<td>PA-18, C-185, Turbine Beaver</td>
</tr>
<tr>
<td>1985</td>
<td>2</td>
<td>10/3, 10/11</td>
<td>Sarvis/King</td>
<td>Dau/Eldridge</td>
<td>PA-18, C-185</td>
</tr>
<tr>
<td>1986</td>
<td>3</td>
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<td>Sarvis/King</td>
<td>Eldridge/Dau</td>
<td>C-185, PA-18</td>
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<td>1987</td>
<td>4</td>
<td>9/25, 10/9, 10/28</td>
<td>Sarvis/Butler/King</td>
<td>Blenden/Dau/Eldridge</td>
<td>PA-18, C-185, C-206</td>
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<td>4</td>
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<td>Dau/King</td>
<td>Ward/Eldridge/West</td>
<td>PA-18, C-185</td>
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<td>1989</td>
<td>4</td>
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<td>West/Chase/Ward/Denlinger</td>
<td>PA-18, C-185</td>
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<td>Chase/Krechmar/Ward/Brackney</td>
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<td>10</td>
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<td>Dau/Butler/King/Hodges/Conant</td>
<td>Chase/Petersen/Larned/Ward/</td>
<td>PA-18, C-185, C-206, Pipeline Beaver</td>
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<tr>
<td>1993</td>
<td>6</td>
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<td>Gill/Ward/Chase/Dewhurst/Mason</td>
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<tr>
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<td>10/4, 10/11, 10/19, 10/20, 10/27</td>
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<td>Petersen/Balogh/Flint/Laing/Schulmeister/Zeillemaker</td>
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<td>1995</td>
<td>7</td>
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<td>Petersen/Flint/Gill/Laing/Schulmeister</td>
<td>PA-18, C-185</td>
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<td>PA-18, C-185, C-206</td>
</tr>
<tr>
<td>1998</td>
<td>6</td>
<td>9/25, 10/1, 10/2, 10/8, 10/13-14</td>
<td>Larned/Roy/King/Dau</td>
<td>Tipplady/Schafer/Mallek/Ward/Dochet</td>
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<tr>
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<td>Ziemba/Tipplady/Mallek</td>
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<td>9/26, 9/28, 9/30, 10/16 (x2)</td>
<td>Larned/Dau</td>
<td>Anderson/Mallek/Ward</td>
<td>C-206</td>
</tr>
<tr>
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<td>9/28, 10/5</td>
<td>Dau</td>
<td>Mallek/Ward</td>
<td>C-206</td>
</tr>
<tr>
<td>2002</td>
<td>5</td>
<td>10/1, 10/2, 10/5, 10/8 (x2)</td>
<td>Mallek/Larned</td>
<td>Dau/Anderson</td>
<td>C-206</td>
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<tr>
<td>2003</td>
<td>5</td>
<td>9/26, 9/30, 10/8, 10/9 (x2)</td>
<td>Larned/Mallek</td>
<td>Anderson/Dau/Bollinger</td>
<td>C-206</td>
</tr>
<tr>
<td>2004</td>
<td>3</td>
<td>10/2, 10/7 (x2)</td>
<td>Mallek/Larned</td>
<td>Dau/Anderson</td>
<td>C-206</td>
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<tr>
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<td>5</td>
<td>10/3, 10/5, 10/7, 10/26, 10/31</td>
<td>Larned/Mallek/Richardson</td>
<td>Anderson/Dau/Sowle</td>
<td>C-206</td>
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<tr>
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<td>9/27 (x2), 10/2-3, 10/30</td>
<td>Mallek/Bollinger/Richardson</td>
<td>Dau/Sowle</td>
<td>C-206, PA-18</td>
</tr>
<tr>
<td>2007</td>
<td>3</td>
<td>9/29, 10/2-3</td>
<td>Mallek/Larned</td>
<td>Dau/Anderson</td>
<td>Turbine Beaver, C-206</td>
</tr>
<tr>
<td>2008</td>
<td>4</td>
<td>9/28-30, 10/1</td>
<td>Larned/Mallek</td>
<td>Anderson/Dau</td>
<td>C-206</td>
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<td>Dau/Bollinger</td>
<td>Turbine Beaver, C-206</td>
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<tr>
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<td>9/28, 10/4, 10/5 (x2)</td>
<td>Larned/Mallek</td>
<td>Wilson/Dau</td>
<td>C-206, Kodiak</td>
</tr>
<tr>
<td>2011</td>
<td>2</td>
<td>9/30, 10/1</td>
<td>Mallek</td>
<td>Dau</td>
<td>Kodiak</td>
</tr>
<tr>
<td>2012</td>
<td>3</td>
<td>9/29 (x2), 9/30</td>
<td>Larned/Mallek</td>
<td>Wilson/Dau</td>
<td>C-206</td>
</tr>
<tr>
<td>2013</td>
<td>2</td>
<td>10/19-20</td>
<td>Wilson</td>
<td>Dau</td>
<td>C-206</td>
</tr>
<tr>
<td>2014</td>
<td>3</td>
<td>9/30, 10/1, 10/5</td>
<td>Wilson</td>
<td>Larned</td>
<td>C-206</td>
</tr>
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<td>10/4, 10/5, 10/6 (x2)</td>
<td>Wilson</td>
<td>Larned/Dau</td>
<td>C-206</td>
</tr>
<tr>
<td>2016</td>
<td>2</td>
<td>10/3 (x2)</td>
<td>Wilson</td>
<td>Larned</td>
<td>C-206</td>
</tr>
<tr>
<td>2017</td>
<td>5</td>
<td>10/2-3, 10/9 (x2), 10/10</td>
<td>Wilson</td>
<td>Larned/Zeller</td>
<td>C-206</td>
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</table>
Appendix 2. Annual and within-year survey information for Pacific brant on all years of the Fall Izembek Brant Survey, 1976-2017. Annual indices represent the average, coefficient of variation (CV) and standard error (SE) of all within-year replicate surveys. Shaded cells indicate imputed survey totals (see footnotes).

<table>
<thead>
<tr>
<th>Year</th>
<th>Index (CV)</th>
<th>SE</th>
<th>Reps</th>
<th>&gt; 22 September</th>
<th>October</th>
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<tbody>
<tr>
<td>1976</td>
<td>107,784</td>
<td>-</td>
<td>1</td>
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<td>107,784</td>
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<tr>
<td>1977</td>
<td>119,173</td>
<td>22%</td>
<td>3</td>
<td>100,688</td>
<td>107,094</td>
</tr>
<tr>
<td>1979</td>
<td>128,204</td>
<td>4%</td>
<td>2</td>
<td>131,797</td>
<td>124,610</td>
</tr>
<tr>
<td>1980</td>
<td>127,667</td>
<td>6%</td>
<td>2</td>
<td>122,145</td>
<td>133,189</td>
</tr>
<tr>
<td>1981</td>
<td>180,734</td>
<td>-</td>
<td>1</td>
<td>180,734</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>127,760</td>
<td>21%</td>
<td>2</td>
<td>108,574</td>
<td>146,945</td>
</tr>
<tr>
<td>1983</td>
<td>184,022</td>
<td>28%</td>
<td>3</td>
<td>147,933</td>
<td>220,110</td>
</tr>
<tr>
<td>1984</td>
<td>127,995</td>
<td>24%</td>
<td>5,855</td>
<td>30</td>
<td>158,467</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>156,124</td>
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<tr>
<td>1985</td>
<td>122,673</td>
<td>19%</td>
<td>2</td>
<td>105,786</td>
<td>139,560</td>
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<tr>
<td>1986</td>
<td>113,487</td>
<td>16%</td>
<td>3</td>
<td>99,198</td>
<td>133,544</td>
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<tr>
<td>1987</td>
<td>142,930</td>
<td>7%</td>
<td>4</td>
<td>129,878</td>
<td>150,415</td>
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<tr>
<td>1988</td>
<td>123,813</td>
<td>17%</td>
<td>4</td>
<td>106,221</td>
<td>142,138</td>
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<tr>
<td>1989</td>
<td>146,038</td>
<td>5%</td>
<td>4</td>
<td>106,397</td>
<td>135,620</td>
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<tr>
<td>1990</td>
<td>123,977</td>
<td>21%</td>
<td>5</td>
<td>120,691</td>
<td>169,934</td>
</tr>
<tr>
<td>1991</td>
<td>128,457</td>
<td>14%</td>
<td>5</td>
<td>152,944</td>
<td>120,434</td>
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<tr>
<td>1992</td>
<td>109,719</td>
<td>21%</td>
<td>10</td>
<td>140,071</td>
<td>174,422</td>
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<tr>
<td>1993</td>
<td>143,539</td>
<td>15%</td>
<td>6</td>
<td>131,311</td>
<td>157,844</td>
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<tr>
<td>1994</td>
<td>142,591</td>
<td>16%</td>
<td>9,905</td>
<td></td>
<td>153,629</td>
</tr>
<tr>
<td>1995</td>
<td>147,133</td>
<td>13%</td>
<td>7</td>
<td>171,709</td>
<td>166,210</td>
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<tr>
<td>1996</td>
<td>119,263</td>
<td>35%</td>
<td>6</td>
<td>142,809</td>
<td>146,234</td>
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<tr>
<td>1997</td>
<td>132,830</td>
<td>29%</td>
<td>22,164</td>
<td>189,062</td>
<td>99,724</td>
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<tr>
<td>1998</td>
<td>105,185</td>
<td>42%</td>
<td>6</td>
<td>93,272</td>
<td>179,741</td>
</tr>
<tr>
<td>1999</td>
<td>131,134</td>
<td>20%</td>
<td>11,839</td>
<td>129,566</td>
<td>91,404</td>
</tr>
<tr>
<td>2000</td>
<td>156,011</td>
<td>13%</td>
<td>9,275</td>
<td>130,513</td>
<td>169,649</td>
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<tr>
<td>2001</td>
<td>112,554</td>
<td>1%</td>
<td>533</td>
<td>113,086</td>
<td>112,021</td>
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<tr>
<td>2002</td>
<td>115,839</td>
<td>14%</td>
<td>7,056</td>
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<td>102,171</td>
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<tr>
<td>2003</td>
<td>135,944</td>
<td>5%</td>
<td>5</td>
<td>144,184</td>
<td>129,455</td>
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<tr>
<td>2004</td>
<td>134,474</td>
<td>21%</td>
<td>16,364</td>
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<td>127,669</td>
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<tr>
<td>2005</td>
<td>152,712</td>
<td>20%</td>
<td>13,840</td>
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<td>162,479</td>
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<tr>
<td>2006</td>
<td>124,170</td>
<td>10%</td>
<td>5,532</td>
<td>127,723</td>
<td>137,180</td>
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<td>140,897</td>
<td>12%</td>
<td>9,077</td>
<td>122,079</td>
<td>146,394</td>
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<td>130,294</td>
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<td>11,546</td>
<td>119,644</td>
<td>120,915</td>
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<tr>
<td>2009</td>
<td>169,429</td>
<td>29%</td>
<td>28,439</td>
<td>120,592</td>
<td>168,596</td>
</tr>
<tr>
<td>2010</td>
<td>150,510</td>
<td>28%</td>
<td>20,697</td>
<td>139,236</td>
<td>123,135</td>
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<tr>
<td>2011</td>
<td>126,028</td>
<td>5%</td>
<td>4,207</td>
<td>121,821</td>
<td>130,234</td>
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<tr>
<td>2012</td>
<td>154,481</td>
<td>18%</td>
<td>16,466</td>
<td>177,954</td>
<td>162,750</td>
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<tr>
<td>2013</td>
<td>157,781</td>
<td>7%</td>
<td>7,426</td>
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<td>165,207</td>
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<tr>
<td>2014</td>
<td>171,635</td>
<td>18%</td>
<td>17,405</td>
<td>168,642</td>
<td>205,706</td>
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<tr>
<td>2015</td>
<td>160,984</td>
<td>5%</td>
<td>3,781</td>
<td>165,544</td>
<td>153,518</td>
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<tr>
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<td>203,735</td>
<td>2%</td>
<td>2,932</td>
<td>206,668</td>
<td>200,801</td>
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<tr>
<td>2017</td>
<td>154,811</td>
<td>5%</td>
<td>3,768</td>
<td>146,525</td>
<td>160,535</td>
</tr>
</tbody>
</table>

Average: (1976-2017 138,743 16% 4)

1 Pilot/observer crews and replicate survey counts are presented in chronological order, corresponding to dates of replicate surveys. "(x2)" in the 'Dates' column indicates two surveys flown in the same year surveys were flown in 1978.
2 All 1979 surveys are of Izembek Lagoon only. No Bechevin/Morzhovi Bay counts were conducted. 4 In 1984, many surveys of Izembek were flown as part of a survey workshop (Conant et al. 1984). 5 Shaded cells indicate imputed totals (i.e., where one or more segments within a survey were not completed and averages from other within-year surveys were used). 6 Typically these missing segments were from areas outside Izembek Lagoon (Segments 60-65), such as Bechevin/Morzhovi Bays (Segments 66-71, 78-81, and 82-86). Details of imputed replicates are as follows: (1976-1992): In 1977, the average of segments 66-68 from the 10/4 & 24 surveys (8,825) was added to the 9/23 survey. In 1981, the counts from segments 66-81 of the 10/8 survey (5,165) was added to the 9/23 survey. In 1984, the average of segments 66-86 (8,486) from surveys on 10/8 and 10/9 were added to all other Izembek-only (Seg 60-65) surveys flown as part of the 1984 Izembek Survey Workshop (Conant et al. 1994). In 1985, the average of segments 66-86 (5,714) from surveys on 10/7 and 10/20 were added to the Izembek only (Seg 60-65) 103 survey. In 1986, the average of segments 66-86 (5,714) from surveys on 10/7 and 10/20 were added to the Izembek only (Seg 60-65) 103 survey. In 1992, surveys 5,7, and 10 include the average of Seg 66-71 (8,482), and Seg 78-81 (3,805) from surveys 1-4 and 8-9 (1993-2017). In 1996, the average of Seg 66-81 (6,062) flown on 9/25-26 was added to 9/28 (3%) survey. In 2006, average counts from Seg 66-81 and 78-81 from 9/27, 10/2 & 10/3 (total = 9,773) was added-in for missing segments on 10/30. In 2007, the average count from Segments 61-68 (8,376) on 9/29 and 10/2 was added to the 10/3 survey. In 2011, the 6,653 birds observed in Bechevin/Morzhovi on 9/30 were added to the 10/1 survey missing those segments. The 2014 replicates each include 10,941 birds observed on a single count of Bechevin/Morzhovi Bays from the 9/30 survey (Wilson 2017a).
Appendix 3. Waterbird and mammal observations by segment for each of five replicate surveys of the 2017 Fall Izembek Brant Survey. Primary species are highlighted in grey.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>SURVEY 1 - 2 October (Obs: HMW/WWL, Tide: High - Falling)</th>
<th>TOTAL</th>
<th>SURVEY 2 - 3 October (Obs: HMW/WWL, Tide: Low)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 61 62 63 64 65 67 68 80 81 84 85</td>
<td></td>
<td>60 61 62 63 64 65 67 68 80 81 84 85</td>
<td></td>
</tr>
<tr>
<td>Am. Green-winged Teal</td>
<td>20 5 25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Am. Wigeon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bald Eagle</td>
<td>2 1</td>
<td></td>
<td>2 1</td>
<td></td>
</tr>
<tr>
<td>Pacific Brant</td>
<td>146,525</td>
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<tr>
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<td>180</td>
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<tr>
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<tr>
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Appendix 3 (continued). Waterbird and mammal observations by segment for each of five replicate survey of the 2017 Fall Izembek Brant Survey. Primary species are highlighted in grey.

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<tr>
<th>SPECIES</th>
<th>SURVEY 3 - 9 October - Morning (Obs: HMW/WWL, Tide: Low - Rising)</th>
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<td>Am. Wigeon</td>
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<tr>
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<td>3</td>
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<tr>
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<tr>
<td>Bufflehead</td>
<td>1 3</td>
<td>4</td>
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<tr>
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<tr>
<td>Common Raven</td>
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<tr>
<td>King Eider</td>
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<tr>
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<td>557 110 50 30 717</td>
<td>1,407</td>
</tr>
<tr>
<td>Northern Pintail</td>
<td>687 115 50 60 400 1,312</td>
<td>1,466</td>
</tr>
<tr>
<td>Northern Shoveler</td>
<td>4 4 1 3 20 32</td>
<td>5</td>
</tr>
<tr>
<td>Pacific Loon</td>
<td>0</td>
<td></td>
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<tr>
<td>Pelagic Cormorant</td>
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<td></td>
</tr>
<tr>
<td>Pigeon Guillemont</td>
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<tr>
<td>Red-breasted Merganser</td>
<td>4 25 1,254 85 11 1,379</td>
<td>1,485</td>
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<tr>
<td>Red-necked Grebe</td>
<td>1 0</td>
<td>1</td>
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<tr>
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<tr>
<td>Walrus</td>
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<td>150</td>
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<tr>
<td>White-fronted goose</td>
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<tr>
<td>White-winged Scoter</td>
<td>10 5 2 8 25</td>
<td>45</td>
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<tr>
<td>Yellow-billed Loon</td>
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<tr>
<td>Bufflehead</td>
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<tr>
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<td>Common Raven</td>
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<tr>
<td>Double-crested Cormorant</td>
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<tr>
<td>Emperor Goose</td>
<td>495 446 21 5 185 271 227 59 1,709</td>
<td>2,306</td>
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<tr>
<td>Goldeneye spp.</td>
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<td>270</td>
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<tr>
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<tr>
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<tr>
<td>Long-tailed Duck</td>
<td>5 5</td>
<td>10</td>
</tr>
<tr>
<td>Mallard</td>
<td>557 110 50 30 717</td>
<td>1,407</td>
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<tr>
<td>Northern Pintail</td>
<td>687 115 50 60 400 1,312</td>
<td>1,466</td>
</tr>
<tr>
<td>Northern Shoveler</td>
<td>3 4 1 3 20 32</td>
<td>5</td>
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<tr>
<td>Pacific Loon</td>
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<tr>
<td>Pelagic Cormorant</td>
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<tr>
<td>Pigeon Guillemont</td>
<td>0</td>
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<tr>
<td>Red-breasted Merganser</td>
<td>4 25 1,254 85 11 1,379</td>
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<tr>
<td>Red-necked Grebe</td>
<td>1 0</td>
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<td>Walrus</td>
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<tr>
<td>White-fronted goose</td>
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<td>White-winged Scoter</td>
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<td>Yellow-billed Loon</td>
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Appendix 3 (continued). Waterbird and mammal observations by segment for each of five replicate survey of the 2017 Fall Izembek Brant Survey. Primary species are highlighted in grey.

<table>
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<td>Am. Wigeon</td>
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<tr>
<td>Bufflehead</td>
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<tr>
<td>Common Raven</td>
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<td>Gull spp.</td>
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<td>Harlequin Duck</td>
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<td>32</td>
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<td>1 115 95 2 213</td>
<td>213</td>
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<td>King Eider</td>
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<td>Mallard</td>
<td>195</td>
<td>200</td>
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<td>Northern Shoveler</td>
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<tr>
<td>Pacific Loon</td>
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<td>Pelagic Cormorant</td>
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<tr>
<td>Pigeon Guillemont</td>
<td>2 3 5</td>
<td>5</td>
</tr>
<tr>
<td>Red-breasted Merganser</td>
<td>60 60</td>
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<td>Shorebird spp.</td>
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<td>350</td>
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<tr>
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<tr>
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16