Aerial survey of wintering Pacific brant and other species at the Izembek Lagoon Complex and the Sanak Islands, Alaska, 2018.

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

ABSTRACT: This report presents results of the 28 February – 3 March 2018 aerial survey of Pacific brant and other species wintering at the Izembek Complex and the Sanak Islands of Alaska. This survey serves as the Alaska component of the annual Mid-Winter Survey for Pacific brant, as outlined in the Pacific Flyway Management Plan. The 2018 estimate is 46,067 brant; the fourth highest since the survey started in 1981. The estimate represents the sum of two components: 1) the average (42,953, CV: 0.16) of three replicate counts for Izembek Complex on 28 February and 3 March morning and afternoon (35,479, 48,735, and 44,645), and 2) a single brant count of the Sanak Islands on 28 February (3,114). Counts of other species, including emperor geese and Steller's eiders are also reported. The long-term growth rate of over-wintering brant in Alaska is 1.082 (95% CI: 1.072-1.092; 1981-2018), and currently, Alaska supports ~30% of the Mid-Winter population of Pacific brant. The size of the brant population wintering in Alaska appears to have stabilized since 2011, averaging 45,654 birds (95% CI: 44,975-46,335); with a growth rate of 1.016 (CI: 0.99-1.03; 2011-2018).

Key words: Mid-Winter survey, Pacific brant, Izembek Complex, Sanak Islands, Alaska.

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INTRODUCTION

Aerial surveys of wintering Pacific brant at the Izembek NWR including refuge coastlines and adjacent marine estuaries (hereafter Izembek Complex) have been conducted annually since the winter of 1980-1981 (Fig. 1, Tables 1-2). In 2010, the survey was expanded to include the Sanak Islands (hereafter Sanak; Figs. 2 and 3, Tables 1, 2 and Appendix 2). This survey is the Alaska component of the Pacific Flyway Mid-Winter Survey (hereafter PF-MWS) for brant, and documents winter distribution, abundance, population trend, and habitat use by brant and other species (Pacific Flyway Council 2002).

In Alaska, eelgrass beds are the primary foraging areas for brant and occur from Moffet Bay to Bechevin Bay along the north side of the Alaska Peninsula (Bering Sea side), and in Kinzarof Lagoon and Morzhovoi Bay along the south (Pacific Ocean) side of the Alaska Peninsula. Brant also occur at Sanak, 80 km south of Cold Bay. Although numbers there were not consistently documented prior to 2010 (Jones 1952, 1955; McKnight 1971; Dau and Chase 1995), it appears brant now regularly use this area; with numbers elevating during severe cold weather events that can freeze some or all of

Izembek Lagoon (this report). At Sanak, brant utilize eelgrass beds and other shallow intertidal habitats which often remain ice free.

METHODS

The 2018 Mid-Winter Survey of Izembek Complex and Sanak was flown from 28 February to 3 March by Migratory Bird Management (MBM) personnel, using an amphibious Cessna 206 aircraft (N9623R; see Figure in Acknowledgements). Survey ground speed was approximately 160 km/hr (100 mph) and altitude was 45m (150 feet) above sea level (ASL). Georeferenced observations made from both sides of the aircraft were voice recorded into panel-mounted computers for later transcription using custom software packages (RECORD, TRANSCRIBE; J. I. Hodges, USFWS-Migratory Bird Management, Juneau, AK).

Systematic flight paths provided coverage of all near shore and open water areas along shorelines and within estuaries, divided into distinct polygon "segments" Fig. 3). For navigation, a combination of panel-mounted computers and GPS units, providing moving map displays, as well as paper topographic maps (scale 1:63,360) with delineated segment boundaries, were used. The crew recorded survey conditions including ice cover, wind speed and direction, temperature, sky condition, visibility, and tide stage, during the course of the survey.

The Izembek Complex includes shorelines and estuaries from Moffet Lagoon to Bechevin Bay, along the north (Bering Sea) side of the Alaska Peninsula, and Kinzarof Lagoon and Morzhovoi Bay on the south (Pacific Ocean) side of the Alaska Peninsula (Figs. 1 and 3). The Sanak Island group includes Sanak and Caton islands and surrounding islets with northern and southern segments in each island group (Figs. 2 and 3). The entire survey is broken into a series of survey segments (distinct polygons) corresponding to landscape features (Figs. 1 and 3). Each segment-polygon is covered following a standardized, meandering flight path; repeated with only slight variations to ensure adequate identification and estimation of large or mixed species flocks.
All of the Izembek Complex segments (60-65, 67-68, 80-81, and 84-85; Figs. 1 and 3) were flown on three repeated surveys in 2018; one on 28 February, and two (morning and afternoon) on 3 March 2018, while the Sanak Islands (Segments: Sanak North, Sanak South, Caton North, Caton South; Figs. 2 and 3) were flown only on 28 February.

SURVEY CONDITIONS

Winter conditions in southwestern Alaska prior to our arrival in Cold Bay were consistent with more recent warm and mild winters; including complete lack of ice in any waterbodies and no snow cover on any of the lowland landscape. The mean temperature for Cold Bay for January-early March 2018 was 35^{o}F; over 6 degrees higher than the long-term (1981-2017) average (29^{o}F) over the same months during the history of survey (http://www.wrcc.dri.edu/). Moreover, the 2018 February and early

March average temperatures were among the highest ever recorded for Cold Bay (since 1950, http://www.wrcc.dri.edu/). Conditions were relatively homogenous during our repeated surveys of the Izembek Complex, with temperatures ranging from 30-40^{o}F (Average: 36.6^{o}F) and clear visibility conditions (resulting in intermittent sun glare), and relatively light winds (average 5-10 kts). We observed no ice cover (0%) in any of the northern (Bering Sea) or southern (Pacific Ocean side) estuaries in the Izembek Complex, nor in any of the marine or fresh-water environments of the Sanak Islands. Moreover, there was no lowland snow cover throughout the Sanak survey area. During surveys, tide levels were low in the Sanak and Caton islands on 28 February, and low, high, and low, respectively, on three replicate surveys of the Bering Sea side of the of the Izembek Complex (28 February, and 3 March morning and afternoon). All surveying in 2018, occurred during full moon, presenting extremem tide cycles (-0.89 to +8.35 ft at Grant Point). This resulted in brant (and Steller's eider) flocks becoming increasingly consolidated in deep water channels of Izembek Lagoon during low tides. Though visibility was not limited by precipitation or fog on any of the surveys, intermittent glare reduced visibility periodically throughout all surveys. Elevated winds were only a factor on the first survey of Izembek complex (28 February), where a 15-18 kt southerly wind predominated at Bechevin and Morzhovoi Bays (Segments 67-68 and 80-81) and Moffet and Kinzarof Lagoons (Segments 60 and 85). However, all other segments (61-65), encompassing where 99% of the brant observed, had winds of <5kts (in the lee of Frosty Mountain).

RESULTS

Pacific Brant

We estimated a combined total of 46,067 brant (Izembek Complex average [42,953] + Sanak [3,114]), of which, 93% were in the Izembek Complex. We counted 35,479, 48,735, and 44,645 brant at the Izembek Complex on 28 February and 3 March – morning and afternoon (Appendix 1), respectively. We also observed 3,114 brant at Sanak on 28 February (Appendix 2), which we added to the Izembek Complex average of 42,953 (CV: 0.16) to calculate the Alaska Mid-Winter total of 46,067. Marine ice averaged 0% at the Izembek Complex in 2018, providing no restriction to the distribution of wintering brant in Izembek Lagoon or adjacent estuaries. Very few brant (<1%) were observed in the deeper, more marine-influenced areas of the Izembek Complex: Bechevin and Morzhovoi Bays, Kinzarof Lagoon. Numbers at the Sanak Islands were also consistent with past low ice years (i.e., Sanak usually represents <13% of the Alaska winter total in non-ice years, and represented <7% in 2018). The long-term average of Alaska Mid-Winter counts (Izembek Complex: 1981-2018 + Sanak: 2010-2018) is 19,352 (95% CI: 14,073-24,631) and counts of brant during the survey show an increasing, long-term growth rate of 8.2% per year (1.082, 95% CI: 1.072-1.092; 1981-2018). Currently, Alaska supports ~30% of the Mid-Winter population of Pacific brant (Fig. 5), and the Alaska wintering population appears to have stabilized since 2011, averaging 45,654 birds in 2011-2018 (95% CI: 44,975-46,335).

Emperor Goose

We estimated a combined total of 4,225 emperor geese (Izembek Complex average [2,286, CV: 0.21] + Sanak [1,839]), with Izembek representing 54% of the combined total. Repeated surveys of the Izembek Complex resulted in observed totals of 3,436, 2,207 , and 1,514 emperor geese on 28 February, and 3 March – morning and afternoon (Appendix 1), resulting in the Izembek average of 2,286 (CV: 0.21). In addition, we observed 1,839 emperor geese at the Sanak Islands on 28 February (Appendix 2). Izembek Complex winter counts of emperor geese have been highly variable throughout the history of the survey (1981-2018, range 542 – 7,502, CV: 53%) likely due to variability in ice cover and habitat availability (long-term average 2,956 [95% CI: 2,440-3,472], growth rate: 1.002 [95% CI: 0.980-1.023]). With no ice present in Izembek Lagoon in 2018, emperor geese did not appear to be restricted to particular areas of Izembek. However, contrary to expectation for a low ice year, a large proportion of the emperor geese during our survey were at Sanak. Unlike brant, the winter range of emperor geese in Alaska spans from Kodiak through the Aleutian Islands, and thus, inferences about population change from this survey are not likely reflective of the entire species.

Steller's Eider

We estimated a combined total of 28,016 Steller's eiders (Izembek Complex average [26,240] + Sanak [1,776]), with Izembek representing 93% of the Steller's eider total. We observed totals of 21,203, 25,337, and 32,179 Steller's eiders in the Izembek Complex on 28 February, 3 March - morning and evening, respectively, resulting in an Izembek Complex average of 26,240 (CV: 0.41, Appendix 1). In addition, 1,776 Steller's eiders were observed at the Sanak Islands on 28 February (Appendix 2); almost half of what was observed there in the high Izembek ice year of 2017. The 2018 average Mid-Winter count (including Sanak: 2011-present) was 42% higher than the previous long-term average count from 1981-2017 (20,058). As with emperor geese, Mid-Winter counts of Steller's eiders have been highly variable (current long-term average: 20,058 [95% CI: 16,530-23,586], growth rate: 1.009 [95% CI: 0.991-1.027]). Similar to emperor geese, the winter range of Steller's eiders in Alaska spans far beyond the Izembek region (from Cook Inlet through the Aleutian Islands), and thus, inferences about population change from this survey are not necessarily reflective of the entire population wintering in Alaska.

DISCUSSION / RECOMMENDATIONS

Pacific Flyway Mid-Winter Brant Survey

Winter counts of brant have been conducted at Izembek since 1981 (Table 1) and the Izembek count of brant has been used as the Alaska component of the Pacific Flyway Mid-Winter survey (PF-MWS) since the winter of 1985-1986. The survey was expanded in winter 2009-2010 to include the Sanak Islands (USFWS 2011, Pacific Flyway Data Book). I continue to recommend the Alaska portion of the PF-MWS be

calculated as the average of replicate counts from the Izembek Complex and a minimum single count at Sanak. Annual counts for both locations, as well as segments within locations, should also continue to be reported separately (e.g., Table 1, Fig. 4, Appendix 1). Historical within-winter replicate counts conducted at Izembek had not been consistently reported prior to 2015. I report these counts and information about each historical survey in Tables 1 and 2. Migratory Bird Management - Alaska continues to recommend that survey crews strive to complete a minimum of three within-winter replicate counts during January or February to remain as close as possible to the timing of PF-MWS counts conducted elsewhere in the Pacific Flyway (Sanders 2017), while capitalizing on increasing daylight and improving weather conditions. However, this report includes historical counts conducted between 28 November and 31 March in the long-term record of annual estimates for the Alaska Mid-Winter brant survey (Table 1), as historical monthly surveys at Izembek demonstrated consistent winter population counts during this period (i.e., spring migration effects and/or observations did not occur until mid-April or later).

Conditions at Izembek

Sea ice was 0% within the Izembek Complex during the 2018 survey, and presented no restriction to brant distribution in the area. Ice conditions can determine habitat accessibility during winter months and can severely restrict brant distribution (particularly in high ice years) to remaining open-water areas. These remaining open-water areas are typically the central Izembek Lagoon, Kinzarof Lagoon, lagoons in northern Bechevin and Morzhovoi Bays, and the Sanak Islands (C. Dau pers. obs.). Much like the winters of 2014-2016, weather conditions along the southern Alaska Peninsula in winter 2018, were warm, with no snow cover on the lowland landscape, nor solid or shore-fast ice present in any of the lagoon areas. All terrestrial waterbodies (i.e., lakes, ponds, and streams) had open water. Ambient temperatures during surveys were remarkably high. The 2018 January-March average Cold Bay temperature was over 6 degrees higher than the previous long-term (1981-2017) average (29^{o}F) over the same months during the history of survey. Though the mean 2018 January temperature (30.8^{o}F) was closer to the previous 1981-2017 January average (28.5^{o}F); suggesting only a slightly warmer January (http://www.wrcc.dri.edu/), the 2018 February and March averages were among the highest ever recorded for Cold Bay (1950-present, http://www.wrcc.dri.edu/). Continued warming throughout the year on northern breeding and wintering grounds is likely an important factor in increasing numbers of over-wintering brant at Izembek (Ward et al. 2009; Fig. 6). Whereas Alaska historically accounted for <5% of the winter brant population (in the 1980's and 90's), over-wintering brant at Izembek currently comprise the second largest geographic component of the 2005-2017 PF-MWS (~30%), with Mexico representing the largest portion (~60%), and the remaining birds (~10%) occurring in California, Oregon, Washington, and British Colombia (Fig. 5).

Sanak Islands

Brant counts at the Sanak Islands over the last 8 years (2010-2018) have averaged 4,586 (95% CI: 2,582-6,590), representing 10% of the overall Alaska winter count during that period. 2018 represented a strikingly warm winter on the Southern Alaska Peninsula;

with no ice restricting any portion of Izembek Lagoon during the survey period. This was in stark contrast with the much colder winter of 2017, during which crews estimated an average of 50% (range: 30-60%) ice cover during surveys. During high ice years, an average of 32% of brant utilize non-Izembek Lagoon areas (i.e., Sanak/Bechevin/Morzhovoi); providing important temporary refugia from sudden, severe icing events in the Izembek Complex (Ward et al. 2009).

Increasing brant and considerations for habitat protection

It is unknown to what extent eelgrass habitats are being impacted by concentrated winter foraging in areas that are also heavily utilized during fall. Research on stability and use of Izembek area eelgrass may become increasingly important in light of milder winter conditions and increased grazing. Data from high ice years in 2010, 2012, and 2017 indicate that a higher proportion of brant utilize non-Izembek estuaries when Izembek is restricted (averages of 10% in Morzhovoi, 25% in Bechevin, 12% in Kinzarof, and 19% in Sanak in high ice years, versus, 2%, 3%, 2%, and 7% of the brant population using these respective areas, in low ice years). Some of these areas are state tidelands lacking any special designation or protection. Consistent with previous survey crews (see Mallek and Dau 2009), we recommend the Alaska Department of Fish and Game consider State Critical Habitat or State Game Refuge designation for sites known to be especially important when severe ice conditions make other Izembek estuaries inaccessible, including: Kinzarof Lagoon; Big, Middle, and Little Lagoons in Morzhovoi Bay; and Hook Bay and St. Catherine's Cove in Bechevin Bay.

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

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The 2018 Izembek Mid-Winter survey crew; William "Bill" Larned (right-front observer) and Heather Wilson (left-front observer/pilot), with Amphibious Cessna-206 N9623R.

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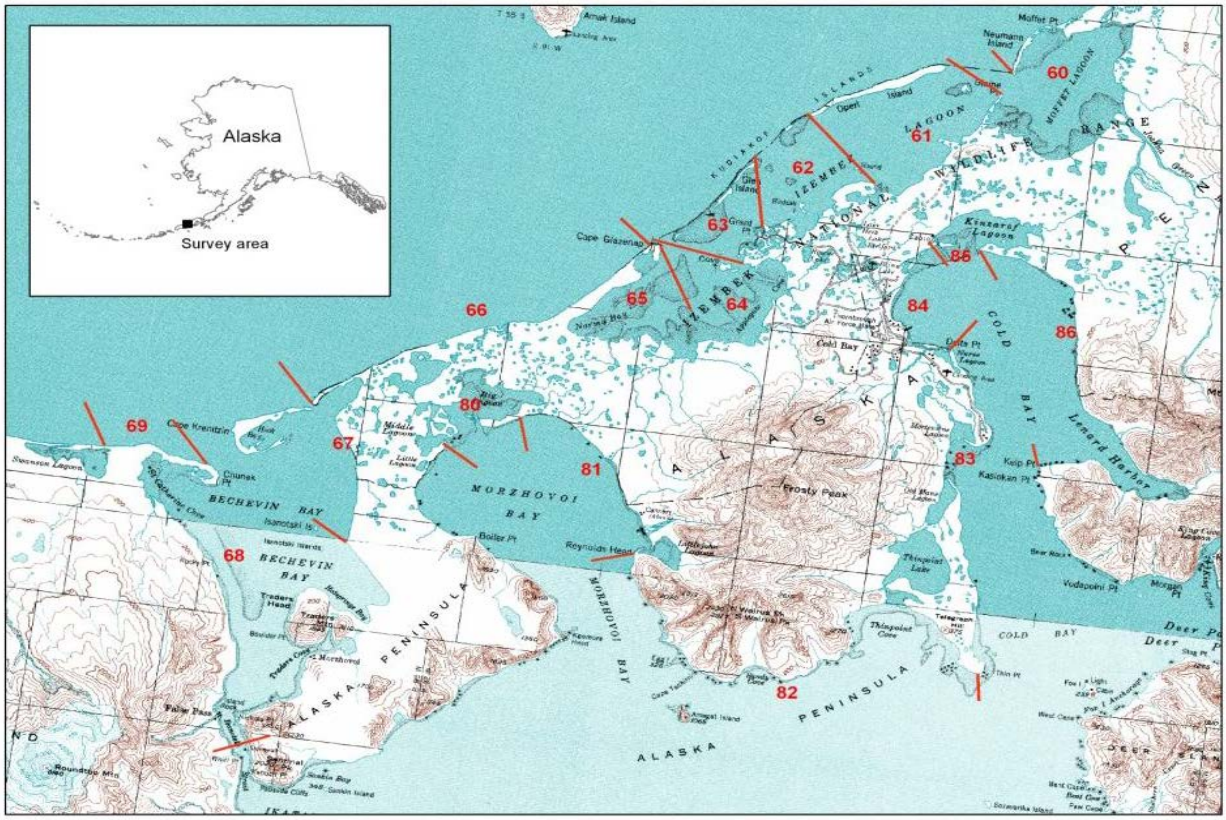

Figure 1. Pacific brant survey area by segment in the Izembek Complex.

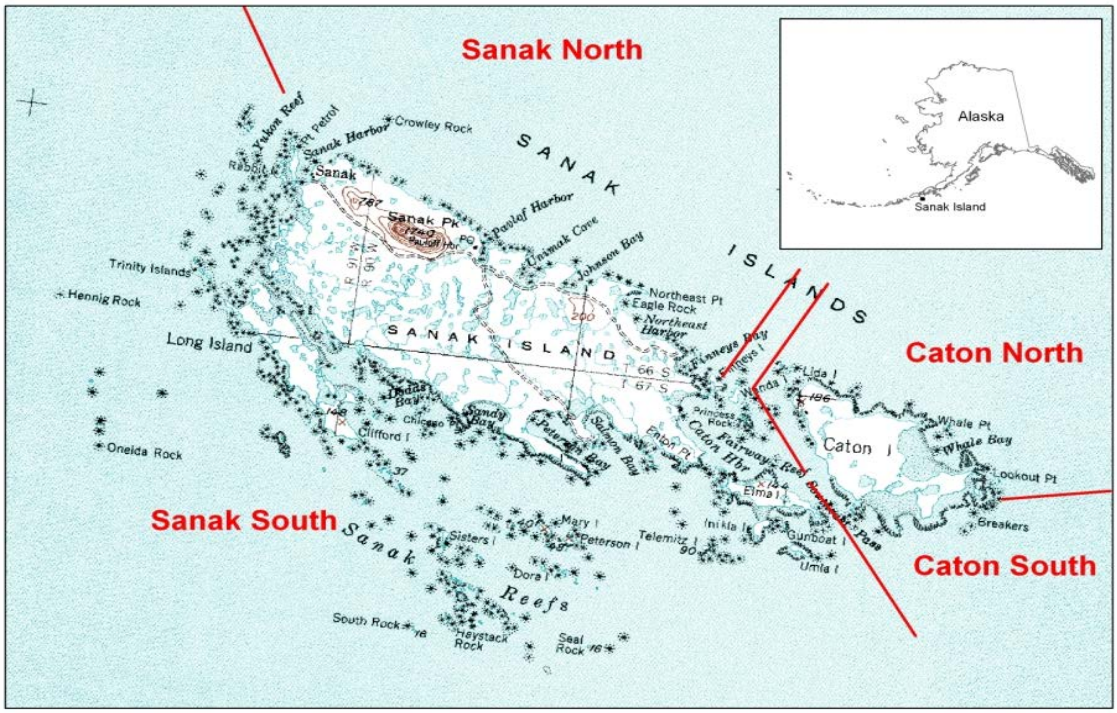

Figure 2. Pacific brant survey area by segment in the Sanak Islands.

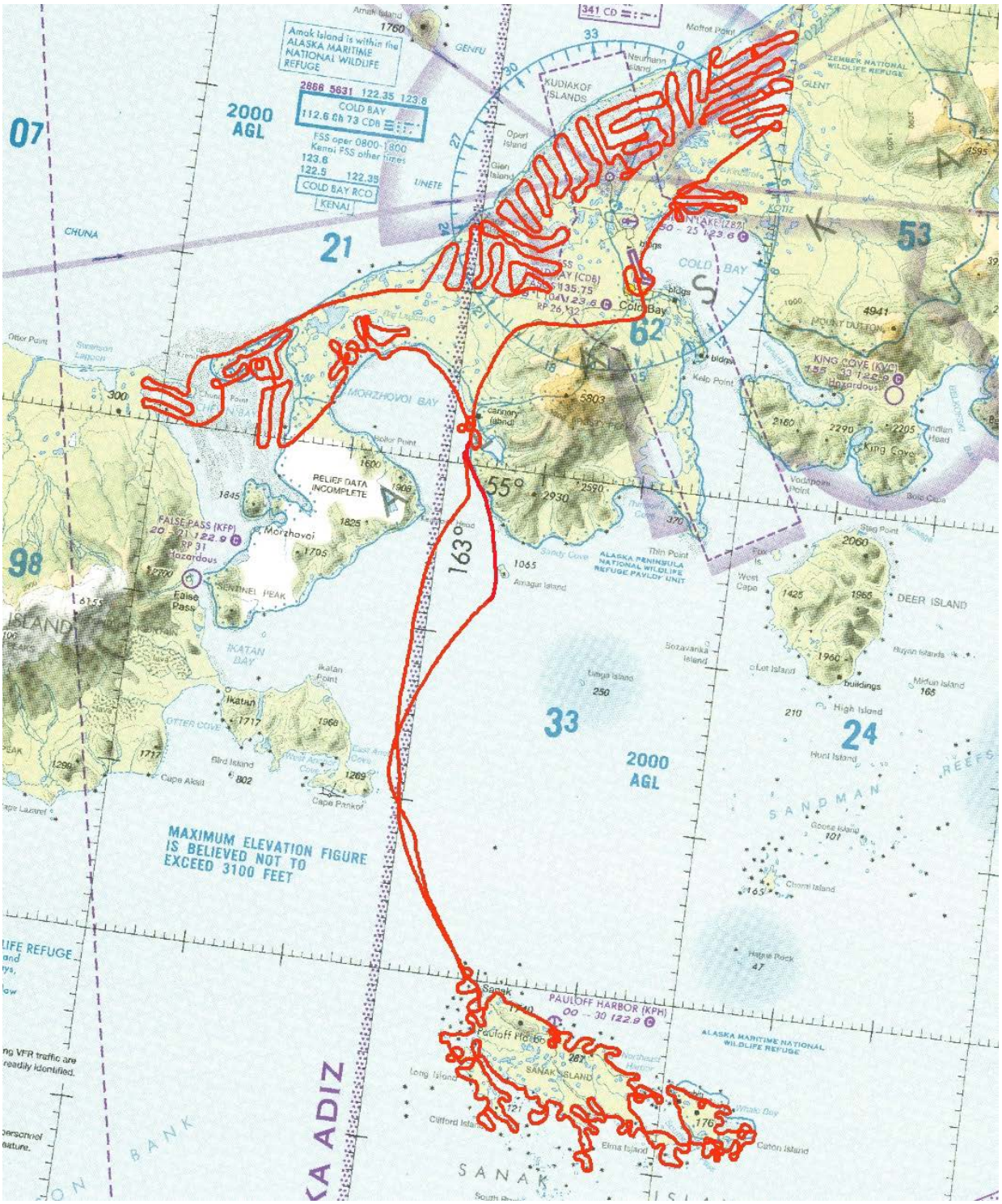

Figure 3. Example aircraft track showing survey path for Alaska Mid-Winter Brant Survey in the Izembek Complex (Izembek Lagoon and Morzhovoi and Bechevin Bays) and the Sanak Islands.

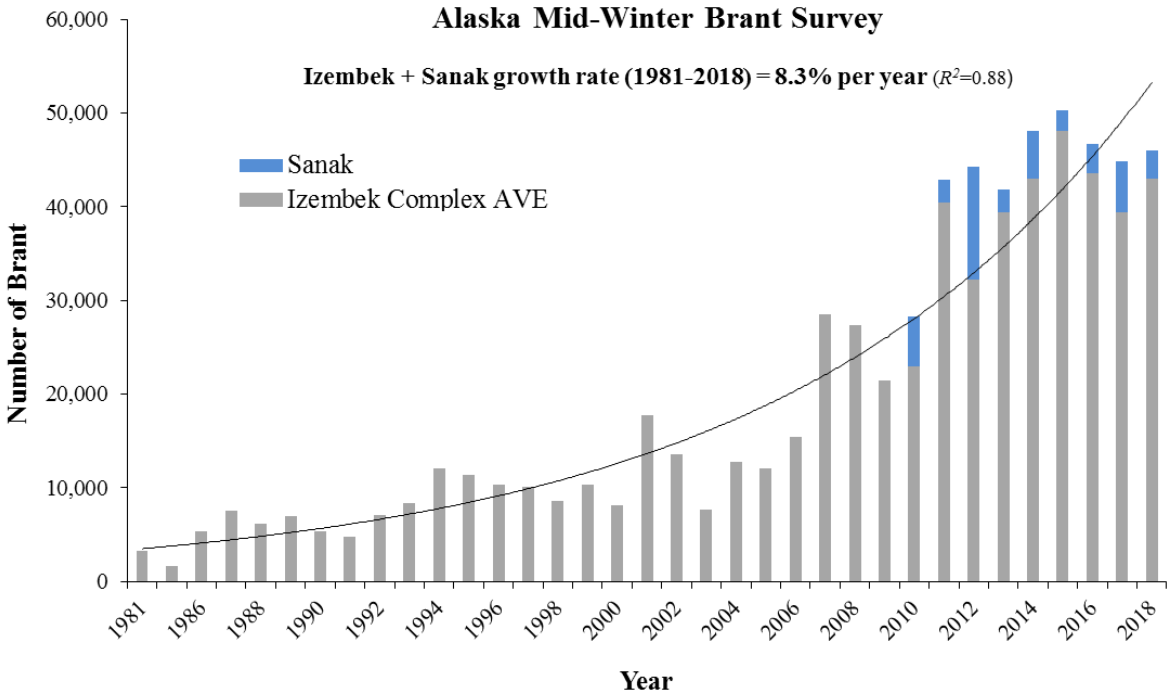

Figure 4. Annual indices and growth rate for the Alaska component of the Pacific Flyway Mid-Winter survey for brant (1981-2018). Annual totals represent averages of within-winter replicates at Izembek (grey bars), plus counts at the Sanak Islands, Alaska (blue bars).

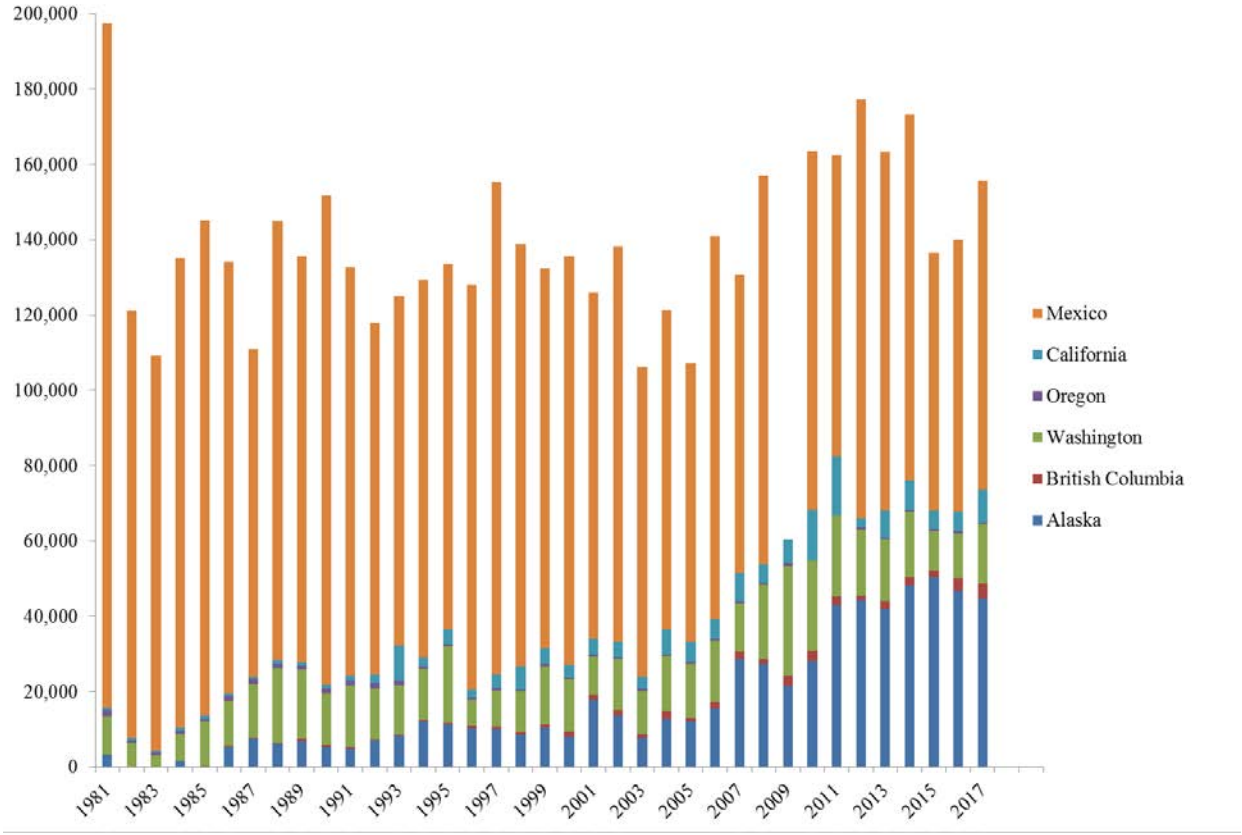

Figure 5. Components of the annual Pacific Flyway Mid-Winter Survey for Pacific brant (1981-2017). The annual Mid-Winter brant index is calculated as the sum of annual indices from Mexico, California, Oregon, Washington, British Columbia, and Alaska (Olson 2017).

Figure 6. Applegate Cove, Izembek Lagoon (Segment 64) on March 3, 2018, during a falling tide. There was no ice nor lowland snow on the landscape during the 2018 Izembek Mid-Winter survey and temperatures for Feb-March 2018 in Cold Bay were the warmest on record (1950-present).

Table 1. Alaska Mid-Winter Survey for brant (AK MWS) 1981-2018. Annual totals are the sum of unreplicated Sanak Island counts (2009-present) and the within-year average (AVE) of Izembek Complex replicate surveys.

Alaska Mid-Winter Brant Survey

			Annual components			Izembek Complex: Within-Year Counts in Chronological Order[2-4]										
YEAR[1]	**TOTAL**	SE	Sanak	Izembek Complex AVE	Izembek Complex CV	≥ Nov. 27th	December		January			Febuary			March	
1981	**3,271**	1,176		3,271	62%		1,602		2,670						5,540	
1984	**1,611**	-		1,611	-				1,611							
1986	**5,338**	2,328		5,338	62%	7,665			3,010							
1987	**7,550**	1,805		7,550	34%	9,355						5,745				
1988	**6,180**	2,205		6,180	50%		3,975		8,385							
1989	**6,918**	1,700		6,918	43%	9,795	7,050		3,910							
1990	**5,303**	338		5,303	11%	5,685			5,595						4,630	
1991	**4,742**	196	*	4,742	7%		4,950		4,350			4,925				
1992	**7,043**	536		7,043	15%		6,790		5,797			7,200			8,386	
1993	**8,369**	628		8,369	17%				7,407	8,008		10,551			8,862	7,015
1994	**12,125**	2,024		12,125	41%	21,249			7,580	13,221		8,942			12,389	9,366
1995	**11,381**	850		11,381	13%	9,703			11,978			12,461				
1996	**10,278**	1,429		10,278	34%		17,218		9,795			7,534	9,735		8,730	8,658
1997	**10,049**	1,694		10,049	29%		7,460	9,451	13,237							
1998	**8,562**	212		8,562	3%				8,350	8,773						
1999	**10,354**	1,183		10,354	20%		12,348		8,255			10,460				
2000	**8,120**	2,424		8,120	52%		11,917		3,610			8,833				
2001	**17,790**	-		17,790	-							17,790				
2002	**13,576**	-		13,576	-				13,576							
2003	**7,677**	1,492		7,677	27%		9,168								6,185	
2004	**12,756**	-		12,756	0%										12,756	
2005	**12,041**	3,490		12,041	65%				19,303	2,638	4,563	17,238	16,463			
2006	**15,404**	2,546		15,404	33%				10,700			11,685	21,394	17,838		
2007	**28,533**	5,312		28,533	37%							15,018	40,041	32,814	26,257	
2008	**27,422**	907		27,422	5%				28,329	26,515						
2009	**21,482**	-		21,482	0%							21,482				
2010	**28,234**	1,299	5,303	22,931	11%				22,567	22,550		26,443	20,165			
2011	**42,937**	5,641	2,517	40,420	24%							46,383	29,145		45,733	
2012	**44,252**	-	11,996	32,256	-				32,256							
2013	**41,821**	-	2,413	39,408	-										39,408	
2014	**48,140**	7,246	5,129	43,011	24%				50,257	35,765						
2015	**50,316**	2,705	2,206	48,110	8%				50,815	45,405						
2016	**46,772**	2,925	3,165	43,607	9%				46,532	40,682						
2017	**44,899**	2,365	5,428	39,471	10%				37,814	44,137	36,462					
2018	**46,067**	3,919	3,114	42,953	16%							35,479			48,735	44,645
Long-term Average	**19,352**	2,693	4,586	18,173												
10-yr Ave.	**41,492**	2,922														
Long-term Growth rate	**0.082**	0.005	-0.042	0.079												

[1]YEAR reflects the year in which the January, February, and March surveys were flown.

*An exploratory survey of Sanak was flown on 15 Feburary 1991 (Dau and Chase 1995); 1,189 brant were observed, extrapolated to an estimated 3,052. The Sanak 1991 estimate is not included in the table, due to the substantial departure from later survey methods.

[2]Within-year replicate surveys conducted under high ice conditions (e.g., 50%+ of Izembek Complex lagoons iced over) are underlined.

[3]Partial surveys "corrected" for missed segments (i.e., segments flown on other days, in the same year, usually Bechevin/Morzhovoi areas, substituted) are as follows: Additions to Izembek Lagoon totals were: 2006-07: (729 and 1,314), 2007-08: (7,815), 2014-15: (4,329)

[4]2012 totals (Sanak and grand total) have been corrected to match those in Mallek and Dau 2012 (11,996 and 44,252, respectively).

Table 2. Annual dates of all surveys, crews, and aircraft for the Alaska Mid-Winter Brant Survey 1981-2018. *Asterisks denote surveys in which the Sanak Islands were flown.

YEAR	REPS	DATES	PILOT OBSERVER	OTHER OBSERVER(S)	AIRCRAFT
1980-81	3	12/30, 1/26, 3/9	J.E. Sarvis	K.A. Metzner	PA-18
1983-84	1	1/16	J.E. Sarvis	M.L. Nunn	PA-18
1985-86	2	11/29, 1/24	J.E. Sarvis	M.D. Blenden	PA-18
1986-87	2	11/27, 2/27	J.E. Sarvis	C.P. Dau	PA-18
1987-88	2	12/11, 1/15	J.E. Sarvis	C.P. Dau	PA-18
1988-89	3	11/29, 12/27, 1/17	C.P. Dau	D. Strom/R.L. West	PA-18
1989-90	3	11/29, 1/10, 3/29	C.P. Dau	M.A. Chase/S.S. Simpson/R.L. West	PA-18
1990-91	3	11/30, 1/9, 2/21 *2/15 (Sanak only)	C.P. Dau *Charter Pilot (Sanak)	J. Chase/M.A. Chase *C.P. Dau/M.A.Chase (Sanak)	PA-18, *PA-31 (Sanak)
1991-92	4	12/17, 1/23, 2/10, 3/26	C.P. Dau	C.F. Zeillemaker/M.A. Chase	PA-18
1992-93	5	1/14, 1/16, 2/26, 3/8, 3/24	C.P. Dau	N. Schlicten/C.F. Zeillemaker	PA-18
1993-94	6	11/30, 1/19, 1/26, 2/15, 3/9, 3/28	C.P. Dau	M.A. Chase/R.P. Schulmeister/D.H. Ward/C.F. Zeillemaker	PA-18
1994-95	3	11/30, 1/2, 2/14	C.P. Dau	S.D. Schulmeister/R.P. Schulmeister	PA-18
1995-96	6	12/1, 1/12, 2/16, 2/26, 3/4, 3/18	C.P. Dau	G.E. Siekaniec/R.P. Schulmeister/ S.D. Schulmeister/D.H. Ward	PA-18
1996-97	3	12/19, 12/23, 1/17	C.P. Dau	G.E. Siekaniec/J.E. Sarvis/R.P. Schulmeister	PA-18
1997-98	2	1/2, 1/8	M. Roy	-	PA-18
1998-99	3	12/15, 1/2, 2/10	M. Roy/C.P. Dau	R. Portwood/T.A. Schafer	PA-18
1999-00	3	12/17, 1/16, 2/22	M. Roy	L. Ziemba	PA-18
2000-01	1	2/26	C.P. Dau	D.H. Ward	PA-18
2001-02	1	1/30	C.P. Dau	D.H. Ward	PA-18
2002-03	2	12/21, 3/4	K.B. Fox	K.M. Sowl	PA-18
2003-04	1	3/5	W.W. Larned	K.M. Sowl	PA-18
2004-05	5	1/19, 1/26, 1/27, 2/26, 2/28	J.K. Richardson E.J. Mallek	K.M. Sowl P.D. Anderson/T.F. Donnelly	PA-18
2005-06	4	1/26, 2/15, 2/17 (x2)	J.K. Richardson E.J. Mallek	K.M. Sowl C.P. Dau	PA-18
2006-07	4	2/9, 2/13, 2/14 (x2)	J.K. Richardson	K.M. Sowl	PA-18
2007-08	2	1/25, 1/26	J.K. Richardson	C.P. Dau	PA-18
2008-09	1	2/2	E.J. Mallek	C.P. Dau	PA-18
2009-10	4	1,29, 1/30, 2/1, 2/2	F. Mueller K.S. Bollinger	C.P. Dau	PA-18 C206 Amphib
2010-11	3	*2/27, 2/28, 3/1	K.S. Bollinger	P.D. Anderson	C206 Amphib
2011-12	2	*1/14	E.J. Mallek	C.P. Dau	Kodiak Amphib
2012-13	1	3/28, *3/29	E.J. Mallek	C.P. Dau	Kodiak Amphib
2013-14	2	1/27, *1/28	H.M. Wilson	C.P. Dau	C206 Amphib
2014-15	2	*1/24, 1/25	H.M. Wilson	C.P. Dau	C206 Amphib
2015-16	2	*1/22, 1/23	H.M. Wilson	C.P. Dau	C206 Amphib
2016-17	3	1/21, 1/23, *1/24	H.M. Wilson	W.W. Larned	C206 Amphib
2017-18	3	*2/28, 3/3 (x2)	H.M. Wilson	W.W. Larned	C206 Amphib

Appendix 1. Waterbird and mammal observations by segment in the Izembek Complex on each of three repeated surveys; 28 February and two surveys on 3 March 2018 (morning and afternoon).

Izembek Complex Survey #1: 28 February 2018

SPECIES	SEGMENT NUMBER											TOTAL
	60	61	62	63	64	65	67	68	80	84	85	
Am. G. W. Teal											10	10
American Wigeon												
Bald Eagle	6	5		3	4	4					1	23
Black Scoter	1,747	271	510	743	662	285	23	7	70	20	8	4,346
Brant	**1,295**	**4,440**	**40**		**746**	**27,633**	**460**	**250**			**615**	**35,479**
Bufflehead											20	20
Common Eider		70										70
Common Loon									1			1
Common Merganser												
Common Murre												
Common Raven		1										1
Double crested Cormorant							4					4
Emperor Goose						**1,200**		**1,000**		**100**	**1,136**	**3,436**
Goldeneye					110	130	71		187		109	607
Greater Scaup	2,735	8			1,970	55		700				5,468
Gull spp.	784	451	36	262	396	127	49	11	355	2	21	2,494
Harbor Seal				95		70						165
Harlequin Duck					10	50	4					64
King Eider							20					20
Long-tailed Duck	394	297	147	82	218		8		8		4	1,158
Mallard	30								25		20	75
Northern Pintail	238				15				450			703
Northwest Crow												
Pacific Loon				3			1					4
Pelagic Cormorant												
R-b Merganser	40	41		245	32	20	35		85		64	562
Red Necked Grebe												
Red-throated Loon												
Sea Otter	6	12		5	37	12	142	1				215
Shorebird spp.				5								5
Steller's Eider	**3,627**	**7,287**	**2,082**	**525**	**2,160**	**4,325**	**32**	**330**			**835**	**21,203**
Surf Scoter							10					10
Tundra Swan					4				2	2		8
W-w. Scoter	20	70		20	30	51	5				15	211

Izembek Complex Survey #2: 3 March 2018 (morning)

SEGMENT NUMBER												TOTAL
60	61	62	63	64	65	67	68	80	81	84	85	
								40				40
				10								10
6	2	1			2				3		5	19
2,174	261	722	124	190	400	178	552		17	10	38	4,666
1,274	**7,630**	**10**	**5,678**	**912**	**32,690**	**3**	**70**	**1**			**467**	**48,735**
								30			6	36
						2	14		300			316
				1		7			1			9
				5							4	9
			1									1
932				**150**			**723**	**50**		**25**	**327**	**2,207**
	1			12	19	68	20	78	2	6	76	282
3,230				1,617	10		750	20				5,627
56	1,065	2,407	255	47	3	864	207	780	2	44	181	5,911
1	2	50	90			234	1	32				410
				9		64			22	10	28	133
4							4		40			48
1,529	277	73	68	264	497	41	147		7		43	2,946
								119			35	154
							50	540			82	672
					1	8	6	1	1			17
83	2	10	1	90	2	341	18	173	4		97	821
1						2						3
2						1						3
30	23	57	7	314	47	233	22			82		815
4,354	**13,737**	**1,449**	**430**	**1,364**	**2,418**	**5**	**396**				**1,184**	**25,337**
17			10			10						37
								2				2
265	112	53	163			29			48	12		682

Izembek Complex Survey #3: 3 March 2018 (afternoon)

SEGMENT NUMBER												TOTAL
60	61	62	63	64	65	67	68	80	81	84	85	
								30				30
3	7	6		2	6	2	1	2	2			31
2,160	1,237	1,358	1,398	208	935	282	571	137	73	30	160	8,549
3,195	**2,465**	**200**	**280**	**14,600**	**23,852**	**3**	**50**					**44,645**
				3				12			16	31
							2		480			482
				1		2		3	1			7
				5		4		2				11
	1											1
						1						1
				1								1
1,045							**284**		**75**		**110**	**1,514**
35	4	26	55	245	53	166		130			136	850
4,680			15	850			710	25				6,280
303	413	655	42	173	146	706	394	748	1	11	169	3,761
	90	45		13		175		3			6	332
			6	18		79	25	43	21	4	27	223
					170							170
2,011	800	699	451	78	42	496	1,123	16	8	40	18	5,782
				3	30			244				277
10		18		5			60	1,011				1,104
2												2
1	3		1	1	1	6	8	1	3			25
							1					1
47	75	10	78	225	35	293	79	224			86	1,152
						1			2			3
2	10	26	4	25	32	363	38	2				502
4,312	**14,780**	**3,685**	**295**	**4,338**	**3,481**	**20**	**707**	**45**	**20**		**496**	**32,179**
	10					23	43	5				81
								2				2
10	40	50	10		35	44	83	50	18		50	390

Appendix 2. Waterbird and mammal observations by segment, Sanak Islands, 28 February 2018.

SPECIES	SEGMENT				TOTAL
	Sanak South	Sanak North	Caton South	Caton North	
Am. G. W. Teal		15			15
Bald Eagle	44	14	3	6	67
Black Oystercatcher	264	81	10	1	356
Black Scoter	845	125	62	46	1,078
Black-legged Kittiwake	2				2
Brant	**1,332**	**16**	**871**	**895**	**3,114**
Bufflehead	117	22	29	5	173
Cattle	643	260			903
Common Eider	1				1
Common Loon	7	4		1	12
Common Murre	97	1			98
Common Raven	2	6	2		10
Emperor Goose	**515**	**440**	**405**	**479**	**1,839**
Goldeneye	205	66	62	25	358
Greater Scaup	30	200			230
Harbor Seal	8				8
Harlequin Duck	816	382	217	171	1,586
Horse	15				15
Long-tailed Duck	307	7	1	5	320
Mallard	245	13	185	2	445
Northern Pintail	208	226	364	108	906
Pacific Loon	3	6			9
Pelagic Cormorant	1				1
R-b Merganser	264	112	58	222	656
Sea Otter	37				37
Steller's Eider	**665**	**312**	**541**	**258**	**1,776**
Tundra Swan	5	15	5	3	28
W-w. Scoter	67		3		70
Steller's Seal Lion	1	6	60		67
Surf Scoter	4				4
American Wigeon	1				1
Double crested Cormorant	183	51	26	23	283
Common Merganser	1				1
Northwest Crow	165	61		30	256
Gyrfalcon	1				1
Gull spp.	314	71	121	37	543
Shorebird spp.	505	70	2,608	75	3,258