

## THE YUKON AND NORTHWESTERN BRITISH COLUMBIA TRUMPETER SWAN SURVEY, 2005

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### ABSTRACT

The 5<sup>th</sup> quinquennial Yukon and northern British Columbia Trumpeter Swan survey was conducted from 11-26 August, 2005. Since 1995, the survey has used a stratified random sample design with optimal allocation to make the most efficient use of aircraft flying time. A total of 68 maps (50,749 km<sup>2</sup>) from a total of 596 maps (442,121 km<sup>2</sup>) was surveyed entirely for swans, using 70.9 hours of flying time on 11 separate days. A total of 1,472 swans was sighted, including 968 adults and 504 cygnets in 143 broods. The mean brood size was 3.52 and 34.2 percent of the birds were cygnets. The total population estimated was 3,034 ( $\pm 183$  SE) swans, including 1,798 ( $\pm 173$ ) from the Rocky Mountain Population (RMP), and 1,236 ( $\pm 62$ ) from the Pacific Coast Population (PCP). An estimated 2,693 swans were in Yukon Territory and 342 in British Columbia. In this survey area, the RMP has been increasing at an annual rate of about 8.5% since 1995 and the PCP has been increasing about 10% annually. Currently, the most densely populated 1:50,000 maps are Koidern (95 swans) and Scottie Creek (69 swans) in the Klondike Plateau ecoregion of extreme western Yukon. Although it is relatively expensive and designed for a single species, this 5-year survey is worthwhile for the valuable information it provides on a high-profile species and the highly productive wetlands it needs for breeding.

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### INTRODUCTION

Trumpeter Swans in the Yukon Territory and northern British Columbia have been surveyed every 5 years beginning in 1985 as part of a continent-wide survey effort that relies on hundreds of cooperators from federal, state, and provincial agencies as well as other groups such as The Trumpeter Swan Society (Anonymous 1986, Anonymous 1994, Caithamer 1996, Caithamer 2001). The goal of the continental survey is to estimate the post-breeding size of the three wild populations of Trumpeter Swans in North America. The Yukon Territory and northwestern British Columbia have portions of both the PCP and the RMP, two of the three major populations of trumpeters in North America.

The first two widespread surveys in the Yukon Territory and northwestern British Columbia in 1985 and 1990 (McKelvey 1986, McKelvey and Hawkings 1990) either followed previously established flightlines or created new ones in areas that were known to have swans, but had not previously been included in the survey. This design did not really allow us to estimate the total swan population of the Yukon Territory, and created the continuing dilemma of how to incorporate new areas as trumpeters expand their range in the Yukon Territory. In 1995, a sampling survey was adopted, modeled to some extent after a design first implemented in Alaska in 1986 for Trumpeter Swans (Conant *et al.* 1991). It used a stratified random sampling procedure with optimal allocation (Cochran 1977) to attempt to minimize variance for a fixed "cost" (i.e. aircraft

flight time). The results of 1995 and 2000 for Yukon Territory and northwestern British Columbia surveys using this method were discussed previously (Hawkings 2000, Hawkings *et al.* 2002). The protocol involved total counts within sample units chosen at random within different density strata. Sample units were assigned to density strata according to the number of swans likely to be present in each unit, based on previous knowledge of the area. Individual 1:50,000 maps were used as sample units. The total population and variance were estimated within each density stratum and the totals were added to obtain an overall estimate for the survey area (Cochran 1977). Post-stratification estimation procedures (Thompson 1992) were used to estimate swan numbers in different geographic units that separate populations (RMP vs. PCP) and provinces (Yukon Territory vs. British Columbia). The 2005 survey used this design, with slightly modified strata definitions.

### METHODS

National Topographic Survey 1:50,000 maps were the sample units for the survey. Most of the Yukon Territory south of 65 ° North was included, as well as a large portion of northwestern British Columbia (Figure 1). All maps were stratified according to the following criteria, using former survey data (primarily the 2000 survey) as the basis:

- 0 apparently no possibility of suitable habitat (either no water or only fast-flowing streams and rivers with no floodplain wetlands and no lakes/ponds of suitable size with emergent vegetation.). Includes much of the high-elevation areas of Kluane National Park, Mackenzie Mountains, Ogilvie Mountains. This stratum was not sampled.
- 1 likely to have no swans because of very limited habitat on the map or because there was no past or recent evidence of swans in spite of suitable habitat being present. This stratum was sampled.
- 2 likely to have 1-10 swans per 1:50,000 map.
- 3 likely to have 11+ swans per 1:50,000 map.

As the cost and logistics of obtaining paper copies of all the 596 sheets were prohibitive, stratification was performed by examining each 1:50,000 map in digital form on a computer monitor.

All sampling and estimation were based on strata 1, 2, and 3 only. Following the stratification of all maps, optimal allocation calculations were performed, using the data total swans per map and total time to survey each map from the 2000 survey (Table 1). Data from the previous two surveys in 1995 and 2000 suggested that, overall, about 1 hour of flying was required to complete each survey unit. Approximately 65 hours of flying time were available for the 2005 survey, so a total sample size of 65 was used to perform the calculations. No swans were expected to occur in Stratum 1 based on all available knowledge (any maps known or strongly suspected to have swans were placed in Stratum 2), so it was impossible to include it in the optimal allocation procedures. After the sampling effort was allocated between strata 2 and 3, a sample size of ten was arbitrarily assigned to stratum 1 and sample sizes in the other two were reduced by a total of 10. The resulting numbers of samples in each stratum were then randomly chosen from the total available maps in each stratum.

The survey was conducted by a pilot (Denny Denison) and one observer (J. Hawkings) using a Maule M7 aircraft. We attempted to search all suitable habitat within each 1:50,000 map on the survey. The aircraft was flown at varying altitudes depending on wind, clouds, visibility, and terrain, but usually between 300-500 feet above the ground. A laptop computer loaded with moving map software and connected to two consumer-grade GPS units was used to navigate to and within each sampled map and record the locations of swans. The location of each group of swans (and often other wildlife) was marked

as a waypoint in the moving map software, and the details of each sighting (number of adults, cygnets, etc.) were recorded on small handheld digital voice recorder. The entire flight track was recorded on the GPS units as well as in the computer. Much of the flying time in the survey was required to ferry the aircraft between sampled maps and to and from the various bases. During this ferry time, we continued to record incidental sightings of swans and we attempted to look at any promising habitat that was enroute.

Following the survey, all waypoints and tracks were exported from the moving map software to a Geographic Information System (GIS). Details of each swan group were transcribed from the voice recorder to a Microsoft Access database and these attributes were linked to the locations in the GIS files.

Population estimates were then generated for each stratum (1, 2, 3) within each population (PCP or RMP). Estimates of precision (standard error) were generated separately for each stratum/population. These estimates were then subdivided by province using the mean values (swans per map) in each stratum of each population and estimating the total for each population/province block. Due to small sample sizes, particularly in British Columbia, I used the same estimates of precision for the province/population blocks as for the larger population blocks.

## RESULTS

Of 596 total maps in the survey area, 509 were assigned to strata 1, 2, or 3. A total of 68 of these were surveyed (Figure 2), with 10, 27, and 31 in strata 1, 2, and 3, respectively. These numbers differ slightly from those in Table 1 because, for various reasons, some maps that were chosen were not surveyed and a few that were not chosen were surveyed. The survey was conducted from 11-26 August 2005. It required 70.9 h of flying on 11 different days, an average of 6.4 h per day (Table 2).

### Sightings

Including incidental sightings, a total of 1,472 swans was seen, including 968 adults and 504 cygnets in 143 broods (Table 3). The mean brood size was 3.52, and 34.2% of the birds counted were cygnets (52.1 cygnets per 100 adults). Swans were sighted on 52 of the 68 maps surveyed, as well as on another 71 maps which were not officially surveyed. The distribution of sightings is shown in Figure 2.

## Population estimates

A total of 960 swans, including 635 adults and 325 cygnets in 92 broods, was sighted on the maps which were officially surveyed in 2005 (Table 4). The resulting population estimates for Yukon Territory and northwestern British Columbia totaled  $3,034 \pm 183$ (SE) swans including  $1,798 \pm 173$  in the range of the RMP and  $1,236 \pm 62$ (SE) in the range of the PCP (Table 5). Estimates of the proportion of cygnets range from 33.3% for RMP to 29.9% for the PCP.

When compared with estimates from earlier surveys, the 2005 estimates (Table 6, Figure 3a,b) indicated that there was continuing growth in both the PCP and the RMP in this region. Since the Yukon Territory survey was redesigned in 1995, the PCP has increased at an annual rate of about 10% and the RMP at about 8.5%. These are quite similar to corresponding recent (2000-2005) growth rates in the Alaska portion of the PCP (6.5%) and the Canadian-breeding portion of the RMP (7.9%). It is difficult to assess population changes in the part of northwestern British Columbia that is covered by this survey because of the small numbers of maps that are surveyed there, and the low density of swans. This is compounded by the fact that there is little overlap in maps surveyed in successive surveys because of the random sample design.

If we look at the number of swans counted on individual maps that were surveyed in both 2005 and 2000 (Table 7), there appears to be a fairly large and consistent increase in the PCP (together, six maps had a total increase of 121% in 5 years, and an annual increase of 17%). There was a much more modest and more inconsistent increase within the RMP range, where only 5 of 13 maps increased (the total increase was 7% in 5 years and the annual rate of increase was less than 1%) and some decreased substantially.

## Distribution

The 2005 distribution of Trumpeter Swans shows two relatively distinct groups corresponding to the ranges of the RMP and PCP. Relative to Ecoregions which have been described for the Yukon Territory and northwestern British Columbia (Figure 2) the RMP birds are in the Liard Basin, Hyland Highland, Selwyn Mountains and Yukon Plateau North and PCP swans are in the Klondike Plateau, Ruby Ranges, Yukon Stikine Highlands, and Yukon Southern Lakes. Swans in the Yukon Plateau-Central are likely from the PCP, although those in the

northern portion may be affiliated with the RMP. Swans in the Nisutlin River area in the eastern portion of the Yukon Southern Lakes are thought to be associated with the RMP. Swans are most abundant in the Ruby Ranges, Yukon Plateau-North, Liard Basin, Yukon Southern Lakes, and Klondike Plateau (Table 7). Pickhandle Lakes along the Koidern River had the most swans (95) of any map in 2005, followed by Scottie Creek and two maps along the Nisutlin River. Of the ten maps having the largest numbers of swans (Table 9), eight were in the PCP range, and two in the RMP range.

## DISCUSSION

There appears to still be substantial unoccupied habitat in the Yukon Territory and northwestern British Columbia that is suitable for breeding. Swans seem to be moving into many of the major river floodplains that were formerly only sparsely occupied, for example the MacMillan, Stewart, and Donjek rivers. There has also been a major population increase in the wetland-rich areas of the Klondike Plateau, such as Scottie Creek. It is very difficult to predict how many Trumpeter Swans can coexist in any area. A case in point is the Pickhandle Lakes area, which in 2005 had double the number seen in any previous survey, even though it appeared well-occupied on those surveys.

The stratified random sample survey technique used since 1995 in this survey was intended to allow estimation of the total population in the area and track changes in distribution. It has done a good job of that, but the random sample design does limit the sample of individual maps which is repeatedly surveyed. This also makes it difficult to say in some cases exactly how populations have changed in various subareas, for example ecoregions or individual river floodplains. Fortunately, it will be possible to address this question for some areas by looking at incidental sightings and the archived aircraft flight tracks over the course of 10 or 15 years (two or three surveys).

Trumpeter Swans appear to be moving into the Old Crow Flats, Fort McPherson Plain, and Peel River Plateau Ecoregions of the northern Yukon Territory. There have been multiple observations of trumpeters, including confirmed breeding, in the Peel River Plateau since 1999 (Eckert *et al.* 2003). There have also been recent reports of likely trumpeters from the Old Crow Flats. These areas are all rich in wetlands, but have not been included in the 5-year survey to date. If the North American survey is to be continued in 2010 and beyond, these areas should be considered

for formal coverage. However, likely overlap with breeding Tundra Swans in these areas is going to make future aerial survey efforts challenging.

This Yukon Territory and northern British Columbia Trumpeter Swan Survey is relatively expensive and designed to count a single species only. However, the trumpeter is a species that is very high-profile, especially in the Yukon Territory. It is a conservation success story – something all too rare in this day and age. It also requires breeding areas that are rich in emergent and submergent aquatic vegetation – generally healthy, highly productive wetlands that have diverse flora and fauna. Thus, the survey results can be used as one indicator of the most productive wetlands in Yukon and northern British Columbia. For these reasons, it is worthwhile to continue this survey every 5 years as part of the North American-wide survey.

#### ACKNOWLEDGMENTS

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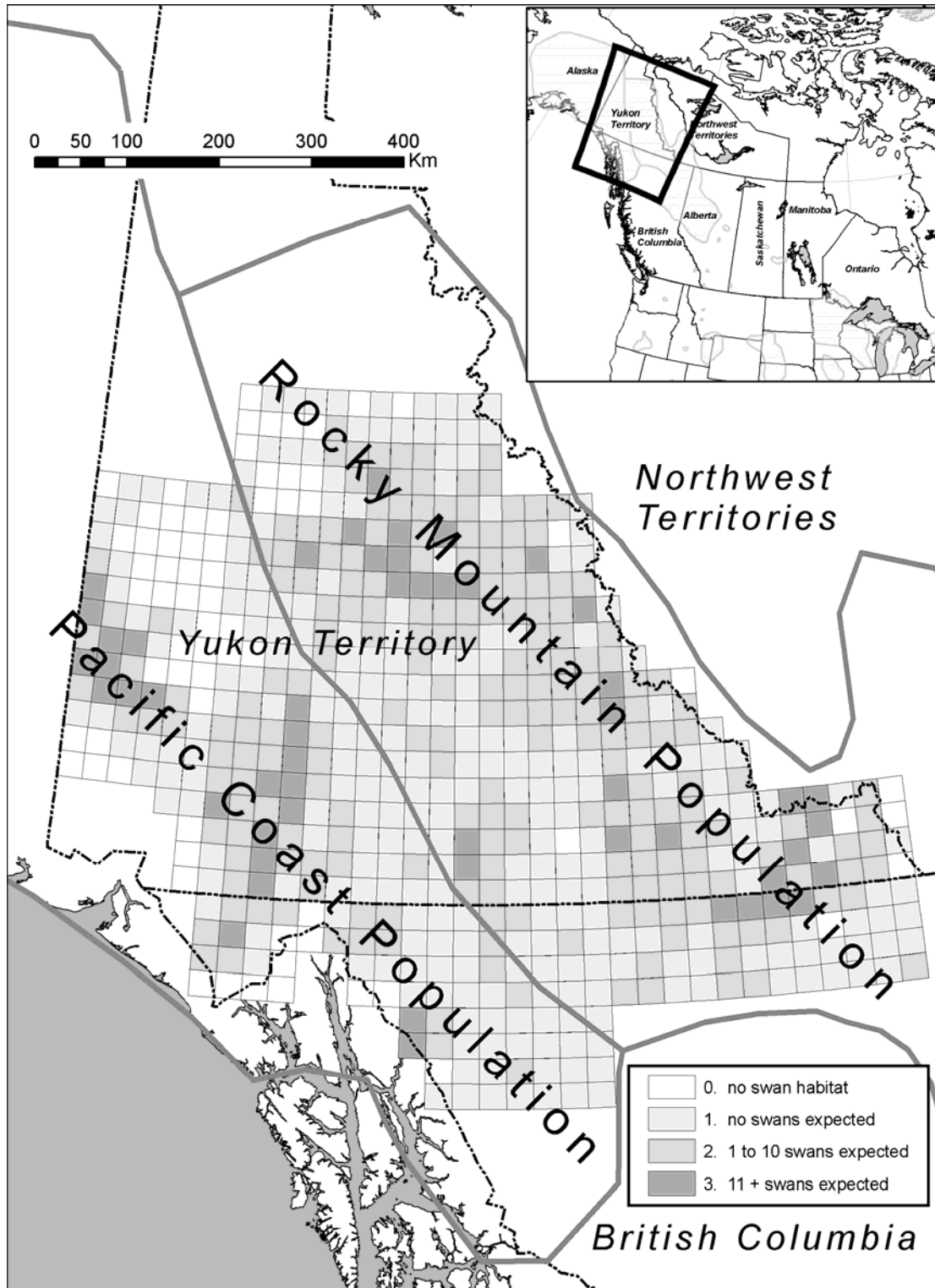


Figure 1. Location of the Yukon and northwestern British Columbia Trumpeter Swan Survey area and distribution of individual maps in four survey strata used for the 2005 survey. Heavy gray lines (and shaded areas of western Canada and Alaska in inset map) indicate the approximate range of the Pacific Coast Population and the Rocky Mountain Population of Trumpeter Swans.

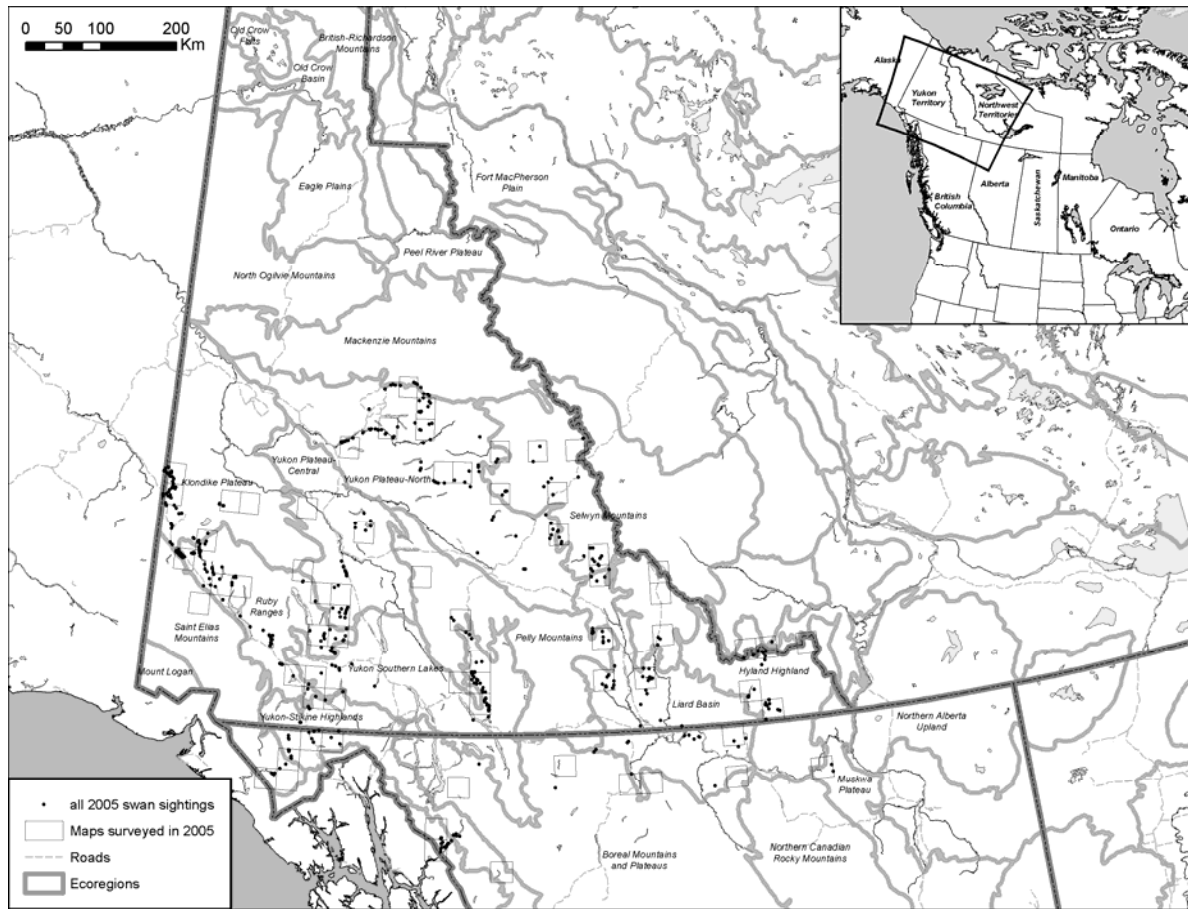


Figure 2. Locations of all swan sightings (including incidental sightings) and 68 individual maps surveyed during the 2005 Yukon and northwestern British Columbia Trumpeter Swan survey.

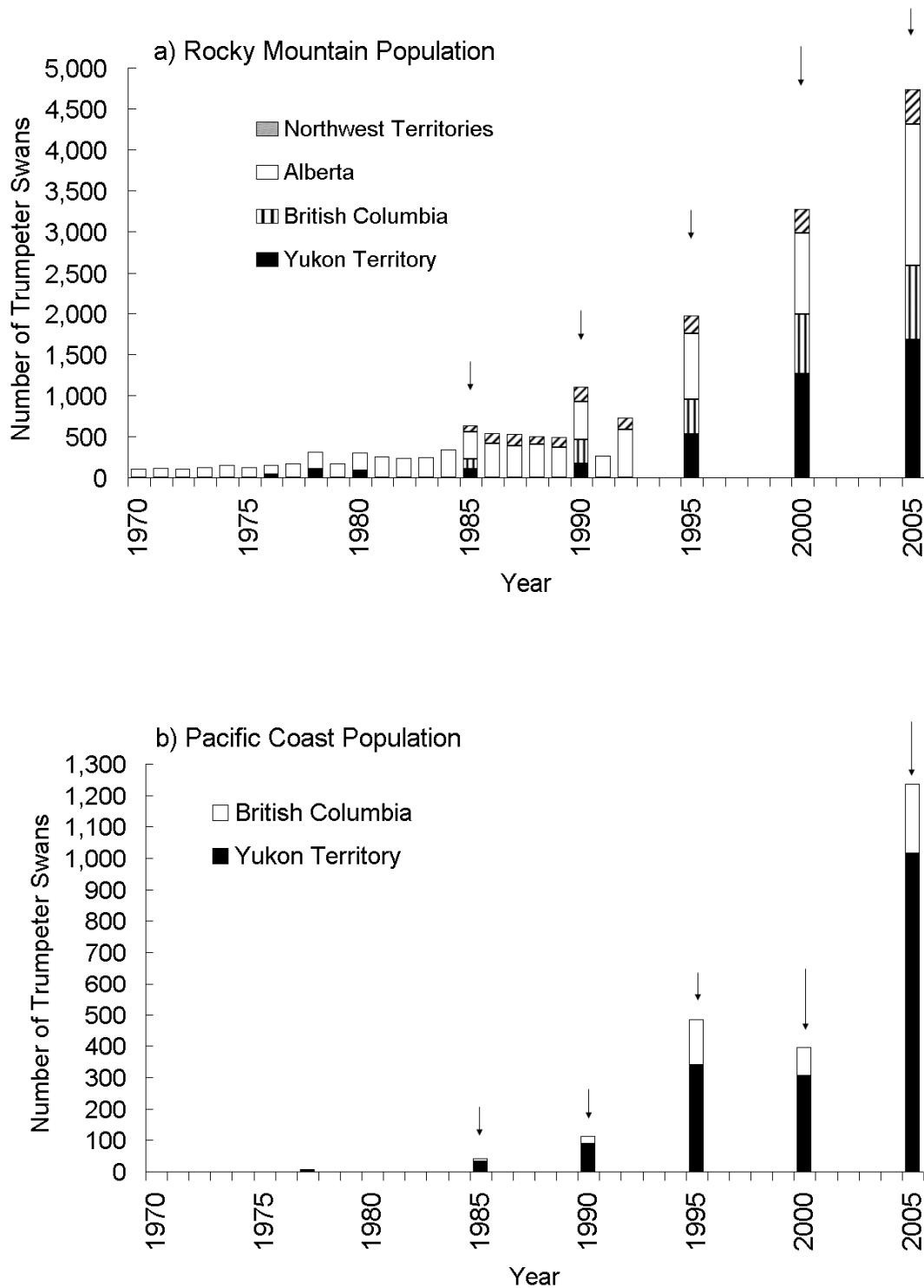


Figure 3. Results of breeding season surveys of (a) the Rocky Mountain Population and (b) the Pacific Coast Population of Trumpeter Swans in British Columbia and Yukon Territory, 1970-2005. Arrows indicate years with comprehensive, range-wide surveys in North America (1985, 1990, 1995, 2000, 2005). Note: (a) includes data gathered from portions of British Columbia outside the survey area covered by this report, as well as from Alberta and Northwest Territories.



Table 1. Data used to determine optimal allocation of sampling effort in the 2005 Yukon and northwestern British Columbia Trumpeter Swan survey.

Parameter	2005 Stratum Number				Total
	0	1	2	3	
Mean swans per sample unit from 2000 survey		0	3.14	19.5	
Standard Deviation (total swans) ( $S_{dh}$ )			2.0	9.38	
Mean Time to Survey 1 Unit (minutes) ( $C_h$ )	13.5	22.55	23.62	33.63	
Number of sample units in Stratum in 2005 ( $N_h$ )	70	263	211	52	596
Number of units sampled in 2000	2	11	14	20	47
(A)square root of $C_h$	3.67	4.75	4.86	5.80	
(B) $N_h * S_{dh}$	0	0	420.84	487.95	
<b>B/A</b>	0.000	0.000	86.60	84.14	170.74
proportion of total samples ( $f_h$ )	0.00	0.00	0.51	0.49	
total allowable samples (approx)					65
desired number of samples in 2005 (n)	0	0	33	32	65
modified target numbers for 2005	0	10	28	27	65
estimated total time (minutes)	0	225.45	661.23	908.05	1794.74
estimated total time (hours)	0	3.76	11.02	15.13	29.91

Table 2. Details of aerial survey flights conducted during the 2005 Yukon and northwestern British Columbia Trumpeter Swan Survey.

Date	Start Time	End Time	Flight Time	Base	General Itinerary	Maps Surveyed
11-Aug	8:30	14:00	5.3	Whitehorse	Whitehorse, Nisling R, Mackintosh Ck, Tahte Ck, Nordenskiold R, Satasha L, Kirkland Ck, Sakata L, Whitehorse	115H/14, 115H/10, 115H/09, 115H/08
11-Aug	15:00	21:00	4.6	Whitehorse	Whitehorse, O'Connor R, Tatshenshini R to Ninetyeighter Ck to O'Connor R to Pirate Ck to Goldrun Ck, Kelsall L, Blanchard L, Blanchard R, Kusawa R, Duff L, Hendon R, Kusawa L, Frederick L, Frederick Ck, Howard L, Dezadeash L, Kluhini R, Frederick L, Kusawa L, Primrose R, Fish L, Whitehorse	114P/05, 114P/06, 114P11, 114P/15, 114P/16, 115A/07, 115A/08
12-Aug	8:05	14:25	5.6	Whitehorse	Whitehorse, North Big Salmon R, Quiet L, Nisutlin R, Teslin, Nisutlin R, Johnson's Crossing, Whitehorse	105E/16, 105F/06, 105C/15, 105C/10, 105C/07, 105C/11
14-Aug	10:20	17:10	7.1	Whitehorse	Whitehorse, Teslin, Gladys L, Trout L, Gladys R, O'Donnel R, Dixie L, Nakina R, Taku R, Tusequah, Flanigan Slough, King Salmon Ck, King Salmon L, Tatsatua L, Tatsameni L, Sheslay R, Nahlin R, Gun L, Sheephorn Ck, Jennings R, Little Rancheria R, Cormier Ck, Watson L	104N/06, 104K/13, 104K/12, 104K/08, 104O/10
15-Aug	08:20	14:35	5.7	Watson Lake	Watson L, Dendale L, La Biche R headwaters, Meilleur R, Spruce L, Balsam L, Caribou R, Beaver R, Toobally Lakes, Crow R, Larsen L, Thorpe Ck, Crooked L, Smith R, Hutchison Ck, Rogers Lakes, Shaw Ck, Barney L, Blind L, Watson L	095C/15, 095C/13, 095D/16, 095D08, 095C/04, 094M/15
16-Aug	07:50	13:45	6.7	Watson Lake	Watson L, Egnell Lakes, Hillgren Lakes, Grayling R, Torpid Ck, Irene L, Toad R, Liard R., Aline L, Nordquist L., Liard R, Fishing L, Fishing Ck, Graveyard L, Boya Ck, Kechika R, Birches L, Twin Island L, Aeroplane L, Deadwood R, Looncry L, Dease R, Good, Hope Lake, Dease R, Boya L, Dease R, Masidoor Ck, Porter Lakes, Upper Liard, Watson L.	094N/07, 094M/07, 104P/07, 104P/06
17-Aug	08:45	17:33	7.4	Watson Lake	Watson L, Little Tom L, Tom L, Stewart L, Hyland R, Oscar L, Sambo Ck, Airplane L, Liard R, Allan Ck, Twin Lakes, Sambo Ck, Tudhitua R, Frances L, Dolly Varden Ck, Hyland R, Lower Hyland L, Little Hyland R, Upper Hyland L, Yusezyu R, Woodside R, Narchilla Brook, Yusezyu R, McPherson L, Ptarmigan Ck, McEvoy L, Olgie L, Faro	105A/10, 105A/12, 105H/04, 105H/01, 105H/09, 105H/16, 105I/04, 105H/13
18-Aug	07:55	13:35	4.2	Faro	Faro, Blink Ck, Blind Lakes, Tay L, Radar L, Otter Ck, Prevost R, Lewis L, Field L, Sheldon L, South MacMillan R, Hess R, Keele Peak, Hess R, Nidderly L, Emerald Ck, Fido Ck, Swan L, Hess R, North Macmillan R, Faro	105J/07, 105J/15, 105O/08, 105O/06
19-Aug	08:05	15:35	7	Faro	Faro, Blind Ck, Tay R, Laforce L, Riddell R, South Macmillan R, North Macmillan R, Fairweather L, Hess R, Fairweather L, North Macmillan R, South Macmillan R, Macmillan R, Mist L, Stewart R, South Nelson Ck, Nelson Ck, Edwards Ck, Edwards L, Tiny Island L, Roop Ck, Keno Ladue R, Stewart R, Beaver R, Scougale Lakes, Clark Lakes, McQuesten L, South McQuesten R, Halfway Lakes, Mayo	105K/16, 105N/08, 105N/03, 105N/04, 105M/09, 105M/16, 105D/02

Table 2. Details of aerial survey flights conducted during the 2005 Yukon and northwestern British Columbia Trumpeter Swan Survey.

Date	Start Time	End Time	Flight Time	Base	General Itinerary	Maps Surveyed
20-Aug	09:30	16:55	6.6	Mayo	Mayo, Stewart R, Janet L, Williamson L, Watson Ck, Stewart R, Ethel L, Crooked Ck, Tatlmain L, Tadru L, Ess L, Kelly L, Tatlmain Ck, Yukon R, Minto, Ingersoll Islands, Dip Ck, Klotassin R, Donjek R, Mackinnon Ck, Donjek R, Kluane R, Tincup L	105M/11, 115P/08, 105L/05, 115I/11, 115J/10, 115J/11, 115J/04
21-Aug	09:55	19:05	7.7	Tincup Lake	Tincup L, Kluane R, Donjek R, Fish Hole Lake, Snag Ck, Scottie Ck, Beaver Ck, Enger Lakes, Dry Ck, White R, Koidern R, Pickhandle Lakes, Wolf Ck, Wolf Lake, Donjek R, Tincup Lake, Donjek R, Steele Ck, Donjek R, Burwash L, Brooks Arm, Brooks Ck, Serpenthed L, Talbot Arm, Kluane L, Cultus Ck, Big Joe L, Jarvis R, Klool, Dezadeash R, Kathleen R, Rainbow L, Kathleen L, Dezadeash L, Six Mile L, Dezadeash R, Champagne, Mendenhall R, Takhini R, Whitehorse.	115K/15, 115K10, 115F/16, 115G/05, 115G/11, 115G/10, 115A/11/115A/10
26-Aug	07:40	10:40	3	Whitehorse	Whitehorse, Taye L, Mendenhall R, Munntiger L, Quamie L, Canyon L, Giltana L, Aishihik L, Hutshi L, Sceptre L, Mendenhall R, Hutshi Lakes, Nordenskiold R, Little R, Takhini R, Whitehorse	115H/02, 115H/01

Table 3. Summary of Trumpeter Swan sightings from the 2005 Yukon and northwestern British Columbia Trumpeter Swan survey. Includes incidental sightings on maps not officially counted in the survey.

Population	Province	No. of Pairs	Adults in Pairs	Single Adults	Flocked Adults	Cygnets	Broods	Adults	Total Swans	Percent Cygnets	Cygnets per 100 Adults	Mean Brood Size
Pacific Coast Population	Yukon	143.0	286	24	130	218	57	440	658	33.1	49.5	3.82
	BC	36.0	72	1	6	51	15	79	130	39.2	64.6	3.40
	<b>PCP Total</b>	<b>179.0</b>	<b>358</b>	<b>25</b>	<b>136</b>	<b>269</b>	<b>72</b>	<b>519</b>	<b>788</b>	<b>34.1</b>	<b>51.8</b>	<b>3.74</b>
Rocky Mountain Population	Yukon	176.5	353	29	31	216	65	413	629	34.3	52.3	3.32
	BC	15.5	31	0	5	19	6	36	55	34.5	52.8	3.17
	<b>RMP Total</b>	<b>192.0</b>	<b>384</b>	<b>29</b>	<b>36</b>	<b>235</b>	<b>71</b>	<b>449</b>	<b>684</b>	<b>34.4</b>	<b>52.3</b>	<b>3.31</b>
Entire Yukon and Northwestern BC	Yukon	319.5	639	53	161	434	122	853	1,287	33.7	50.9	3.56
	BC	51.5	103	1	11	70	21	115	185	37.8	60.9	3.33
	<b>Total</b>	<b>371.0</b>	<b>742</b>	<b>54</b>	<b>172</b>	<b>504</b>	<b>143</b>	<b>968</b>	<b>1,472</b>	<b>34.2</b>	<b>52.1</b>	<b>3.52</b>

Table 4. Sample sizes, swans counted, and estimated means and variances (in brackets) per map by Stratum, Population, and Province for the 2005 Yukon and northwestern British Columbia Trumpeter Swan Survey. Means and totals are calculated from counts in each Stratum/Population/Province, but variances are those from Stratum/Populations only.

Strat	Prov	Pop	n <sup>1</sup>	N <sup>2</sup>	Numbers of Swans Counted							Estimated Means per Sample Unit (Map)										
					Pairs	Adults in Flocks	Lone Adults	Cygnets	Broods	Paired Adults	Total Adults	Total Swans	No. of Pairs	Adults in Flocks	Lone Adults	Cygnets	Broods	Adults in Pairs	Total Adults	Total Swans		
0	BC	PCP	0	11																		
0	YK	PCP	0	37																		
0	BC	RMP	0	1																		
0	YK	RMP	0	21																		
1	BC	PCP	2	44	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
													0.67									
1	BC	RMP	3	38	2	0	0	0	0	4	4	4	(0.048)	0.00	0.00	0.00	0.00	0.00	(0.048)	(0.193)	(0.193)	
1	YK	PCP	3	65	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
													0.00									
1	YK	RMP	2	116	0	0	0	0	0	0	0	0	(0.048)	0.00	0.00	0.00	0.00	0.00	(0.048)	(0.193)	(0.193)	
													2.75	1.50	0.00	3.00	1.00	5.50	7.00	10.00		
2	BC	PCP	4	17	11	6	0	12	4	22	28	40	(0.056)	(0.068)	(0.002)	(0.215)	(0.016)	(0.223)	(0.438)	(1.144)		
													0.50	0.00	0.00	1.50	0.50	1.00	1.00	2.50		
2	BC	RMP	2	20	1	0	0	3	1	2	2	5	(0.160)	(0.043)	(0.009)	(0.216)	(0.023)	(0.639)	(0.725)	(1.406)		
													1.89	2.78	0.33	2.56	0.67	3.78	6.89	9.44		
2	YK	PCP	9	40	17	25	3	23	6	34	62	85	(0.056)	(0.068)	(0.002)	(0.215)	(0.016)	(0.223)	(0.438)	(1.144)		
													2.58	0.42	0.33	2.67	0.83	5.17	5.92	8.58		
2	YK	RMP	12	134	31	5	4	32	10	62	71	103	(0.160)	(0.043)	(0.009)	(0.216)	(0.023)	(0.639)	(0.725)	(1.406)		
													4.67	0.00	0.33	7.33	2.00	9.33	9.67	17.00		
3	BC	PCP	3	3	14	0	1	22	6	28	29	51	(0.195)	(0.360)	(0.013)	(0.463)	(0.028)	(0.779)	(2.282)	(4.397)		
													1.00	0.00	0.00	3.00	1.00	2.00	2.00	5.00		
3	BC	RMP	1	4	1	0	0	3	1	2	2	5	(0.097)	(0.012)	(0.007)	(0.484)	(0.033)	(0.387)	(0.419)	(1.551)		
													7.72	6.56	1.33	10.22	2.67	15.44	23.3	33.56		
3	YK	PCP	9	19	69.5	59	12	92	24	139	210	302	(0.195)	(0.360)	(0.013)	(0.463)	(0.028)	(0.779)	(2.282)	(4.397)		
													5.64	0.44	0.89	7.67	2.22	11.28	12.6	20.28		
3	YK	RMP	18	26	101.5	8	16	138	40	203	227	365	(0.097)	(0.012)	(0.007)	(0.484)	(0.033)	(0.387)	(0.419)	(1.551)		
Totals			68	596	248	103	36	325	92	496	635	960										

<sup>1</sup> number of maps sampled in stratum

<sup>2</sup> total number of maps in stratum

Table 5. Trumpeter Swan population estimates and Standard Errors (SE) for the Yukon Territory and northwestern British Columbia based on the 2005 Trumpeter Swan survey. Totals are calculated from Population/Province data in 3 density strata, but SE is calculated from population data (not by Province) in 3 density strata.

Population	Province	N*	n*	Total Stratum Area (km <sup>2</sup> )	Total Surveyed Area (km <sup>2</sup> )	No. of Pairs	Adults in Pairs	Single Adults	Fledged Adults	Cygnets	Broods	Total Adults	Total Swans	Percent Cygnets	Cygnets per 100 Adults	Mean Brood Size
						Total SE	Total SE	Total SE	Total SE	Total SE	Total SE	Total SE	Total SE			
Pacific Coast Population	Yukon	161	21	118,325	15,504	222 <i>12.6</i>	445 <i>25</i>	39 <i>3</i>	236 <i>15</i>	296 <i>23</i>	77 <i>6</i>	719 <i>39</i>	1,015 <i>58</i>	29.2	41.2	3.83
	BC	75	9	59,831	7,148	61 <i>4</i>	121 <i>8</i>	1 <i>1</i>	25 <i>5</i>	73 <i>8</i>	23 <i>2</i>	148 <i>12</i>	221 <i>19</i>	33.0	49.3	3.17
	<b>PCP Total</b>	<b>236</b>	<b>30</b>	<b>178,156</b>	<b>22,652</b>	<b>283</b> <i>13</i>	<b>566</b> <i>27</i>	<b>40</b> <i>3</i>	<b>261</b> <i>16</i>	<b>369</b> <i>24</i>	<b>100</b> <i>6</i>	<b>867</b> <i>41</i>	<b>1,236</b> <i>62</i>	<b>29.9</b>	<b>42.6</b>	<b>3.68</b>
	<b>Total</b>															
Rocky Mountain Population	Yukon	297	32	214,285	23,366	493 <i>60</i>	986 <i>111</i>	68 <i>13</i>	67 <i>28</i>	557 <i>65</i>	169 <i>21</i>	1,121 <i>126</i>	1,677 <i>170</i>	33.2	49.7	3.29
	BC	63	6	49,681	4,732	39 <i>12</i>	79 <i>18</i>	0 <i>2</i>	0 <i>4</i>	42 <i>10</i>	14 <i>3</i>	79 <i>24</i>	121 <i>29</i>	34.8	53.4	3.00
	<b>RMP Total</b>	<b>360</b>	<b>38</b>	<b>263,965</b>	<b>28,098</b>	<b>532</b> <i>61</i>	<b>1,064</b> <i>113</i>	<b>68</b> <i>13</i>	<b>67</b> <i>28</i>	<b>599</b> <i>66</i>	<b>183</b> <i>21</i>	<b>1,199</b> <i>128</i>	<b>1,798</b> <i>173</i>	<b>33.3</b>	<b>49.9</b>	<b>3.26</b>
	<b>Total</b>															
Entire Yukon and Northwest BC	Yukon	458	53	332,609	38,869	715 <i>61</i>	1,430 <i>114</i>	106 <i>77</i>	303 <i>32</i>	853 <i>69</i>	247 <i>22</i>	1840 <i>132</i>	2,693 <i>180</i>	31.7	46.4	3.46
	BC	138	15	109,512	11,880	100 <i>12</i>	200 <i>20</i>	1 <i>2</i>	25 <i>6</i>	115 <i>13</i>	37 <i>4</i>	227 <i>27</i>	342 <i>35</i>	33.7	50.7	3.11
	<b>Total</b>	<b>596</b>	<b>68</b>	<b>442,121</b>	<b>50,749</b>	<b>815</b> <i>62.4</i>	<b>1,630</b> <i>116</i>	<b>107</b> <i>13</i>	<b>328</b> <i>32</i>	<b>968</b> <i>70</i>	<b>283</b> <i>22</i>	<b>2,066</b> <i>135</i>	<b>3,034</b> <i>183</i>	<b>31.9</b>	<b>46.9</b>	<b>3.41</b>
	<b>Total</b>															

\* N=number of 1:50,000 map sheets in stratum, n=number of map sheets surveyed in stratum.

<sup>a</sup> some totals do not add correctly because component estimates in decimals were added together, yet components are reported in this table in whole numbers.

Table 6. Historical population estimates for the Pacific Coast Population and the Rocky Mountain Population segments within the Yukon and northwestern British Columbia survey area.

Pop	Year	Number of White Swans						Cygnets	Total Swans	No. of Broods	Average Brood Size	Percent Juvenile	Percent Pairs with Broods
		In Pairs		As Singles		In Flocks	Number of flocks						
		With cygnets	Without cygnets	Without cygnets	With cygnets								
PCP	1985	2	6	3	1	23	4	6	41	2	3.00	14.6	25.0
	1990	24	24	8	0	19	4	44	119	12	3.67	37.0	50.0
	1995	86	100	16	1	99	n/a	190	492	44	4.32	38.6	46.2
	2000	54	120	20	1	95	n/a	106	396	28	3.79	26.8	31.0
	2005	196	368	40	2	261	n/a	369	1236	100	3.69	29.9	34.8
RMP	1985	14	62	16	0	4	1	16	112	7	2.29	14.3	18.4
	1990	30	66	14	1	40	n/a	44	195	16	2.75	22.6	31.3
	1995	124	268	34	0	67	n/a	273	766	62	4.40	35.6	31.6
	2000	310	314	55	8	369	n/a	469	1525	163	2.88	30.8	49.7
	2005	364	700	67	1	67	n/a	599	1798	183	3.27	33.3	34.2

Table 7. Total swans counted on maps officially surveyed in both 2000 and 2005.

		Total Swans		
Population	Map	2000	2005	Change %
PCP	114P/06	2	0	-
	114P/11	7	31	+342
	115F/16	33	95	+188
	115H/01	9	20	+122
	115H/08	33	40	+21
	115I/11	0	0	0
PCP Total		84	186	+121
RMP	095C/04	35	26	-26
	095C/13	16	19	+19
	095D/08	15	10	-30
	105A/10	25	23	-8
	105C/07	23	47	+104
	105C/10	22	59	+164
	105H/04	34	21	-38
	105H/13	8	10	+25
	105I/04	27	16	-41
	105M/09	17	17	0
	105N/04	11	13	+36
	105O/06	11	4	-63
	106D/02	10	7	-30
RMP Total		254	272	+7
Grand Total		338	458	+35

Table 8. Distribution of Trumpeter Swans by Ecoregion as determined from all sightings during the 1990, 1995, 2000, and 2005 Yukon and northwestern British Columbia surveys.

Ecoregion		Year			
Number	Name	1990	1995	2000 <sup>a</sup>	2005
62	Sibbeston Lake Plain				2
66	Muskwa Plateau				4
170	Mackenzie Mountains			17	14
171	Selwynn Mountains	38	46	55	90
172	Klondike Plateau	43	73	45	154
173	St.Elias Mountains		15	12	19
174	Ruby Ranges	29	98	166	379
175	Yukon Plateau-Central		15	125	112
176	Yukon Plateau-North	20	57	117	211
177	Yukon Southern Lakes	11	53	114	151
178	Pelly Mountains	9	11	23	19
179	Yukon-Stikine Highlands		17	32	87
180	Boreal Mountains and Plateaus		1	5	4
181	Liard Basin	54	41	110	130
182	Hyland Highland	67	71	80	64
185	Northern Coastal Mountains			56	32
Total		271	498	957	1,472

<sup>a</sup>includes 93 swans sighted during other surveys which were not part of the official Trumpeter Swan Survey. These additional sightings were primarily in ecoregions 174, 175, 177.

Table 9. Forty most densely populated 1:50,000 maps encountered during the 2005 Yukon and northwestern British Columbia Trumpeter Swan survey. Includes incidental sightings.

Map ID	Map Name	Prov	Population	Broods	Cygnets	Total Pairs	Single Adults	Flocked Adults	Total Adults	Total Swans
115F/16	KOIDERN	YK	PCP	7	29	22	4	18	66	95
115K/10	SCOTTIE CREEK	YK	PCP	4	16	12.5	4	24	53	69
105C/10	THIRTYMILE CREEK	YK	RMP	8	27	16	0	0	32	59
115G/13	TOM MURRAY CREEK	YK	PCP	7	28	11	0	0	22	50
105C/07	LONE TREE CREEK	YK	RMP	6	25	10	2	0	22	47
115H/08	VOWEL MOUNTAIN	YK	PCP	5	18	9	1	3	22	40
115J/04	MACKINNON CREEK	YK	PCP	4	15	8	0	6	22	37
115H/04	MCKINLEY CREEK	YK	PCP	3	14	5	0	13	23	37
115H/16	MOUNT MORRISON	YK	PCP	5	17	6	0	5	17	34
115K/15	WIENERWURST MOUNTAIN	YK	PCP	1	5	9	2	6	26	31
114P/11	CARMINE MOUNTAIN	BC	PCP	4	16	7	1	0	15	31
105M/11	WILLIAMSON LAKE	YK	RMP	4	17	6	0	0	12	29
105A/12	SAMBO CREEK	YK	RMP	3	11	8	0	0	16	27
095C/04	LARSEN LAKE	YK	RMP	2	8	8	2	0	18	26
115H/02	HUTSHI LAKES	YK	PCP	3	13	6	0	0	12	25
105J/07		YK	RMP	3	9	8	0	0	16	25
114P/15	PARTON RIVER	BC	PCP	3	10	5	0	3	13	23
105A/10	STEWART LAKE	YK	RMP	3	8	7	1	0	15	23
105H/04		YK	RMP	1	1	7	2	4	20	21
115H/01	MOUNT COOPER	YK	PCP	2	6	5	0	4	14	20
094M/13	EGNELL LAKES	BC	RMP	2	8	3.5	0	5	12	20
115A/13	KLOO LAKE	YK	PCP	3	10	4.5	1	0	10	20
115G/10	SERPENTHEAD LAKE	YK	PCP	1	3	4	1	8	17	20
115A/16	CHAMPAGNE	YK	PCP	1	5	7	0	0	14	19
095C/13	BALSAM LAKE	YK	RMP	2	7	6	0	0	12	19
105M/16	TINY ISLAND LAKE	YK	RMP	1	3	7	1	0	15	18
105N/03	MOUNT ARMSTRONG	YK	RMP	3	11	3	0	0	6	17
105M/09	EDWARDS LAKE	YK	RMP	2	7	5	0	0	10	17
115P/08	ETHEL LAKE	YK	RMP	1	3	3.5	2	4	13	16
104K/12	TULSEQUAH RIVER	BC	PCP	2	6	5	0	0	10	16
105I/04	MOUNT PIKE	YK	RMP	1	4	5	2	0	12	16
114P/14	SURVEY LAKE	BC	PCP	2	7	3	0	0	6	13
105C/02	TESLIN	YK	PCP	0	0	1	0	11	13	13
105C/15		YK	RMP	2	5	4	0	0	8	13
105H/01	LOWER HYLAND LAKE	YK	RMP	2	7	3	0	0	6	13
105M/12	MAYO	YK	RMP	3	5	4	0	0	8	13
105N/04	PLATEAU MOUNTAIN	YK	RMP	2	4	4	1	0	9	13
115K/07	ENGER CREEK	YK	PCP	1	2	5	0	0	10	12
104K/11	STUHINI CREEK	BC	PCP	2	6	3	0	0	6	12
104K/14	INKLIN	BC	PCP	1	4	4	0	0	8	12