Memorandum

14 July 2010

To: Chief, Migratory Bird Management, Region 7 USFWS

From: Robert Stehn, William Larned, William Eldridge
Migratory Bird Management, USFWS, Anchorage

Subject: Report to the Pacific Flyway Study Committee on 2010 aerial survey results for Dusky Canada geese on the Copper River Delta, Alaska.

The annual Dusky Canada goose survey on the Copper River Delta was flown on 16-18 May 2009. We repeated the same systematic transects as flown since 1997 using standard aerial transect survey protocol (USFWS & CWS, 1967). Where most of the Dusky geese occur on West Delta, we observed transects on 17 May and replicated the same flightlines on 18 May, flying in the opposite direction. We flew a Cessna 206 on amphibious floats along east-west straight line transects at an altitude of approximately 45 m and airspeed of 150 km/hr. The left-seat pilot observer (Bill Larned) and the right-seat observer (Bill Eldridge) recorded singles, pairs, and flocks of geese and swans within a fixed-width strip of 200 m on each side of the plane. Observations were voice-recorded directly to a laptop computer that simultaneously recorded geographic coordinates from the aircraft Global Positioning System. Transect spacing (sampling intensity) varied among three strata with the West Delta sampled at 0.93 km (0.5 nautical mile) intervals, the East Delta at 1.85 km (1.0 nautical mile) intervals, and Egg Island at 0.78 km (0.42 nautical mile) intervals.

Population Indices

The aerial index measure included the standard assumption that a single goose observed represents one member of a nesting pair with an undetected mate on a nest. Single geese observed on a nest were rarely detected and were not recorded. Population indices for geese were calculated as:

Indicated Paired Birds = 2 * (n singles + n pairs)

Indicated Total Birds = 2 * (n singles + n pairs) + birds in flocks.

The average densities of each aerial index measure were calculated from all transects within each of the 3 strata. Because transects are of unequal length, we used a ratio estimate to calculate the average density and variance (Caughley 1977). Average density multiplied by total stratum area calculated the population index, and the population indices from the three strata were summed. Analysis was performed by a VisualBASIC program written by John Hodges, USFWS, Migratory Bird Management, Juneau Field Station. All flightlines were assumed to have been flown precisely as designed, and all bird locations were associated with the nearest flight line.

As a check to our analysis procedure, we used slightly different methods with essentially the same data. Typically the density on each transect was calculated assuming the flightline was flown exactly to the geographic coordinates as designed and that all birds seen are between the transect endpoints. In the reported data (Table 1), observations from a less experienced right-seat observer in 2005 and 2006 were not used, and in 2010, only the first replicate of transects on the West Delta was included. Using GIS processing (geographic information system, ArcGIS 9.3), we constructed each flown half-transect (right- and left-seat) along the recorded flight track and assigned geographic coordinates to all aerial observations. We calculated density based on the 200 m width and straight line distance between the actual start and end points on each half-transect. We excluded geese observed beyond stratum boundaries, we did not replace any missing data, we used data from both observers in 2005 and 2006, and we used both replicates of the 2010 flightlines. Stratification was also different with the typical analysis using 3 strata (East Delta, Egg Island, West Delta) while the GIS analysis subdivided the West Delta strata into 6 sections (medium, low, sparse, Castle Island, Castle fringe, new marsh).

Conversion of Aerial Indices to an Estimated Population

The Dusky Canada Goose Management Plan (Pacific Flyway Council 2008) has presented justification and methodology to convert the aerial survey population indices to a population estimate (Hodges and Eldridge 2007, Eldridge et al. 2005). This process results in a population closer to the actual number of birds and is therefore more useful for waterfowl managers concerned with regulating harvest. The steps are:

a) indicated breeding birds index changed to an aerial pair index (= 0.5 aerial pairs per indicated breeding birds aerial index)
b) ground nest density per aerial pair density (= 3.39 nests per aerial pair) based on 22 stratum averages of nest and aerial index density, 1993-2007 (Hodges and Eldridge 2007)
c) nest detection rate (= 0.832 nests detected per actual nest) (Youkey 1998)
d) average renesting rate (= 1.2 nests per pair, Fondell et al. 2006)
e) birds per pair (= 2 birds per nest)

Multiplied, the conversion factor is 0.5 * 3.39 * (1 / 0.832) * (1 / 1.2) * 2 = 3.3954.

Thus, the aerial index of indicated breeding birds * 3.3954 was used to estimate the actual breeding population of geese. Assuming 100% detection rate of flocked geese, the estimated numbers of Dusky geese observed in flocks on the CRD were added to the indicated breeding birds population estimate (Table 1). The number of adult geese observed on Middleton Island (Pacific Flyway Council 2008, Petrula 2008) was also added as a third contribution to the total population. For those years without Middleton Island surveys, the same number of adult geese as seen in the most recent year with data was repeated to estimate the population size (Table 1). The Middleton Island observations conducted in late June 2010 indicated 1,249 adult geese (ADF&G, unpubl. data). Ground plot sampling was conducted on the CRD in 2010 and the ratio of nest density to aerial index pair density will be examined and recalculated to determine if it may have changed with time and revision of the 2010 population estimation may be appropriate.

The actual Dusky goose fall population in wintering areas will vary from these annual estimates with any departure from the average conversion factors, variation among years in the June to October adult mortality rate, and the annual addition of surviving goslings. The count of goslings and adults in the July helicopter production survey (Petrula 2009) does not contribute to the estimates of the mid-May goose population tabulated in this report.

Results

The aerial indices and the estimated population are shown for all years 1986 to 2010 (Table 1, Fig. 1). The 2010 estimated population of 9,530 increased above the lowest number recorded in 2009 but remained the third lowest on record. The 1986-2010 average annual growth rate of the estimated population determined by log-linear regression was 0.974 (-2.6% annual change) with an approximate 90% confidence interval of 0.966 to 0.982. Following 25 years of decline, in spite of the addition of about 1,300 geese on Middleton Island, the average population index is now 52% (=0.9743^{25}) of its initial average size. Using only the last 10 years of estimated population data, the average 2001-2010 annual growth rate was 0.961 (0.926 to 0.997, 90% c.i.).

The annual deviation in daily mean temperatures averaged for each month in April and May (Fig. 2). Average temperatures, which may relate to seasonal phenology and nesting conditions, and survey timing (Fig. 3), were near average for 2010 with a deviation near 0 towards the center of their range among years. Also, both observers were highly experienced and observation conditions were good, therefore, we have no reason to question the accuracy of the aerial index in 2010. We noticed that the unusually high count in 2005 and the low count in 2009 coincided with earliest (9-10 May 2005) and latest (22-23 May 2009) dates for flying the survey (Fig. 3). Although thinking it appropriate, we used the relatively warm conditions in 2005 (Fig. 2) and the delayed phenology in 2009 to adjust survey timing, however given the abrupt change in indices observed compared to the overall population trend, some questions about survey timing remain. Excluding these two years, there was no significant correlation (r = -0.05) between the aerial index and survey timing. The abrupt drop in the aerial index of 1991 was unrelated to any known factor of survey conditions.

Using the same data, both the slightly different analysis using more exact GIS procedures and the traditional analysis using design-based flightlines gave the same results (Fig. 4). The most noticeable difference was caused by the exclusion of data from the less experienced right-seat observer data in 2005. This produced a more extreme outlying point compared to the general population trend, but whether it is more or less correct cannot be determined. The standard errors and the coefficient of variation (= SE / mean) were generally higher with the more complex stratification in the GIS analysis. The average of 1986-2009 CVs of the indicated breeding birds aerial index was 8.6% versus 7.3% with fewer strata. This indicates either that the strata boundaries did a poor job of delineating areas with homogeneous density, or that other variables had a larger effect. The additional data from the replicated West Delta in 2010 reduced the coefficient of variation to 5.4% or about 1/3 less than the average CV of 8.6% in prior years.

Discussion and Management Implications

Although the 2010 estimated population of 9,530 Dusky geese increased above the low number in 2009, it is not possible with a single year of data to separate sampling error from a possible change in population trend. Sampling error is estimated from variability among transect densities within each strata and this does not reflect other possible sources of variation between years due to potential change in observers, observation conditions, timing, habitat, and behavior of geese. In summary, the aerial survey indices and the derived population estimate strongly support a continued long-term decline in population size. The Flyway Management Plan specifies a population management goal for Dusky Canada geese between 10,000 to 20,000 birds. With the 3-year running population average below 10,000 as seen in 2009 and again in 2010, this requires implementation of management procedures (Action Level 2) to ensure conservation and protection of Dusky Canada geese.

Taking a more optimistic view, the large number of goslings observed in July 2008 and July 2009 production surveys compared to prior years (Petrula 2009) may now be contributing to the breeding population. The lag of 2 years before seeing an increase in breeding bird numbers, and the lack of an increase in flocked birds in the 2009 and 2010 aerial surveys (Fig.1), suggests that 1-year and 2-year old non-breeding geese may occupy habitats other than the nesting areas of the CRD. Assuming the observed increase in numbers this year was in part from these surviving young geese beginning to nest in their 3rd year of life, perhaps even more birds will be observed next year.

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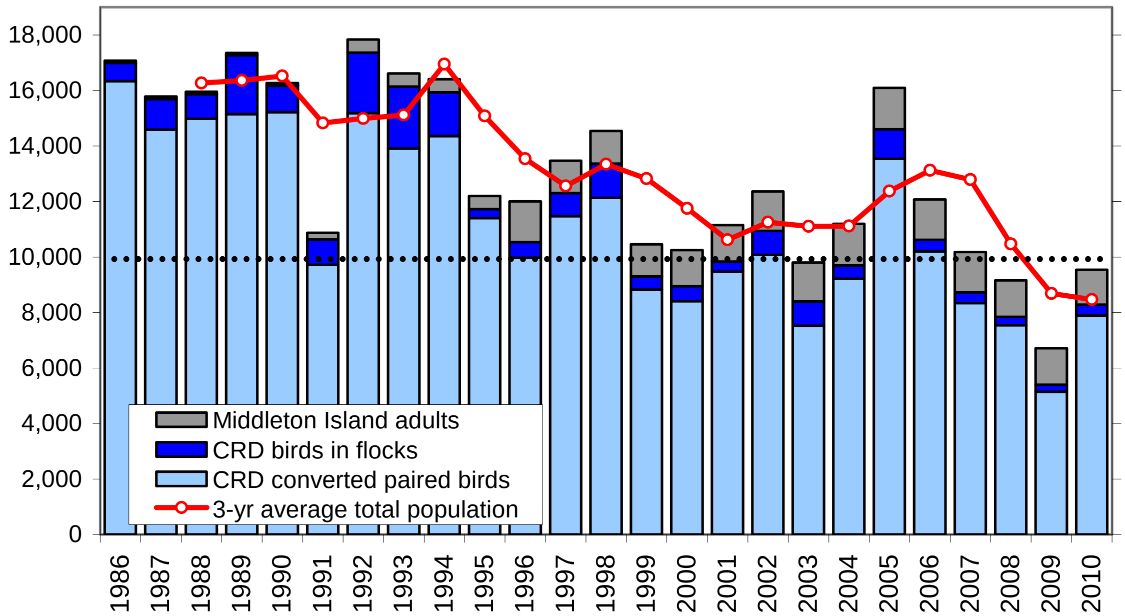
Table 1. Aerial population indices and converted population estimates for Dusky Canada geese, 1986-2009.

Year	Indicated total birds index	SE		Indicated breeding birds index	SE		3.3954 * CRD breeding birds index	CRD birds in flocks	Middleton Island adults	Total estimated Dusky population	3-year running average
1986	5469	356		4811	389		16335	658	80	17073	
1987	5408	504		4294	409		14580	1114	84	15778	
1988	5296	364		4412	325		14981	884	90	15955	16269
1989	6582	565		4463	369		15154	2119	75	17348	16360
1990	5442	669		4482	457		15218	960	93	16271	16525
1991	3773	437		2861	356		9714	912	249	10875	14831
1992	6648	835		4472	284		15184	2176	473	17833	14993
1993	6334	495		4096	265		13908	2238	473	16619	15109
1994	5810	432		4226	253		14349	1584	473	16406	16953
1995	3685	323		3357	250		11398	328	473	12199	15075
1996	3509	267		2936	190		9969	573	1456	11998	13534
1997	4208	271		3379	176		11473	829	1168	13470	12556
1998	4814	350		3571	203		12125	1243	1168	14536	13335
1999	3068	224		2599	174		8825	469	1168	10462	12823
2000	3009	184		2477	128		8410	532	1309	10251	11750
2001	3157	202		2788	181		9466	369	1309	11144	10619
2002	3836	294		2966	173		10071	870	1416	12357	11251
2003	3083	222		2215	129		7521	868	1416	9805	11102
2004	3198	235		2712	190		9208	486	1499	11193	11118
2005	5050	614		3986	418		13534	1064	1499	16097	12365
2006	3412	326		3006	301		10207	406	1453	12066	13119
2007	2848	188		2456	157		8339	392	1453	10184	12782
2008	2512	192		2222	167		7545	290	1317	9152	10467
2009	1768	165		1513	103		5137	255	1317	6709	8682
2010	2714	193		2324	131		7891	390	1249	9530	8464



Average population growth 1986-2010 = -2.6% (90%c.i. -3.3% to -1.8%)
Average population growth 2001-2010 = -3.9% (90%c.i. -7.4% to -0.3%)

Figure 1. Estimated total population size of Dusky Canada geese based on indicated breeding birds x 3.3954, birds in flocks on the CRD, plus Middleton Island adults. The 3-year running average is indicated by the red line.

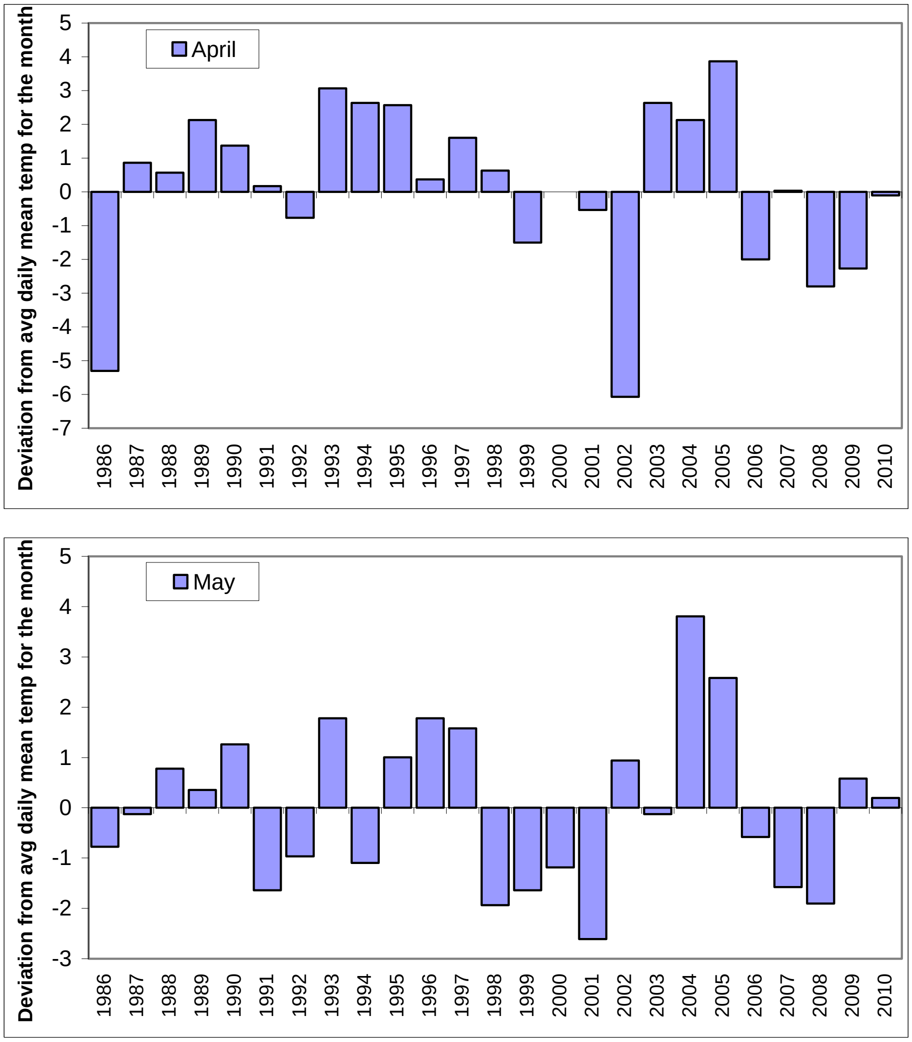


Figure 2. Annual deviations from the 30-year average daily mean temperature for the month of April and May at the Cordova (PACV) weather station from 1980 to 2010. Positive values indicate warmer than average temperature.

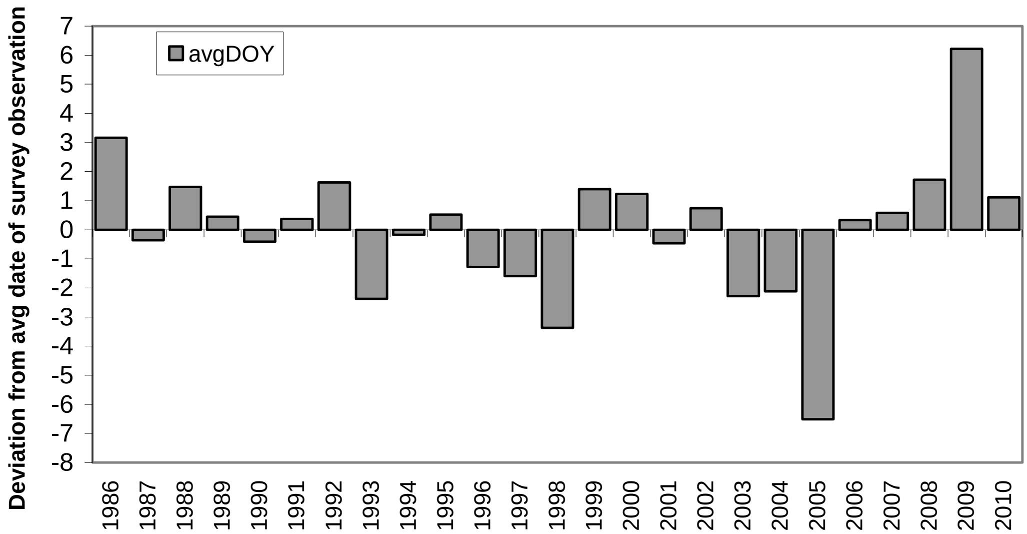


Figure 3. Relative timing of the Dusky Canada goose surveys on the Copper River Delta measured as annual deviations from the average observation date of 16 May. Positive values indicate later-flown surveys.

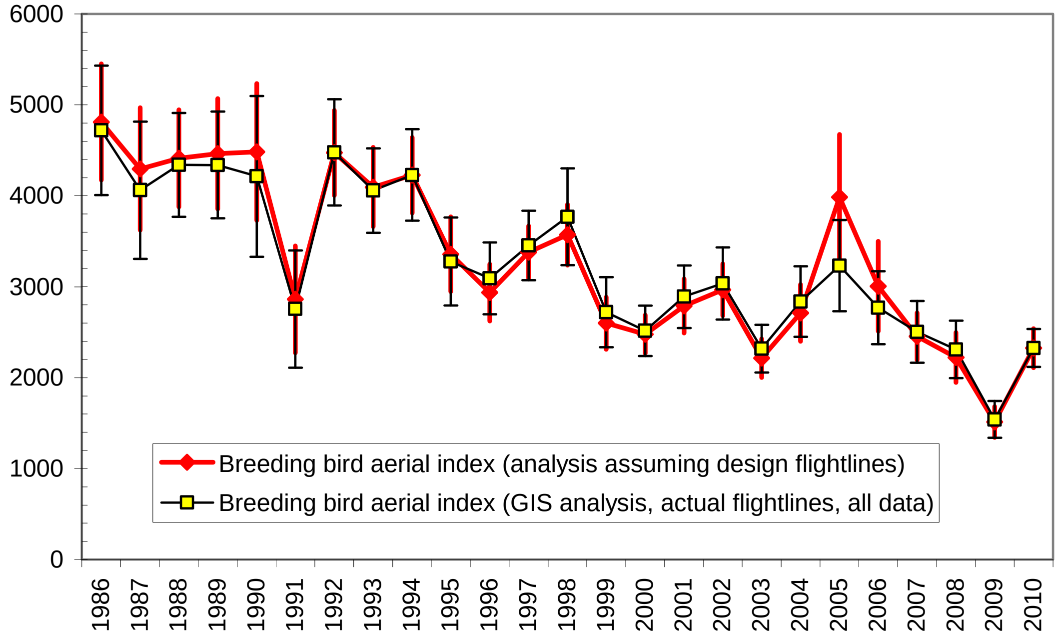


Figure 4. Comparison of breeding bird aerial survey indices of Dusky geese based on the same data but with minor differences in assumptions used in analysis (specified in text). Vertical lines indicate 90% confidence intervals.