# A SURVEY OF TRUMPETER SWANS ON ALASKAN SUMMERING HABITATS, 2010

**Deborah J. Groves and John I. Hodges**, *U.S. Fish and Wildlife Service, Migratory Bird Management, Waterfowl Management Branch, 3000 Vintage Blvd., Suite 240, Juneau, AK 99801, USA.*

May 2013

**ABSTRACT:** The ninth quinquennial survey of Trumpeter Swans (*Cygnus buccinator*) in Alaska was conducted on 3-25 August 2010. We used a stratified random-sample plot design with optimal allocation of effort to maximize survey efficiency. We used adult swan abundance data from our 2000 and 2005 censuses to delineate strata. We used the number of miles flown and adult abundance from the 2005 census to estimate cost per plot and variance for optimally allocating sample sizes among strata. Of a total of 780 plots (1:63,360 topographic maps) in the survey area (493,573 $km^2$), we surveyed 100 plots (63,891 $km^2$) for swans, using an aerial cruise survey method that covered all potential swan habitat in each plot. The survey required 189 hours of flight time. Abundance estimates (and 95% confidence limits) in 2010 were 19,638 (± 1,845) adults, 5,709 (± 823) cygnets, 2,004 (± 279) broods, and 25,347 (± 2,020) total swans. The estimated mean brood size was 2.85, and 23% of the swans were cygnets. The mean brood size was 10% below the 1968-2005 average. The number of adult Trumpeter Swans increased at an average annual rate of 2.6% during 2005-2010.

**KEY WORDS:** aerial survey, Alaska, *Cygnus buccinator*, Trumpeter Swan, abundance, productivity, population trend

---

## INTRODUCTION

The Alaska Trumpeter Swan survey has been conducted every five years as part of a cooperative, range-wide survey to monitor the status of Trumpeter Swans (*Cygnus buccinator*) in North America (Groves 2012). The first range-wide survey occurred in 1968, and the five-year cycle began in 1975. The objective was to assess Trumpeter Swan abundance and productivity by determining the numbers of adults (swans >1 year old), cygnets, and broods present on the breeding grounds in late summer. Through 2005, this was accomplished in Alaska via censuses of essentially the entire Alaskan summering range (Conant et al. 2002, Conant et al. 2007). The censuses provided accurate results, allowed comparisons of results among regions of the state, and produced complete, georeferenced datasets that were used for a variety of conservation purposes. However, as Trumpeter Swans increased and expanded their range over time, so did the cost and effort required to accomplish the census. In 2010, we determined that a census was cost-prohibitive and thus switched to a random sample design.

## METHODS

Our survey area in 2010 was the same area that was covered in the 2005 census (Conant et al. 2007) (Figure 1). It included most of the known and potential Trumpeter Swan summering habitats in the interior Alaskan boreal forest and along the southern coastal plain from Cook Inlet to southeastern Alaska. From 1968 through 2005, survey coverage expanded with each successive survey to accommodate range expansion of the increasing Trumpeter Swan population. However, we did not extend the survey area in 2010 because the extension would have encroached on Tundra Swan (*Cygnus columbianus*) habitat. We were unable to differentiate Trumpeter and Tundra Swans during the aerial survey, so we wanted to minimize the likelihood of including Tundra Swans in our counts. A portion of the survey area along its western and northern peripheries likely did host an unknown number of Tundra Swans (Wilk

1993, Bryant et al. 2005, Bryant unpublished data); nevertheless, we included it because it had been included in previous quinquennial surveys.

We used a stratified random sample design with optimal allocation of effort to minimize cost for a fixed variance (Cochran 1977) (Figure 1, Table 1). Sample units were individual U.S. Geological Survey 1:63,360 topographic maps. We sorted the maps into five strata, based on the number of adult swans observed on each map during the previous (2005) survey: 1) 0 - 5, 2) 6 - 15, 3) 16 - 30, 4) 31 - 100, and 5) >100. Following Conant et al. (1991), we computed the predicted total sample size needed to obtain an abundance estimate of adult swans, $\hat{T}$, with 95% confidence limits of $\hat{T} \pm .10\hat{T}$. The sample-size formula required stratum-specific estimates of adult swan variability (standard deviation, $s_h$) and average survey cost per map ($C_h$), as well as a designated value of $\hat{T}$. We used the 2005 survey results to estimate the standard deviation in each stratum, but we used the 2000 survey results to stratify the maps, thereby assuring independence. Strata definitions were identical to those shown above. We defined "cost" as the number of statute miles flown to survey all potential swan habitat on a map. For each stratum, we computed the mean number of miles flown per map in 2005 and then added an arbitrary value of 40 miles to account for cross-country flights between maps. To project a value of $\hat{T}$, we multiplied the mean number of adult swans per map in each stratum in 2005 by the total number of maps in the stratum in 2010 and then summed the results for all strata. Our predicted total sample size was 97 maps, which we optimally allocated among the five strata in accordance with Cochran (1977). The resulting $n_h$ values were fractions, so we rounded each number up to the next integer. We arbitrarily added one more map to stratum 3 to obtain a final sample size of 100 maps. We then randomly selected the samples in each stratum from the total available maps in each stratum.

We conducted the survey in August when the swans, especially families, were dispersed on the breeding grounds, and cygnets were flightless but large enough to be easily counted from the air. We apportioned the sample maps among five survey crews, each of which comprised a left-seat pilot-observer (hereafter pilot) and a right-seat observer (hereafter observer). We used the survey method that was described by King (1973, 1982), with modifications to record swan observations and the survey flight track digitally. Each crew used a single-engine aircraft to survey all suitable habitat within a sampled map, attempting to count all swans. The pilot was responsible for ensuring adequate survey coverage, modifying the flight path as necessary to account for factors that affected visibility (e.g., lighting conditions, vegetation height). The survey was generally flown at an altitude of 150-180 m above ground, but the crew sometimes descended to obtain an accurate count of cygnets. The crew also circled when necessary to verify counts. The observer recorded the location and attributes of each observation on a digital 1:63,360 topographic map, using a laptop computer that was linked to the aircraft's GPS unit and a custom moving-map program developed by author Hodges. Observations were recorded as a single adult, adult pair, single with brood, pair with brood, or flock of adults, with cygnets and flocked swans enumerated. The pilot also used the moving map, which displayed the flight track, to determine where potential swan habitat occurred within the map and to monitor survey coverage. The program produced two files: a swan data file containing the geographic coordinates and attributes of each swan observation, and a flight track file containing point locations of the aircraft during the survey flight in five-second intervals. After the survey, we

linked each swan observation with its appropriate sample map. The resulting data file was used for analyses.

We generated estimates of population abundance and precision for several swan age and group categories using stratified sampling estimators (Cochran 1977). We then used the ratios of relevant estimates to estimate the mean brood size, the percentage of cygnets in the total population, and the percentage of pairs that had a brood. We did not correct for detection bias in our estimates, but detection was likely high and fairly constant due to the swans' large size, white plumage, and tendency to occupy relatively open habitats (Schmidt et al. 2009).

We compared the 2010 survey results with results from prior (1968-2005) surveys to assess potential trends in the population parameters. We treated the prior surveys as censuses with no associated sampling variances, because the entire suspected range of Trumpeter Swans at the time of each survey was searched, and detection bias was likely small. We performed two-sample *z*-tests to evaluate differences between the 2005 and 2010 estimates (Thompson et al. 1998). We used least-squares regression on log-transformed abundance estimates to estimate population growth rates, and we used linear regression to assess trends in productivity (percentage of cygnets and mean brood size). We tested the trends for equality to zero using *t*-tests. We selected an alpha level of 0.05 for all tests of significance.

## RESULTS

The survey was conducted during 3-25 August. Five survey crews flew a total of 189 hours, using Cessna 206's on wheels, Cessna 206's on amphibious floats, and the USFWS modified de Havilland Turbine Beaver (N754).

The numbers of swans counted in each sample unit are listed in Appendix A. We estimated a total of 19,638 (±1,845, 95% confidence limits) adults, 5,709 (±823) cygnets, and 25,347 (±2,020) total swans (Table 2). Compared to estimates from the 2005 survey, the number of adult swans increased 14% ($P = 0.01$), cygnets decreased 11% ($P = 0.07$), and total swans increased 7% ($P = 0.10$) (Table 3). Only the adult swan estimates were significantly different at our selected alpha level of 0.05. The estimated average growth rate of the adult swan population during 2005-2010 was +2.6% per year, which was lower than rates seen previously. A comparison of growth rates during the first and second halves of the 1968-2010 time period indicated that adult swans increased an average of 8.1% per year during 1968-1990 ($P = 0.0009$) and 3.6% per year during 1990-2010 ($P = 0.0002$) (Figure 2).

The 2010 productivity estimates indicated that Trumpeter Swan production was slightly below average that year (Tables 2, 3). The percentage of pairs with a brood, 27.2%, was 14% below the 1968-2005 mean, and the mean brood size of 2.85 was 10% below the 1968-2005 mean. Cygnets comprised 22.5% of the total population, 13% below the 1968-2005 mean. The mean brood size has experienced a downward trend since 1968 ($P = 0.04$) (Figure 3). We did not detect a significant long-term trend in the percentage of cygnets ($P = 0.12$) (Figure 4); however, the trend may be following a similar pattern to that of mean brood size but may require a few more data points to show significance.

## DISCUSSION

Trumpeter Swans in Alaska continued to increase since the 2005 survey and reached a new record level since surveys began in 1968. The growth rate has slowed over time, which we expect to occur as the best nesting territories become filled and the population expands into less productive habitats. It is also possible that some areas of the state have reached or are approaching carrying capacity. A decline in the mean brood size since 1968 and a possible decline in the percentage of cygnets suggest that productivity has decreased for the statewide population. Productivity and growth rates during 2005-2010 undoubtedly varied among regions in the state, depending on factors such as habitat availability, habitat quality, and weather conditions during the breeding season.

The 2010 Alaska survey did not provide sufficient information by region to examine regional trends. However, four areas were intensively surveyed by the U.S. Fish and Wildlife Service (USFWS) in late summer 2010. During 2005-2010, adult swans increased an average of 7.3% per year on Kanuti National Wildlife Refuge (NWR) (Harwood 2010), 5.7% per year on Yukon Flats NWR (Guldager 2011), and 3.7% per year in the upper Tanana River valley (Tetlin NWR, unpublished data) (Figure 5). On the Copper River Delta, which was surveyed annually during 2005-2010, adult swans decreased 6.5% per year (Groves et al. 2010; USFWS-Migratory Bird Management, unpublished data). Whereas Kanuti NWR and Yukon Flats NWR both had substantial amounts of previously unoccupied habitat available to support population growth, the Copper River Delta has hosted swans since at least the mid-1950's (Hansen et al. 1971) and has likely reached carrying capacity, as evidenced by the cyclical trend that has been documented in the population there since 1968 (Groves et al. 2010).

Our decision to use the 2005 survey area boundary as our area of inference in 2010 had pros and cons. One benefit was that we could directly compare the 2010 estimates to the 2005 survey results. From 1968 to 2005, the survey area increased with each successive survey, and Schmidt et al. (2009) found that failing to account for the changing area resulted in slightly biased trend results. We did not account for the change in survey area when we calculated long-term growth rates, because doing so would have entailed more complicated analysis methods, and we felt that the bias was sufficiently minimal for our purposes. (For example, we estimated an average annual increase of 6.1% in adult swans during 1968-2005, compared to Schmidt et al.'s estimate of 5.9%.)

Another benefit of using the 2005 survey area was that we limited inclusion of sympatric Trumpeter and Tundra Swan summering areas to those that had been included in prior surveys. While this minimized the number of Tundra Swans in our counts, it also undoubtedly resulted in some Trumpeter Swans being missed. Based on the amount of boreal forest wetland habitats that were excluded, we believe that a maximum of a few hundred adult Trumpeter Swans might have been present outside our survey area in 2010. The number could be greater, however, if Trumpeter Swans were able to occupy wetlands within the nearby tundra landscape. Conversely, we do not know how many Tundra Swans were present or the extent to which they occupied habitats within our survey area in 2010. Bryant et al. (2005; unpublished data) estimated that 50%, 20%, and 0% of all swans nesting on the Koyukuk NWR, Northern Unit of Innoko NWR (Kaiyuh Flats), and Nowitna NWR, respectively, were Tundra Swans in 2004-2006 (Figure 5).

Wilk (1993) observed that 41% of nesting pairs in a study area within and near Kanuti NWR in 1989 were Tundra Swans, although this proportion had likely changed to an unknown degree by the time of our survey in 2010 (Harwood 2010). The accuracy of Trumpeter Swan survey results in the future will be improved if we can assess the spatial extent of species overlap in the state and determine the relative proportions of each species within the sympatric area. This information should be updated periodically, as the degree and location of overlap will likely not remain static.

## ACKNOWLEDGMENTS

The majority of funding for the 2010 survey came from the USFWS-Migratory Bird Management (MBM) Surveys, Monitoring, and Assessment Fund. We appreciate the assistance of Eric Taylor, Russ Oates, Bob Blohm, and Nancy Minor in obtaining and administering these funds. We also thank Carol McIntyre (National Park Service) and John Haddix (U.S. Army-Fort Wainwright) for supporting the survey and providing additional funding. Prior quinquennial Alaska Trumpeter Swan surveys were coordinated by Jim King (1968-1980) and Bruce Conant (1985-2005) of the USFWS-MBM Juneau Waterfowl Project. We thank Chris Harwood (Kanuti NWR), Nikki Guldager (Yukon Flats NWR), and Peter Keller (Tetlin NWR) for sharing the results of their 2010 Trumpeter Swan surveys, and we thank Jenny Bryant and Brad Scotton (Koyukuk/Nowitna NWR Complex) for sharing the results of their Trumpeter/Tundra Swan sympatric nesting range study. Participants in the 2010 survey included pilot-observers Paul Anderson, Karen Bollinger, Bill Larned, Ed Mallek, and Heather Wilson; and right-seat observers Lynn Denlinger, Chase Freeman, Deb Groves, Rod King, and Eric Taylor.

## LITERATURE CITED

Bryant, J. M., B. D. Scotton, and M. R. Hans. 2005. Sympatric nesting range of Trumpeter and Tundra Swans on the Koyukuk National Wildlife Refuge in northwest interior Alaska. U.S. Fish and Wildlife Service, Koyukuk/Nowitna National Wildlife Refuge Complex, Galena, Alaska, USA.

Cochran, W. G. 1977. Sampling techniques, third edition. John Wiley & Sons, New York, USA.

Conant, B., J. I. Hodges, D. J. Groves, and J. G. King. 2002. Census of Trumpeter Swans on Alaskan nesting habitats, 1968-2000. Waterbirds 25(Special Publication 1):3-7.

_____, _____, _____, and _____. 2007. Alaska Trumpeter Swan status report – 2005. U.S. Fish and Wildlife Service, Migratory Bird Management, Juneau, Alaska, USA.

_____, _____, and J. G. King. 1991. Continuity and advancement of Trumpeter Swan *Cygnus buccinator* and Tundra Swan *Cygnus columbianus* population monitoring in Alaska. Pages 125-136 *in* J. Sears and P. J. Bacon, editors. Proceedings of the Third IWRB International Swan Symposium, Oxford, 1989. Wildfowl Supplement No. 1.

Groves, D. J. 2012. The 2010 North American Trumpeter Swan survey – a cooperative North American survey. U.S. Fish and Wildlife Service, Migratory Bird Management, Juneau, Alaska, USA.

Groves, D. J., W. W. Larned, and P. D. Anderson. 2010. Trumpeter Swan surveys on the Chugach National Forest – 2009. U.S. Fish and Wildlife Service, Migratory Bird Management, Juneau, Alaska, USA.

Guldager, N. 2011. Trumpeter Swan survey, Yukon Flats, Alaska – 2010. U.S. Fish and Wildlife Service, Yukon Flats National Wildlife Refuge, Fairbanks, Alaska, USA.

Hansen, H. A., P. E. K. Shepherd, J. G. King, and W. A. Troyer. 1971. The Trumpeter Swan in Alaska. Wildlife Monographs 26.

Harwood, C. M. 2010. Trumpeter Swan survey, Kanuti National Wildlife Refuge, August – September 2010. U.S. Fish and Wildlife Service, Kanuti National Wildlife Refuge, Fairbanks, Alaska, USA.

King, J. G. 1973. The use of small airplanes to gather swan data in Alaska. Wildfowl 24:15-20.

_____. 1982. Swans. Pages 32-34 *in* D. E. Davis, editor, Handbook of Census Methods for Terrestrial Vertebrates. CRC Press, Inc., Boca Raton, Florida, USA.

Schmidt, J. H., M. S. Lindberg, D. S. Johnson, B. Conant, and J. King. 2009. Evidence of Alaskan Trumpeter Swan population growth using Bayesian hierarchical models. Journal of Wildlife Management 73(5):720-727.

Thompson, W. L., G. C. White, and C. Gowan. 1998. Monitoring vertebrate populations. Academic Press, San Diego, California, USA.

Wilk, R. J. 1993. Observations on sympatric Tundra, *Cygnus columbianus*, and Trumpeter Swans, *C. buccinator*, in north-central Alaska, 1989-1991. Canadian Field-Naturalist 107(1):64-68.

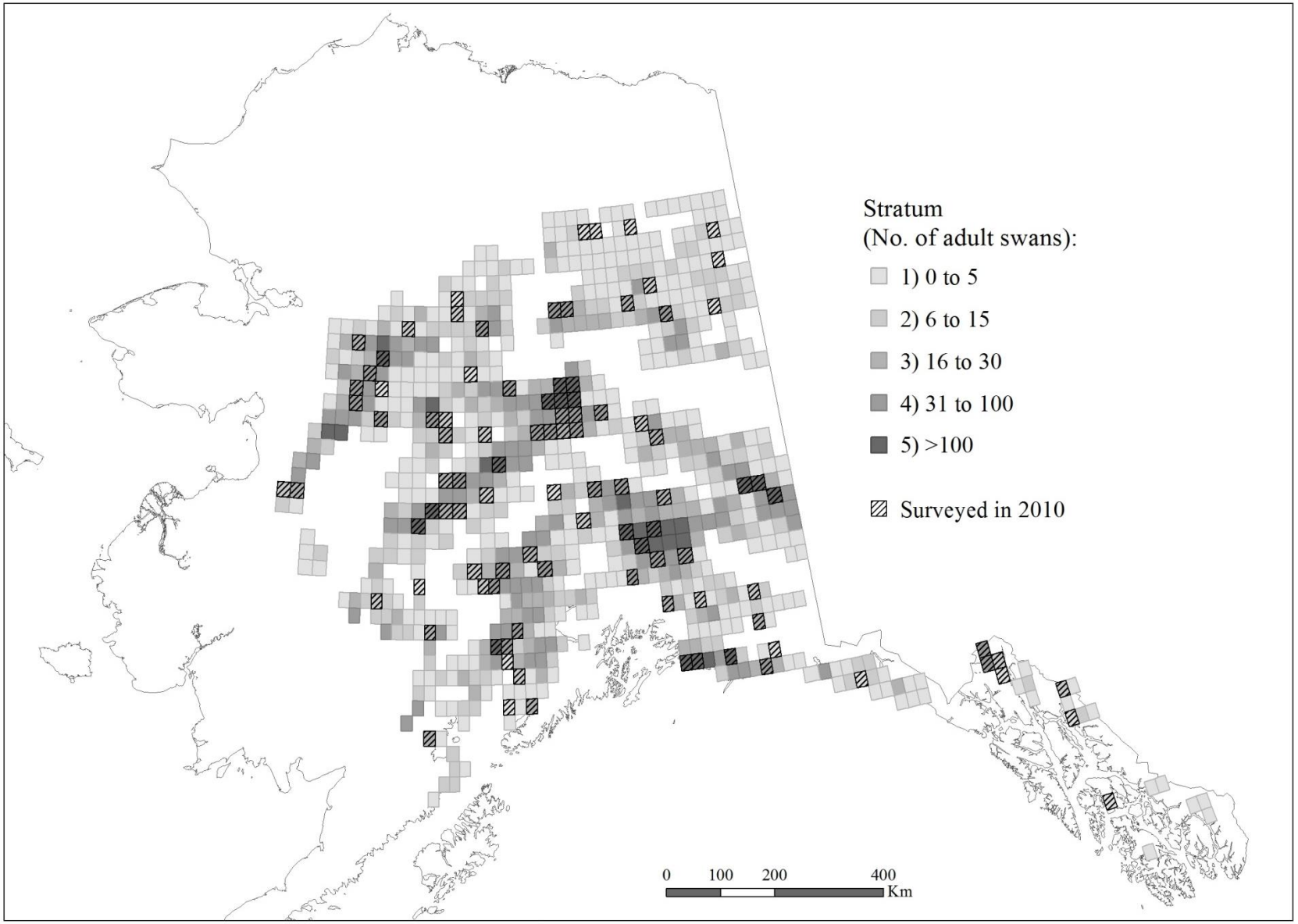


Figure 1. The 2010 Alaska Trumpeter Swan survey area, showing the distribution of sample units (1:63,360 maps) within five survey strata and the 100 randomly selected maps. The size of the survey area was 493,573 sq. km.

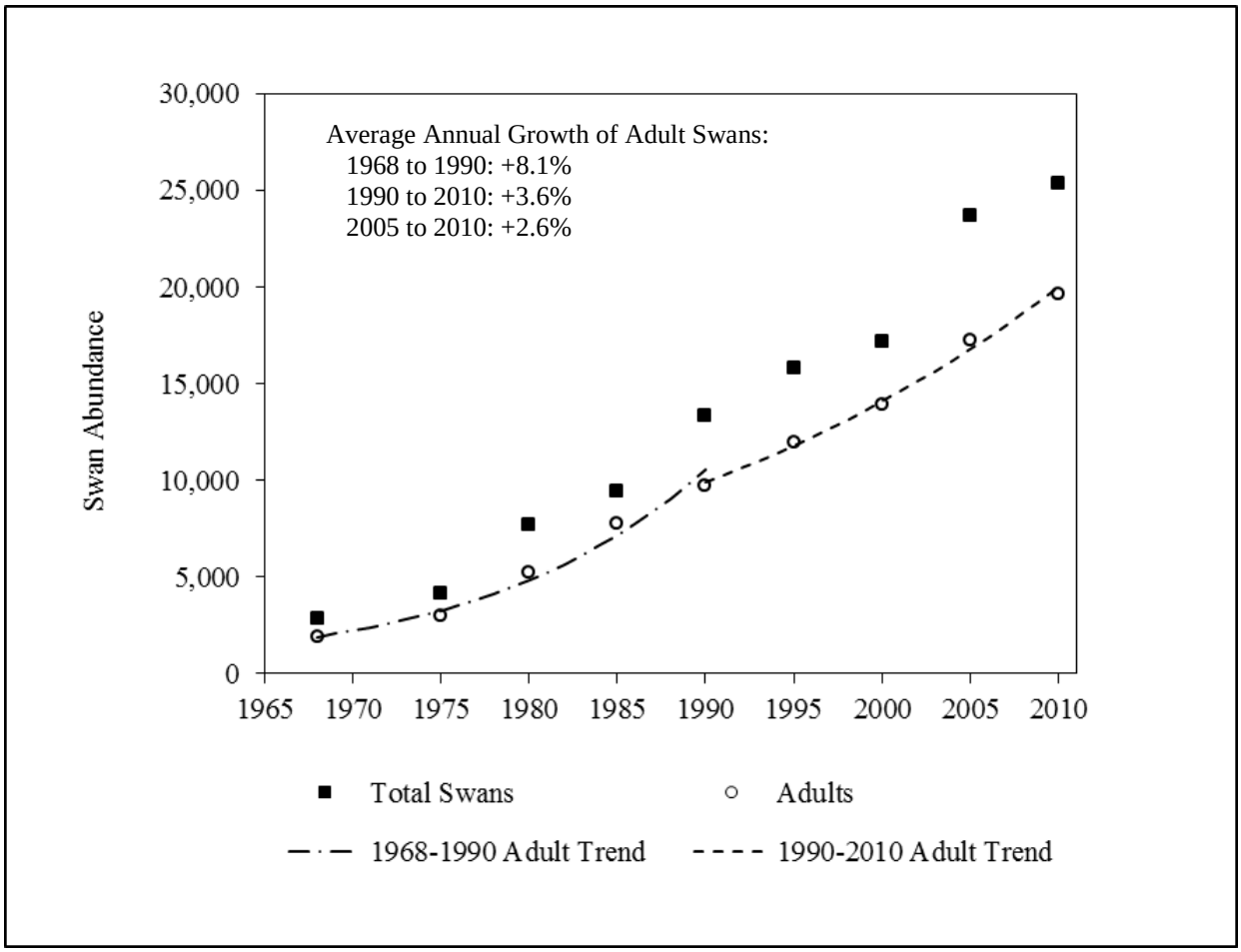


Figure 2. Trumpeter Swan abundance estimates from quinquennial surveys in Alaska, 1968-2010. Fitted lines are from least-squares regression performed on log-transformed adult swan estimates.

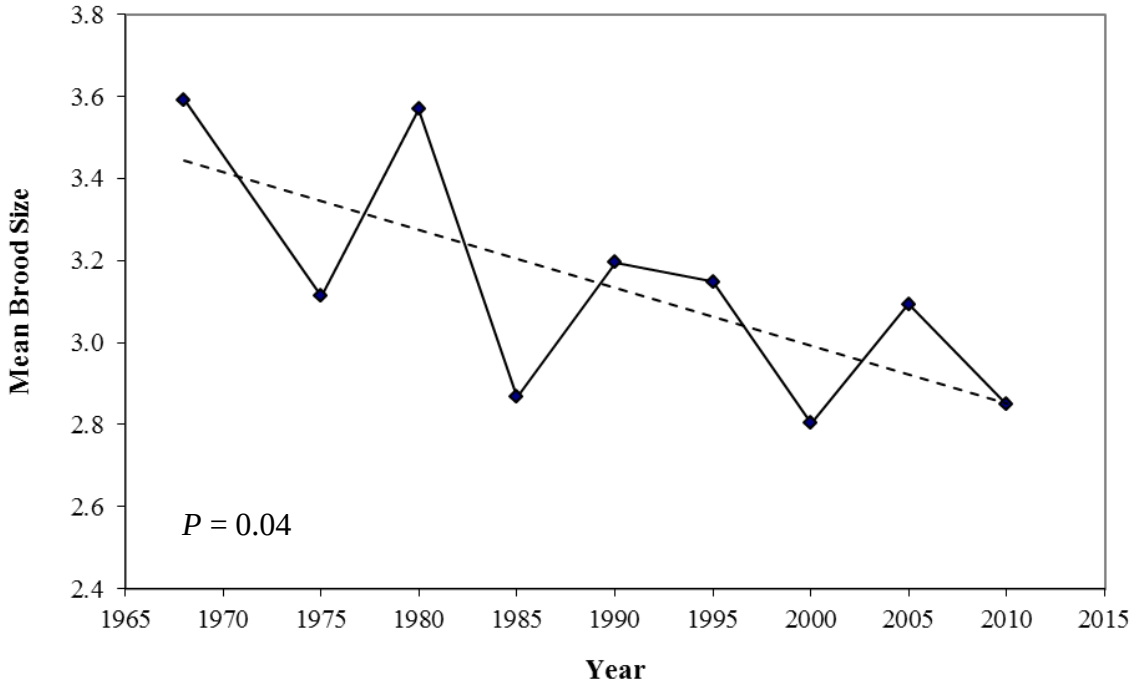


Figure 3. Mean size of Trumpeter Swan broods during quinquennial Alaska Trumpeter Swan surveys, 1968-2010. The fitted line is from linear regression.

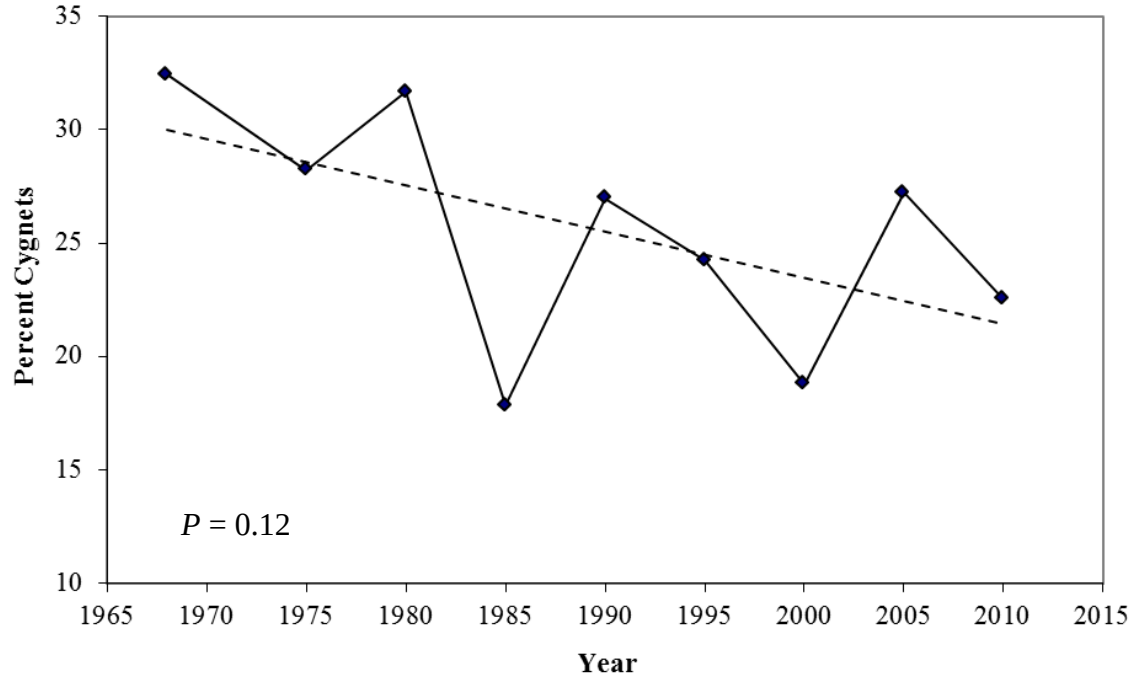


Figure 4. Percentage of cygnets in the total Alaska Trumpeter Swan population during quinquennial surveys, 1968-2010. The fitted line is from linear regression.

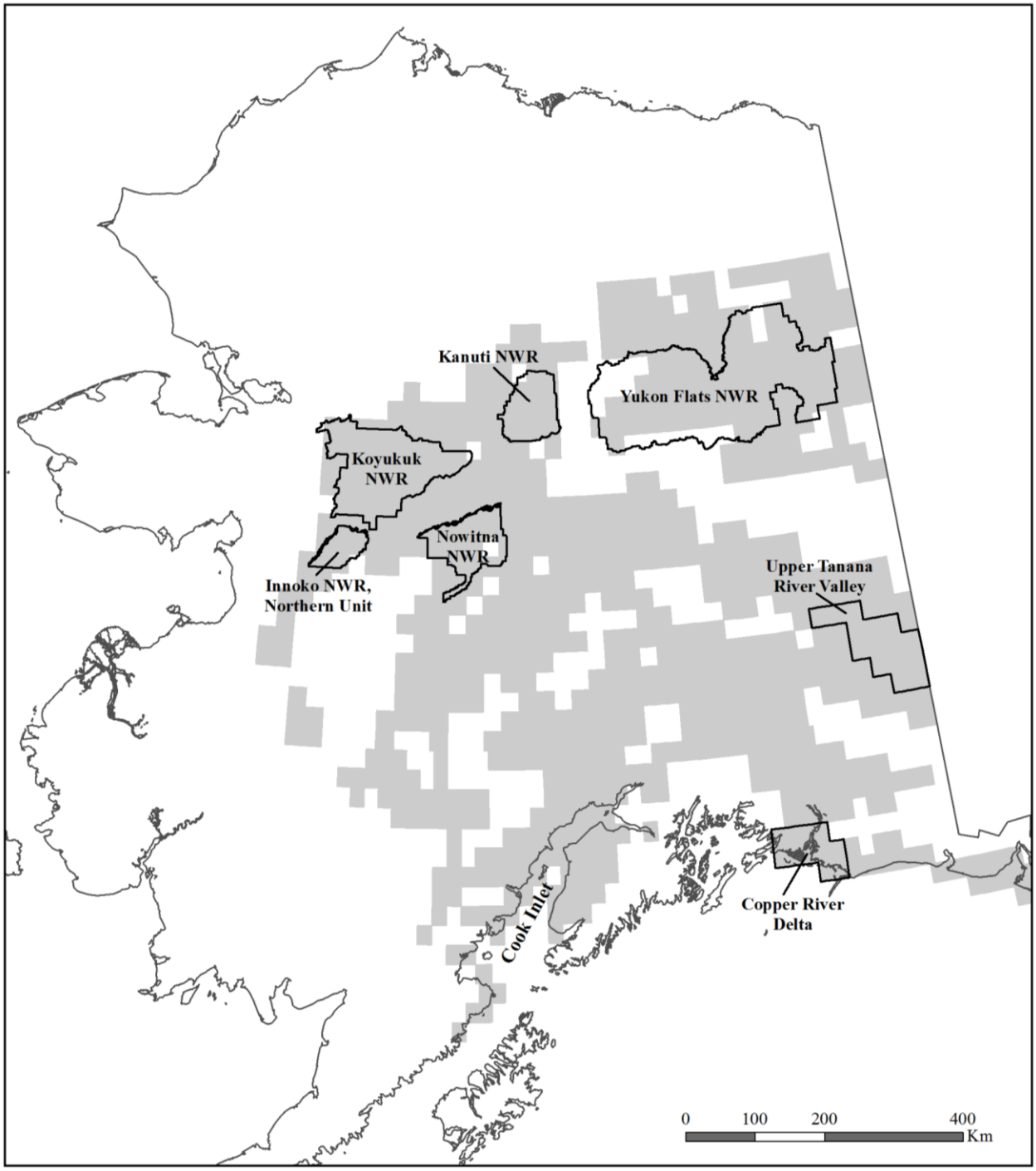


Figure 5. Locations of place names used in the text. The 2010 survey area (excluding southeast Alaska) is shown in gray.

Table 1. Data used to determine optimal allocation of sampling effort in the 2010 Alaska Trumpeter Swan survey.

| | 2010 Stratum (Number of adult swans per sample unit in 2005) | | | | | |
|---|---|---|---|---|---|---|
| Parameter | 1 (0 to 5) | 2 (6 to 15) | 3 (16 to 30) | 4 (31 to 100) | 5 (>100) | Total |
| $N_h$ = Stratum size in 2010 (number of maps) | 350 | 168 | 102 | 128 | 32 | 780 |
| Mean number of adults per sample unit (map) in 2005[a] | 3.52 | 14.77 | 30.65 | 60.87 | 185.32 | |
| $s_h$ = Standard deviation of adult swans in 2005[a] | 4.33 | 10.49 | 17.18 | 29.70 | 95.16 | |
| T^ = Projected total number of adult swans in 2010 ($N_h$*Mean Adults) | 1,231.7 | 2,481.7 | 3,126.8 | 7,791.7 | 5,930.3 | 20,562.1 |
| $C_h$ = Mean cost per sample unit in 2005 (number of miles flown)[a] | 94 | 143 | 176 | 216 | 337 | |
| P = Degree of precision desired[b] | | | | | | 0.10 |
| Predicted sample size | 17.6 | 16.6 | 14.9 | 29.2 | 18.7 | 97 |
| $n_h$ = Final sample size | 18 | 17 | 16 | 30 | 19 | 100 |

[a]Computed using census maps stratified by 2000 adult swan data.

[b]Size of 95% confidence interval about the estimated number of adult swans.

Table 2. Trumpeter Swan population estimates and associated precision from the 2010 Alaska Trumpeter Swan survey.

| | Adult Swans | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | As Singles | In Pairs | In Flocks | No. of Flocks | Total Adults | Cygnets | No. of Broods | No. of Pairs with Brood | Total Swans | Percent Cygnets | Mean Brood Size | Percent Pairs with Brood |
| Population Estimate | 1,591 | 14,276 | 3,771 | 605 | 19,638 | 5,709 | 2,004 | 1,938 | 25,347 | 22.5 | 2.85 | 27.2 |
| Standard Error | 127 | 622 | 437 | 57 | 923 | 411 | 140 | 133 | 1,010 | | | |
| Coefficient of Variation | 0.080 | 0.044 | 0.116 | 0.094 | 0.047 | 0.072 | 0.070 | 0.069 | 0.040 | | | |
| ± 95% Confidence Limits[a] | 253 | 1,243 | 875 | 114 | 1,845 | 823 | 279 | 266 | 2,020 | | | |

[a]2*standard error

Table 3. Historical Trumpeter Swan population estimates from Alaska Trumpeter Swan surveys, 1968-2010.

| | Adult (White) Swans | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | As Singles | In Pairs | In Flocks | No. of Flocks | Total Adults | Cygnets | Total Swans | No. of Broods | Percent Cygnets | Mean Brood Size | Percent Pairs with Brood |
| 1968 | 108 | 1,320 | 496 | 69 | 1,924 | 923 | 2,847 | 257 | 32.4 | 3.59 | 37.1 |
| 1975 | 151 | 2,102 | 740 | 125 | 2,993 | 1,177 | 4,170 | 378 | 28.2 | 3.11 | 35.4 |
| 1980 | 169 | 3,324 | 1,766 | 210 | 5,259 | 2,437 | 7,696 | 683 | 31.7 | 3.57 | 40.3 |
| 1985 | 449 | 5,120 | 2,204 | 317 | 7,773 | 1,686 | 9,459 | 588 | 17.8 | 2.87 | 22.6 |
| 1990 | 647 | 7,056 | 2,039 | 326 | 9,742 | 3,595 | 13,337 | 1,124 | 27.0 | 3.20 | 31.2 |
| 1995 | 859 | 7,946 | 3,184 | 563 | 11,989 | 3,834 | 15,823 | 1,218 | 24.2 | 3.15 | 30.1 |
| 2000 | 899 | 9,986 | 3,049 | 530 | 13,934 | 3,221 | 17,155 | 1,149 | 18.8 | 2.80 | 22.4 |
| 2005 | 1,157 | 11,940 | 4,148 | 658 | 17,245 | 6,447 | 23,692 | 2,084 | 27.2 | 3.09 | 33.9 |
| 2010[a] | 1,591 (±253) | 14,276 (±1,243) | 3,771 (±875) | 605 (±114) | 19,638 (±1,845) | 5,709 (±823) | 25,347 (±2,020) | 2,004 (±279) | 22.5 | 2.85 | 27.2 |
| % Change 2005 to 2010 | 38 | 20 | -9 | -8 | 14 | -11 | 7 | -4 | -17 | -8 | -20 |
| *P* -value[b] | 0.0006 | 0.0002 | 0.39 | 0.35 | 0.01 | 0.07 | 0.10 | 0.57 | | | |
| 1968-2005 Mean | | | | | | | | | 25.9 | 3.17 | 31.6 |
| % Change from 1968-2005 Mean | | | | | | | | | -13 | -10 | -14 |

[a] 95% confidence limits are in parentheses (2*standard error).

[b] Results of a two-sample z-test comparing 2005 and 2010 estimates.

Appendix A. Raw counts and associated totals of swans on 100 stratified random sample plots (1:63,360 maps) surveyed during the 2010 Alaska Trumpeter Swan Survey.

| | | | | Adult (White) Swans | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | As Singles | | In Pairs | | | | | | | |
| Map | Stratum | Date Surveyed | No. of Observations | With Cygnets | Without Cygnets | With Cygnets | Without Cygnets | In Flocks | No. of Flocks | Total Adults | Cygnets | No. of Broods | Total Swans |
| Bering Glacier B5 | 1 | 08/12/2010 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 2 |
| Black River A4 | 1 | 08/10/2010 | 2 | 0 | 0 | 2 | 2 | 0 | 0 | 4 | 3 | 1 | 7 |
| Black River D3 | 1 | 08/10/2010 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 3 | 1 | 1 | 4 |
| Chandalar C1 | 1 | 08/09/2010 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 2 |
| Chandalar C2 | 1 | 08/09/2010 | 2 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 4 |
| Christian C4 | 1 | 08/09/2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coleen B3 | 1 | 08/10/2010 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 2 |
| Healy B6 | 1 | 08/10/2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hughes C1 | 1 | 08/10/2010 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Kateel River A1 | 1 | 08/11/2010 | 10 | 0 | 3 | 2 | 10 | 4 | 1 | 19 | 1 | 1 | 20 |
| Kenai C5 | 1 | 08/03/2010 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 3 | 1 | 1 | 4 |
| Lime Hills D5 | 1 | 08/19/2010 | 2 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 4 |
| Petersburg C5 | 1 | 08/09/2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Seldovia D5 | 1 | 08/03/2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skagway A2 | 1 | 08/07/2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Taku River A6 | 1 | 08/09/2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tanana B6 | 1 | 08/13/2010 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 2 |
| Yakutat C6 | 1 | 08/12/2010 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Big Delta B5 | 2 | 08/14/2010 | 8 | 0 | 2 | 0 | 10 | 4 | 1 | 16 | 0 | 0 | 16 |
| Fort Yukon C3 | 2 | 08/11/2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hughes A5 | 2 | 08/10/2010 | 6 | 0 | 1 | 2 | 6 | 3 | 1 | 12 | 2 | 1 | 14 |
| Hughes B1 | 2 | 08/10/2010 | 3 | 0 | 0 | 2 | 4 | 0 | 0 | 6 | 3 | 1 | 9 |
| Kantishna River B5 | 2 | 08/14/2010 | 3 | 0 | 0 | 4 | 2 | 0 | 0 | 6 | 5 | 2 | 11 |
| Kenai B4 | 2 | 08/03/2010 | 4 | 0 | 0 | 4 | 4 | 0 | 0 | 8 | 7 | 2 | 15 |
| McCarthy B6 | 2 | 08/11/2010 | 17 | 1 | 4 | 10 | 10 | 8 | 2 | 33 | 13 | 6 | 46 |
| Mt. McKinley B5 | 2 | 08/20/2010 | 13 | 0 | 3 | 0 | 20 | 0 | 0 | 23 | 0 | 0 | 23 |
| Ruby C2 | 2 | 08/13/2010 | 3 | 0 | 0 | 0 | 4 | 3 | 1 | 7 | 0 | 0 | 7 |
| Skagway B2 | 2 | 08/07/2010 | 2 | 0 | 0 | 2 | 0 | 8 | 1 | 10 | 3 | 1 | 13 |
| Sleetmute C1 | 2 | 08/19/2010 | 9 | 0 | 0 | 8 | 8 | 4 | 1 | 20 | 13 | 4 | 33 |
| Taku River C6 | 2 | 08/09/2010 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 3 | 5 | 1 | 8 |
| Talkeetna A6 | 2 | 08/13/2010 | 5 | 0 | 1 | 0 | 8 | 0 | 0 | 9 | 0 | 0 | 9 |
| Talkeetna Mts. D4 | 2 | 08/06/2010 | 4 | 0 | 2 | 2 | 2 | 0 | 0 | 6 | 3 | 1 | 9 |
| Tyonek D7 | 2 | 08/13/2010 | 2 | 0 | 0 | 2 | 2 | 0 | 0 | 4 | 1 | 1 | 5 |
| Unalakleet B2 | 2 | 08/12/2010 | 5 | 0 | 0 | 2 | 8 | 0 | 0 | 10 | 3 | 1 | 13 |
| Valdez B3 | 2 | 08/11/2010 | 2 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 4 |
| Bering Glacier D6 | 3 | 08/11/2010 | 7 | 0 | 1 | 4 | 6 | 4 | 1 | 15 | 11 | 2 | 26 |
| Big Delta A4 | 3 | 08/14/2010 | 11 | 0 | 1 | 8 | 12 | 0 | 0 | 21 | 6 | 4 | 27 |
| Fairbanks B5 | 3 | 08/13/2010 | 25 | 0 | 4 | 6 | 32 | 8 | 2 | 50 | 8 | 3 | 58 |
| Fort Yukon B5 | 3 | 08/12/2010 | 4 | 0 | 1 | 2 | 4 | 0 | 0 | 7 | 3 | 1 | 10 |
| Iliamna B4 | 3 | 08/18/2010 | 7 | 0 | 3 | 4 | 2 | 5 | 1 | 14 | 4 | 2 | 18 |
| Kateel River D3 | 3 | 08/10/2010 | 25 | 1 | 10 | 6 | 22 | 0 | 0 | 39 | 8 | 4 | 47 |
| Lime Hills A4 | 3 | 08/19/2010 | 13 | 0 | 3 | 6 | 10 | 9 | 2 | 28 | 11 | 3 | 39 |
| Medfra A1 | 3 | 08/20/2010 | 15 | 0 | 2 | 2 | 22 | 4 | 1 | 30 | 3 | 1 | 33 |
| Medfra A2 | 3 | 08/20/2010 | 14 | 0 | 0 | 6 | 22 | 0 | 0 | 28 | 10 | 3 | 38 |
| Medfra C2 | 3 | 08/21/2010 | 9 | 0 | 0 | 0 | 16 | 3 | 1 | 19 | 0 | 0 | 19 |
| Mt. Hayes A4 | 3 | 08/07/2010 | 18 | 0 | 1 | 6 | 26 | 4 | 1 | 37 | 13 | 3 | 50 |
| Ruby B2 | 3 | 08/13/2010 | 8 | 0 | 0 | 8 | 8 | 0 | 0 | 16 | 11 | 4 | 27 |
| Seldovia D3 | 3 | 08/03/2010 | 10 | 0 | 0 | 8 | 10 | 3 | 1 | 21 | 13 | 4 | 34 |
| Talkeetna B2 | 3 | 08/06/2010 | 13 | 0 | 5 | 6 | 10 | 0 | 0 | 21 | 6 | 3 | 27 |
| Unalakleet B1 | 3 | 08/12/2010 | 15 | 0 | 2 | 6 | 20 | 0 | 0 | 28 | 11 | 3 | 39 |
| Valdez B6 | 3 | 08/11/2010 | 6 | 0 | 0 | 4 | 8 | 0 | 0 | 12 | 5 | 2 | 17 |
| Anchorage D1 | 4 | 08/08/2010 | 29 | 0 | 6 | 12 | 34 | 0 | 0 | 52 | 18 | 6 | 70 |
| Beaver B4 | 4 | 08/09/2010 | 29 | 1 | 5 | 18 | 24 | 9 | 2 | 57 | 31 | 10 | 88 |
| Beaver B5 | 4 | 08/09/2010 | 25 | 0 | 2 | 8 | 36 | 4 | 1 | 50 | 13 | 4 | 63 |
| Bering Glacier A6 | 4 | 08/12/2010 | 27 | 0 | 4 | 8 | 36 | 3 | 1 | 51 | 18 | 4 | 69 |
| Bettles A5 | 4 | 08/10/2010 | 22 | 0 | 4 | 18 | 18 | 0 | 0 | 40 | 21 | 9 | 61 |
| Fairbanks B4 | 4 | 08/23/2010 | 27 | 0 | 3 | 6 | 34 | 18 | 4 | 61 | 8 | 3 | 69 |
| Fairbanks B6 | 4 | 08/13/2010 | 24 | 0 | 1 | 8 | 30 | 17 | 4 | 56 | 11 | 4 | 67 |
| Fairbanks C2 | 4 | 08/10/2010 | 30 | 1 | 5 | 8 | 40 | 0 | 0 | 54 | 15 | 5 | 69 |
| Fairbanks C4 | 4 | 08/12/2010 | 31 | 0 | 4 | 16 | 38 | 0 | 0 | 58 | 23 | 8 | 81 |
| Fairbanks C5 | 4 | 08/13/2010 | 40 | 0 | 6 | 22 | 38 | 16 | 4 | 82 | 36 | 11 | 118 |
| Fort Yukon A2 | 4 | 08/10/2010 | 43 | 0 | 9 | 14 | 48 | 10 | 3 | 81 | 13 | 7 | 94 |
| Gulkana A3 | 4 | 08/07/2010 | 25 | 0 | 6 | 4 | 32 | 6 | 1 | 48 | 8 | 2 | 56 |
| Gulkana A5 | 4 | 08/08/2010 | 51 | 0 | 13 | 24 | 46 | 10 | 3 | 93 | 31 | 12 | 124 |

Appendix A (cont'd). Raw counts and associated totals of swans on 100 stratified random sample plots (1:63,360 maps) surveyed during the 2010 Alaska Trumpeter Swan Survey.

| | | | | Adult (White) Swans | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | As Singles | | In Pairs | | | | | | | |
| Map | Stratum | Date Surveyed | No. of Observations | With Cygnets | Without Cygnets | With Cygnets | Without Cygnets | In Flocks | No. of Flocks | Total Adults | Cygnets | No. of Broods | Total Swans |
| Healy B1 | 4 | 08/10/2010 | 28 | 0 | 2 | 10 | 42 | 0 | 0 | 54 | 10 | 5 | 64 |
| Healy B3 | 4 | 08/10/2010 | 19 | 0 | 2 | 12 | 20 | 4 | 1 | 38 | 17 | 6 | 55 |
| Kantishna River B1 | 4 | 08/13/2010 | 23 | 0 | 4 | 2 | 30 | 13 | 3 | 49 | 4 | 1 | 53 |
| Kateel River A3 | 4 | 08/10/2010 | 38 | 0 | 6 | 10 | 50 | 6 | 2 | 72 | 13 | 5 | 85 |
| Kateel River B2 | 4 | 08/10/2010 | 35 | 1 | 3 | 18 | 44 | 0 | 0 | 66 | 21 | 10 | 87 |
| Kenai D5 | 4 | 08/03/2010 | 32 | 0 | 6 | 14 | 34 | 8 | 2 | 62 | 20 | 7 | 82 |
| Medfra C1 | 4 | 08/21/2010 | 30 | 0 | 4 | 8 | 42 | 4 | 1 | 58 | 8 | 4 | 66 |
| Nulato C1 | 4 | 08/12/2010 | 43 | 0 | 9 | 22 | 44 | 3 | 1 | 78 | 33 | 11 | 111 |
| Nulato D3 | 4 | 08/10/2010 | 28 | 0 | 4 | 8 | 34 | 10 | 3 | 56 | 11 | 4 | 67 |
| Ruby C3 | 4 | 08/13/2010 | 30 | 0 | 5 | 0 | 42 | 14 | 4 | 61 | 0 | 0 | 61 |
| Skagway B3 | 4 | 08/07/2010 | 32 | 2 | 1 | 24 | 28 | 23 | 3 | 78 | 40 | 14 | 118 |
| Skagway C3 | 4 | 08/07/2010 | 19 | 0 | 2 | 14 | 14 | 15 | 3 | 45 | 16 | 7 | 61 |
| Talkeetna A1 | 4 | 08/06/2010 | 23 | 1 | 6 | 4 | 28 | 0 | 0 | 39 | 9 | 3 | 48 |
| Talkeetna A4 | 4 | 08/09/2010 | 22 | 0 | 6 | 6 | 22 | 9 | 2 | 43 | 11 | 3 | 54 |
| Tanana A3 | 4 | 08/13/2010 | 34 | 0 | 7 | 6 | 36 | 55 | 6 | 104 | 9 | 3 | 113 |
| Tyonek A4 | 4 | 08/05/2010 | 27 | 0 | 4 | 4 | 42 | 0 | 0 | 50 | 4 | 2 | 54 |
| Tyonek D6 | 4 | 08/13/2010 | 24 | 0 | 5 | 10 | 28 | 0 | 0 | 43 | 13 | 5 | 56 |
| Cordova B1 | 5 | 08/13/2010 | 33 | 0 | 2 | 6 | 42 | 143 | 7 | 193 | 13 | 3 | 206 |
| Cordova B4 | 5 | 08/13/2010 | 66 | 0 | 9 | 36 | 66 | 26 | 6 | 137 | 51 | 18 | 188 |
| Cordova B5 | 5 | 08/13/2010 | 31 | 0 | 9 | 8 | 34 | 7 | 1 | 58 | 12 | 4 | 70 |
| Fairbanks D4 | 5 | 08/15/2010 | 128 | 2 | 12 | 108 | 106 | 175 | 7 | 403 | 170 | 56 | 573 |
| Fairbanks D5 | 5 | 08/15/2010 | 205 | 2 | 23 | 116 | 216 | 64 | 14 | 421 | 161 | 60 | 582 |
| Fairbanks D6 | 5 | 08/15/2010 | 87 | 2 | 13 | 26 | 96 | 133 | 11 | 270 | 44 | 15 | 314 |
| Gulkana B6 | 5 | 08/06/2010 | 56 | 0 | 13 | 6 | 68 | 24 | 6 | 111 | 12 | 3 | 123 |
| Gulkana C5 | 5 | 08/07/2010 | 69 | 0 | 18 | 6 | 92 | 6 | 2 | 122 | 7 | 3 | 129 |
| Kateel River C1 | 5 | 08/10/2010 | 53 | 1 | 4 | 22 | 70 | 43 | 2 | 140 | 26 | 12 | 166 |
| Kenai D6 | 5 | 08/13/2010 | 50 | 1 | 5 | 32 | 54 | 4 | 1 | 96 | 42 | 17 | 138 |
| Livengood A4 | 5 | 08/25/2010 | 132 | 0 | 10 | 116 | 120 | 45 | 4 | 291 | 189 | 58 | 480 |
| Livengood A5 | 5 | 08/25/2010 | 117 | 1 | 10 | 90 | 98 | 272 | 12 | 471 | 163 | 46 | 634 |
| McGrath D4 | 5 | 08/20/2010 | 56 | 0 | 8 | 24 | 68 | 9 | 2 | 109 | 27 | 12 | 136 |
| Medfra A3 | 5 | 08/20/2010 | 60 | 0 | 13 | 12 | 66 | 26 | 8 | 117 | 15 | 6 | 132 |
| Mt. McKinley D4 | 5 | 08/14/2010 | 78 | 0 | 7 | 46 | 88 | 20 | 4 | 161 | 68 | 23 | 229 |
| Nabesna D2 | 5 | 08/07/2010 | 230 | 2 | 44 | 68 | 264 | 82 | 18 | 460 | 136 | 36 | 596 |
| Talkeetna Mts. C1 | 5 | 08/06/2010 | 61 | 0 | 19 | 14 | 68 | 3 | 1 | 104 | 17 | 7 | 121 |
| Tanacross A3 | 5 | 08/07/2010 | 165 | 3 | 24 | 56 | 172 | 123 | 24 | 378 | 107 | 31 | 485 |
| Tanacross A4 | 5 | 08/05/2010 | 37 | 0 | 10 | 16 | 34 | 9 | 2 | 69 | 26 | 8 | 95 |