



An Investigation of Migrant Shorebird Use of the Peace-Athabasca Delta, Alberta in 1999*

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INTRODUCTION

Many shorebird species annually migrate long distances between breeding and wintering areas and are capable of non-stop flights of several thousand kilometres, fuelled by fat (energy) reserves (Mercier, 1985; Gudmundsson *et al.*, 1991 and Harrington *et al.*, 1991). Large concentrations of migrant shorebirds have been observed using a series of lakes throughout the continent's interior where they rest and replenish their fat reserves. These sites are critical to shorebirds for the completion of their annual migration (Harrington and Perry, 1995; Morrison *et al.*, 1995). The sites in prairie Canada have been well documented. However, there is little information available on wetland use by migrant shorebirds in the boreal forest region.

Migration routes of a number of western and central arctic nesting shorebirds including species such as Semipalmated Sandpiper, Sanderling, Baird's Sandpiper, Stilt Sandpiper, Least Sandpiper, Pectoral Sandpiper, White-rumped Sandpiper, Black-bellied Plover and Red-necked Phalarope (Appendix 1) take them over the Peace-Athabasca Delta (PAD), located within Wood Buffalo National Park and the Chipewyan I.R. 201 in northeastern Alberta. The PAD, covering 3,820 square kilometres, is a flood based ecosystem that requires periodic flooding to re-supply nutrients and water. It consists of a complex of variable sized lakes, perched basins and tributaries which may provide suitable habitat for migrating shorebirds. During the past decade, Dr. L. Carbyn observed large numbers of shorebirds (e.g. thousands) in the delta. Other studies

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(Soper, 1942; Hohn, 1971; Hennan, 1972a; Kuyt and Johnson, 1975; Wayland and Arnold, 1992; 1993) have provided anecdotal accounts of shorebirds but numbers reported were generally small (e.g. hundreds or less).

Recent flooding of the PAD caused by ice dams in 1996 and 1997 resulted in the flooding of a number of perched basins and expansion of the water surface area of some of the larger lakes (e.g. Mamawi and Claire Lakes). A recent technical report (Peace-Athabasca Delta Technical Studies, 1996) indicates standing water is unlikely to remain in perched basins for more than five to seven years following a flood event without an exceptional series of years with large snowfall, summer precipitation or both. If recharging does not occur, then the natural process of water level draw-down will provide areas of open shoreline or shallow water basins that may be suitable habitat for migrating, arctic nesting shorebirds. It was expected that the recent flooding and water level draw-down processes would provide suitable conditions for shorebird use this year. Studies in the mid-continental United States have shown that shorebirds use available habitat opportunistically (Skagen and Knopf, 1993; 1994), thus the changing conditions on the delta should provide suitable habitat for shorebird use.

These surveys were directed at gathering baseline information on a guild of water birds that do appear to use the delta but have never been the focus of previous studies. This study is a pilot project directed towards addressing the following questions:

- 1) Does the Peace-Athabasca Delta ecosystem provide suitable habitat for migrant, arctic nesting shorebirds and is it used by these shorebirds for resting and feeding during their spring and fall migration?
- 2) If migrant shorebirds use the delta: what is the species composition, in what abundance, during which migration period(s) and in what specific areas or habitats?
- 3) Would shorebird numbers and species involved warrant that the Peace-Athabasca Delta be proposed as a Western Hemisphere Shorebird Reserve Network (WHSRN) site?

METHODS

General survey timing and coverage

Fixed-wing aerial survey was the primary technique to survey shorebirds in the delta. Based on results of shorebird monitoring studies on the prairies, surveys were timed to coincide with the expected peak periods of spring and fall migration. The spring surveys overlapped with the greatest number of individuals among a variety of species while the fall surveys attempted to cover two peaks: adults in late July and juveniles in mid-August. The survey area (Figure 1) included all lakes and basins within the PAD (Wood Buffalo National Park and Chipewyan IR 201) that had suitable habitat identified through literature review and consultations with researchers, Parks Canada staff and local residents (Traditional Ecological Knowledge) as well as reconnaissance flight observations.

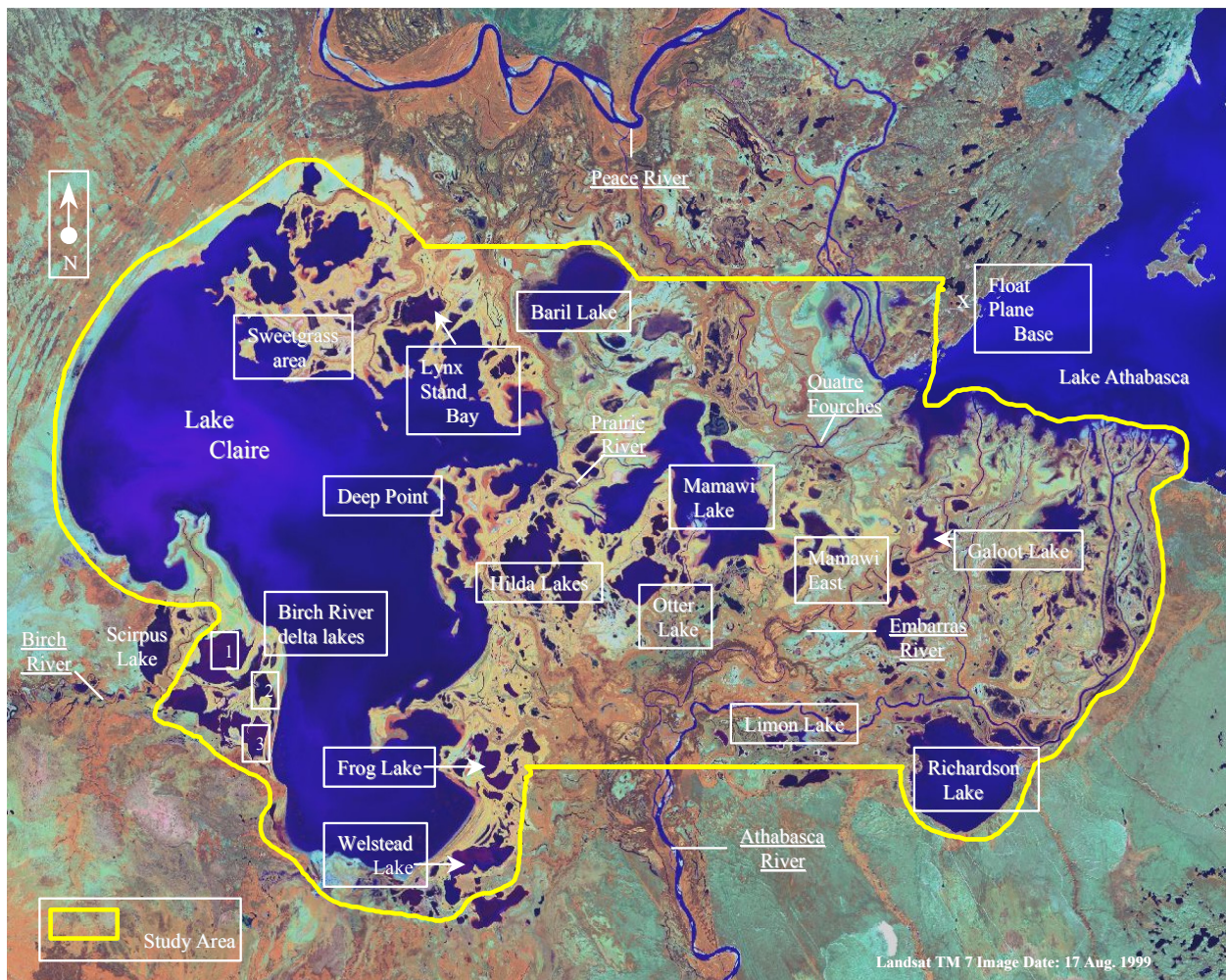


Figure 1. 1999 Shorebird survey area – Peace-Athabasca Delta, Alberta.

Reconnaissance flight and survey route design

A four hour reconnaissance flight was conducted prior to commencement of the first aerial survey to familiarize the survey crew with the delta, identify existing shorebird habitat, refine the survey route, and test survey techniques and moving map software. The final routes (Figure 2) included all available and recognizable shorebird habitat and were flown, in their entirety, in the same sequence for each of the four scheduled surveys. Flying time for each of the two-day survey sets was approximately 8.5 hours. As a test of navigation accuracy, periodic time checks with known geographical reference points on the routes were recorded on the audio cassette recorders for comparison with survey plotted GPS locations.

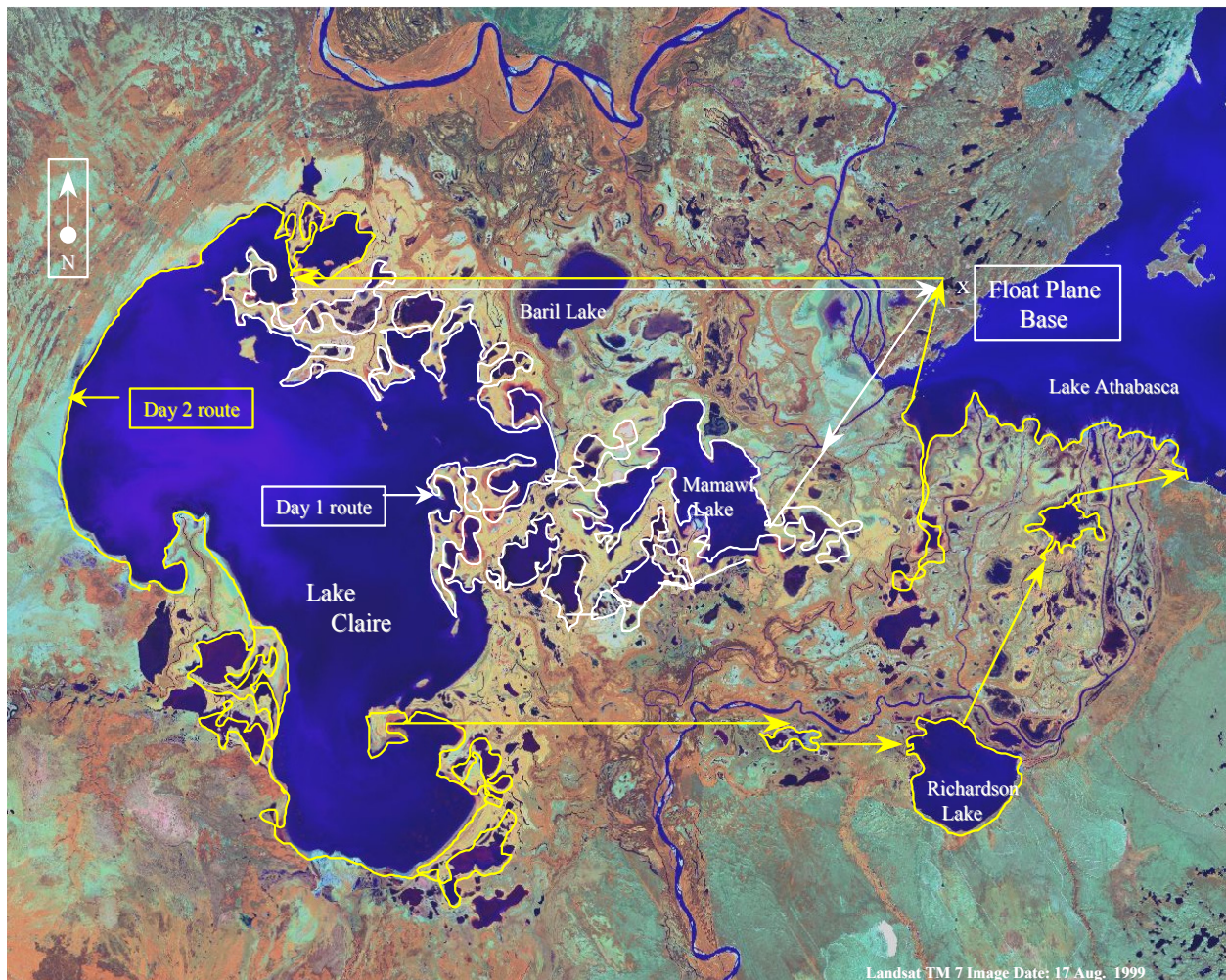


Figure 2. Flight routes for shorebird aerial surveys Peace-Athabasca Delta: 1999.

PAD shorebird aerial survey protocols and methodology

Survey techniques were adapted from those used by Canadian Wildlife Service personnel conducting aerial surveys of shorebird wintering areas in South America, Panama and Mexico (Morrison and Ross, 1989; Morrison *et al.*, 1998). Surveys were not initiated if adverse weather conditions existed prior to scheduled take-off (e.g. heavy rain, fog, thunderstorm, strong winds) or if light conditions were insufficient to reliably observe shorebirds. Furthermore, surveys were discontinued if excessive turbulence or other adverse conditions developed affecting visibility or safety.

Surveys were conducted using a Cessna 185 aircraft on floats, at an altitude of 35-50 m above ground level and air speed ranging between 130 km/h and 160 km/h, depending on bird densities, habitat conditions and shoreline complexity. The survey crew of three consisted of the pilot, an observer-navigator sitting beside the pilot and an observer sitting in the seat behind the pilot. The observers identified and counted all birds on their respective sides of the aircraft and recorded the data on audio cassette recorders. The data recorded on shorebird observations included time (to the nearest second), number of birds, identification by species or size category (Appendix 1) and subjective comments on habitat conditions. Specific species identification was limited to small groups of birds or shorebirds with distinguishable features such as size, colouration or flight pattern. The similarity of several species of smaller shorebirds, mixing of multiple species of shorebirds in large flocks and the speed of the aircraft made specific identification difficult resulting in the identification by size category. Suitable shorebird habitat was characterized as including exposed mudflats or shallow water zones having sparse or no emergent vegetation. Time was noted using digital clocks mounted in the aircraft which were readily viewed by each observer.

Low level navigation was aided by using a Global Positioning System (GPS) unit connected to a laptop computer. Moving map software (Fugawi[®]) constantly tracked the aircraft's position onto a digital map image and downloaded geo-reference coordinates (latitude, longitude), at 2 second intervals, into a track file on the laptop. National Topographical System of Canada maps (Department of Mines and Technical Surveys map sheets - Lake Claire 84 I and Fort Chipewyan 74 L) at 1:250,000 were used for all surveys. This technique enhanced navigation capabilities at low altitudes during the survey by displaying the actual flight route on the map on the computer screen. After each flight the track file was saved to the hard drive and converted into a Microsoft[®] EXCEL file format.

Each day, upon completion of the survey, observation data were transcribed onto hard copy field data forms (Appendix 2). These data were then entered into the appropriate Microsoft[®] EXCEL file, ensuring that the time of the shorebird observation was matched with the corresponding time of the latitude and longitude co-ordinate in the Fugawi[®] track file.

Ground Reconnaissance Trips

Several trips were made by air-boat or helicopter to select areas of the delta where concentrations of shorebirds were observed during aerial surveys. These trips were conducted with local Parks staff (Wood Buffalo National Park) and provided the opportunity for a more detailed look at habitat as well as enabling species identification.

Field studies in the park were carried out under National Park Research Permit: WB - 99 - 1021 (CEAA/EARP Registry # : WBNP - 000030).

RESULTS

Habitat conditions - aerial observations

Spring

Spring surveys were successfully completed as scheduled (Appendix 3). Those lakes and perched basins with any shorebird use were identified with a map reference number and latitude-longitude coordinates (Appendix 4) which were plotted on Landsat TM 7 Imagery (17 August, 1999) of the PAD (Appendix 5). Approximately 1250 kilometres of shoreline habitat were surveyed during each of the survey periods and habitat conditions were noted subjectively as described in the methods. Open water habitat was available in numerous areas for species such as the Red-necked Phalarope.

Mamawi Lake shorebird habitat was primarily in the small deltas of the Prairie River, Quatre Fourches Channels and Mamawi (Cree) Creek while the remainder of the shoreline had steep banks or was edged with a variety of willow species or emergent vegetation such as *Phragmites australis*. On Lake Claire available shorebird habitat was quite variable. The east half had numerous sheltered bays with exposed mudflats and adjacent shallow water zones while the west side of the lake featured large expanses of exposed mud and silt shorelines. Otter, Hilda (East and West), Frog and Welstead Lakes and the Birch River delta lakes provided variable amounts of suitable habitat throughout the spring. Limon and Galoot Lake had minimal water with exposed lake bottom mudflats and no emergent vegetation. Richardson Lake had a narrow sand and silt beach along the southern half of the lake while the northern shoreline was covered with willow and phragmites stands. The Athabasca River delta stretches across about 25 kilometres of the Lake Athabasca shoreline and provides large expanses of exposed mud and silt areas and shallow water habitat. Suitable habitat for shorebirds was also evident in Lynx Stand Bay and the numerous perched basins surveyed on the PAD.

Fall

Habitat conditions changed dramatically for the fall surveys as a result of the elevated water levels of the Athabasca River and resultant flow into the Embarras River and adjoining lakes and basins (Appendix 6). Water levels on the Embarras River break into Mamawi Creek increased by 0.735 m from early June levels and probably occurred between late June and early July based on observations made on the July 24-25 fall survey. This flooded shorebird habitat on Mamawi and Otter Lakes, Limon, Richardson and Galoot Lakes as well as the Athabasca River delta basins, also had flooded conditions on the July 24-25 survey. In early August, water levels on the Athabasca River above Jackfish Creek were 0.887 m above levels recorded in early June.

At the Prairie River outlet into Lake Claire water levels increased 0.035 m between late June and late July. Also, new growth vegetation covered most of the exposed mudflats, on the west shore and the sheltered east bays of Lake Claire that had been visible during spring surveys. The combination of these two factors, vegetation growth and flooding, eliminated the majority of shorebird habitat on Lake Claire with the water's edge visibly extending well into the new vegetated shoreline.

There were a number of shorebird sites, identified in the spring, that were not affected by the mid-summer flood of the delta : Frog; Welstead and Hilda (East and West) Lakes; the Birch River delta lakes; and the perched basins, including Lynx Stand Bay. Habitat conditions on these sites appeared to have changed only as a result of the natural seasonal draw-down of spring water levels, likely through evapo-transpiration. This provided newly exposed mudflats and continued shallow water habitat as the season progressed.

Some of the perched basins observed with water in the spring were dry by the first fall survey. They had not been refilled by the summer floods or local precipitation. Additionally, the spring exposed mudflats of these basins were covered with new growth vegetation.

Shorebird observations

Aerial surveys

Shorebird observations were combined, by survey period, to provide totals for the larger lakes and regional groups of smaller lakes and perched basins. These totals are represented as a percentage of the survey total or a numerical value (Table 1). These values help to identify the relative importance of specific sites within the survey period as well as enable comparisons between survey periods. Shorebird numbers are further refined as a summary of shorebird records (Appendix 7) and as a species and size category listing (Appendix 8), by survey period, for each of the 62 identified shorebird sites in the delta.

Table 1. Shorebird observations, shown as percent of total, for each of the sites in the Peace-Athabasca Delta.

Site Name	May 24 / 25	May 30 / 31	July 24 / 25	August 10 / 11
Lake Claire - East - Sheltered Bays	3.91 (296)*	9.05 (1622)	5.57 (1270)	1.22 (164)
Lake Claire - Exposed Shoreline: NW to SE	3.67 (278)	1.39 (249)	0.80 (183)	1.39 (187)
Birch River delta Lakes	16.86 (1276)	13.42 (2404)	34.95 (7976)	48.44 (6510)
Welstead Lake	9.79 (741)	12.43 (2228)	16.40 (3742)	11.78 (1583)
Frog Lake	1.61 (122)	14.03 (2513)	6.16 (1405)	7.09 (953)
Hilda Lakes (East / West)	7.95 (602)	2.79 (500)	10.62 (2424)	6.39 (859)
Otter Lake	3.18 (241)	8.85 (1586)	2.63 (600)	0.09 (12)
Mamawi Lake	9.62 (728)	6.11 (1095)	0.25 (57)	1.14 (153)
Limon Lake	0.03 (2)	0.00 (0)	0.00 (0)	1.19 (160)
Richardson Lake	1.94 (145)	0.71 (128)	0.02 (1)	0.73 (98)
Galoot Lake	0.71 (54)	19.67 (3525)	0.00 (0)	0.05 (7)
Athabasca River delta (Lake Athabasca shore)	3.45 (261)	0.56 (100)	0.00 (4)	0.60 (80)
Perched Basins :	[37.29] (2822)**	[10.99] (1968)	[22.59] (5156)	[19.9] (2674)
Sweetgrass Area	15.29 (1157)	3.38 (605)	2.16 (494)	4.24 (570)
Mamawi - East	4.47 (338)	2.52 (451)	4.50 (1028)	0.39 (52)
Prairie River	8.69 (658)	2.84 (509)	6.06 (1382)	2.16 (290)
Deep Point Complex	3.12 (236)	1.37 (246)	6.02 (1373)	8.58 (1153)
Lynx Stand Bay	5.72 (433)	0.88 (157)	3.85 (879)	4.53 (609)
Total	100% (7,568)	100% (17,918)	100% (22,818)	100% (13,440)

* Number of shorebirds in each geographic area for the survey period.

** Sum total for all perched basins.

There were several shorebird species that were readily identifiable during aerial surveys (Table 2). The Spotted Sandpiper and Solitary Sandpiper were combined for observation results as “SPSA/SOSA” but numbers were low with a peak of 29 birds in the second spring survey. Lesser Yellowlegs and Greater Yellowlegs were combined and identified as “yellowlegs” species. Observations were nearly ten times higher during the fall than the spring periods. The American Avocet was noted in all surveys and observed, at least once, in Lynx Stand Bay, Birch River Delta lakes, Welstead, Frog and Otter Lakes and Lake Claire East Bay 4. Dowitchers, noted only in the first spring survey, were simply referred to as “dowitchers” because separation of the two species was not practical. Killdeer were only recorded during spring surveys but were likely mixed in with the large flocks of shorebirds observed during the fall period. During the spring surveys, species observed and within their breeding range (Godfrey, 1986) such as Killdeer, Spotted Sandpiper, Solitary Sandpiper, Lesser Yellowlegs and Greater Yellowlegs were usually observed as individuals, pairs or small groups. Spring observations of these species were widely scattered throughout the delta wetlands (Appendix 8) which would be indicative of breeding activity.

Table 2. Total number of shorebirds, by species, observed during each of the aerial surveys of the Peace-Athabasca Delta in 1999.

	May 24	May 25	Total	May 30	May 31	Total	July 24	July 25	Total	Aug 10	Aug 11	Total
American Avocet	24	27	51	14	13	27	8	83	91		1	1
Black-bellied Plover		96	96	169	47	216						
Dowitcher Spp.	15		15									
Killdeer	10	4	14	2	2	4						
Large Shorebirds	9	17	26				2		2			
Medium Shorebirds	297	364	661	308	377	685	1755	4881	6636	2464	2905	5369
Other Shorebirds (Small & Medium)				374		374	5885	5693	11578	236	3655	3891
Small Shorebirds	2790	3751	6541	5727	7828	13555	668	3132	3800	694	2815	3509
Spotted/Solitary Sandpiper	4	11	15	15	14	29	5	2	7	1		1
Red-necked Phalarope		80	80		3000	3000						
Yellowleg Spp.	60	9	69	5	23	28	267	437	704	262	407	669
Daily shorebird totals	3209	4359		6614	11304		8590	14228		3657	9783	
Shorebird totals (Survey Set)			7568			17918			22818			13440

The only arctic migrant shorebird species identified were Black-bellied Plover and Red-necked Phalarope. Black-bellied Plover although readily visible from the air were only detected once during spring surveys. As well, phalaropes were only recorded once from the air, a flock of 3,000 on Galoot Lake. The phalarope's behavior of utilizing large, open water habitat may have precluded observation of these birds as surveys were focused along the shoreline and large numbers of this species may have been missed in the centre of some of the larger delta lakes.

Among the various size categories (Appendix 1), small shorebirds "SHSM" were the largest component observed throughout the four survey periods. Even though the numbers appeared low in the two fall surveys, they likely composed a large part of the "SHOT" category which included mixed flocks of small and medium shorebirds. There was a marked increase in proportion of medium shorebirds "SHME" in both fall surveys compared to the two spring surveys. The category of large shorebirds "SHLA" was seldom used and primarily occurred during the first spring survey for a small number of shorebirds.

Shorebirds were observed on nearly all lakes and perched basins with suitable habitat in the delta. However, the majority of shorebird observations were highlighted in key regions or sites on the delta. The lake basins of the Birch River delta appeared to provide the best conditions overall for shorebirds but were most notable during the two fall survey periods. Only two of the three basins in the Birch River delta were used in the spring. The high water levels in basin 3 had dropped by

late July and the result was an increase in shorebird use from zero in the spring to several thousand in the fall. Individually, five large lakes including Mamawi Lake, Welstead Lake, Otter Lake, Hilda Lakes and Frog Lake had quite variable shorebird numbers but collectively they accounted for the next major proportion of shorebird observations during each of the four surveys. The collection of perched basins of the Sweetgrass, Prairie River, Deep Point Complex, Lynx Stand Bay and Mamawi-East areas had the next highest proportion of observations for all surveys.

Shorebird numbers and geographic distribution of these birds changed during the four surveys. Numbers of birds more than doubled between the first and second spring survey from 7,568 to 17,918 observations. The Birch River delta lakes and the collection of perched basins accounted for 54.2% of shorebird use in the first spring survey but only 24.4% in the second spring survey. Several of the larger lakes including Welstead, Otter and Mamawi accounted for 22.6% and 27.4% of observed shorebirds during the first and second spring surveys, respectively. The

Hilda Lakes numbers remained fairly even at 602 and 500 birds during the spring surveys but percentage of total use was reduced by 5.2% in the second survey. The shift in shorebird distribution in the second spring survey saw an increase of 12.4% on Frog Lake and a one time high of 3,525 shorebirds (19.0%) on Galoot Lake on May 30-31 which had minimal use during the other surveys. Lake Claire's east bays provided habitat for 4% and 9% of the shorebirds observed during the two spring surveys. The large expanses of open shoreline habitat on Lake Athabasca / Athabasca River delta and the west shore of Lake Claire had minimal use with a combined total of 539 and 349 birds observed during each of the respective spring surveys.

Distribution of shorebird use drastically changed between the spring and fall as a result of the rising water levels of the Athabasca River and its effects on shorebird habitat. Mamawi, Otter and Galoot lakes registered a combined drop in use of nearly 32% between the May 30-31 and July 24-25 survey. The Birch River delta lakes showed the largest increases in shorebird use accounting for 35.0% of 22,818 birds and 48.4% of 13,440 shorebirds sighted during the July 24-25 and August 10-11 surveys, respectively. Welstead, Frog and Hilda Lakes and the grouped perched basins shorebird records accounted for 55.8% and 45.2% of first and second fall survey totals, respectively. After the peak of 1,622 on May 30-31, the east bays of Lake Claire showed a steady decline in numbers through the two fall surveys. There was a further drop in shorebird use on Lake Athabasca, Athabasca River delta and the west shore of Lake Claire in the fall.

Ground check data

Trips onto the delta resulted in the positive identification of a small sample of shorebirds of various size categories, particularly the small shorebird category, observed during aerial surveys (Appendix 9). The smaller sized shorebirds included numerous species of sandpipers as well as

Semipalmated Plover and the Red-necked Phalarope. The medium sized species included larger sandpipers and plovers, dowitchers and yellowlegs. American Avocets were also observed at a couple of sites.

Observations during the spring ground trips were primarily of small category shorebirds. Three species were identified including Semipalmated Sandpiper, White-rumped Sandpiper and Sanderling, all arctic migrants. American Golden-Plover were not identified from the air but were observed during a ground trip to the delta. Trips in the fall migration period to the Birch River delta and Welstead Lake, both with high shorebird use during this period, provided a detailed account of species using these sites. Lesser Yellowlegs were most common then Pectoral Sandpiper and Stilt Sandpiper, all of which fall into the “medium” size category for shorebirds.

DISCUSSION

General habitat characteristics of the PAD for waterbirds

The topographic relief on the delta is quite low and seldom exceeds 1 metre above the surface of the major delta lakes (Peace-Athabasca Delta Technical Studies, 1996). Slight water level changes expose lake bottom mudflats or flood adjacent shorelines. This results in quite variable water-bird habitat conditions on the delta among and within years (Hennan, 1976b; Hennan and Ambrock, 1977) depending on local precipitation and the spring or summer floods of the major delta rivers. Fluctuating water levels are doubly beneficial in that with lowering, they expose large areas of mudflats and with flooding, kill off encroaching vegetation. Exposed mudflats are quickly colonized by germinating seeds (Dirschl, 1972) and flooding is an important feature in maintaining the dynamic and productive shoreline habitat. Another important feature is the type of drainage system which characterizes the wetland: open or restricted. Open drainage system wetlands are more influenced by floods which affects the degree of waterbird use (Hennan 1972b; Townsend , 1972).

The dramatic effects, on delta habitat and wildlife, of damming the Peace River by the Bennett Dam have been previously addressed in a variety of studies throughout the past three decades (Peace-Athabasca Delta Project, 1973; Peace-Athabasca Delta Technical Studies, 1996). More recently, spring flooding caused by ice dams on the Peace River in 1996 and 1997 changed habitat conditions on the delta. The resulting floods have temporarily rejuvenated a large number of the dry perched basins and refilled the delta’s larger lakes.

One area of special note is the changing landscape of the Birch River delta. Over the past several decades silt deposition and beach ridges developed by wave action have resulted in the creation of several lake basins on the Birch River delta which are cut off from Lake Claire (Dirschl,1970;

Hennan, 1972b). It appears that extremely high flood water levels or severe wave action would be required to breach the barrier now separating these basins from Lake Claire. The end result is that natural environmental cycles have produced a large area of very good shorebird habitat on the southwestern shore of Lake Claire.

Habitat and shorebird distribution - spring

The lack of high spring runoff or ice jams in 1999 resulted in low water levels in the large lakes and perched basins of the delta which exposed large tracts of mudflats along the shoreline of these wetlands. Mamawi Lake was especially shallow and travel through it by motor boat was restricted to a narrow channel (W. Courtorielle, pers. comm.). The west shore of Lake Claire and the Athabasca River delta/Lake Athabasca shoreline had very broad bands of exposed, non-vegetated shoreline. There were few sites in the Athabasca River delta with potential habitat, as most wetlands appeared to have deep water surrounded by stands of willow and emergent vegetation (e.g. phragmites). The bays on the east shore of Lake Claire were sheltered from the lake's wave action and the shoreline provided large tracts of exposed mudflats. Overall, there appeared to be considerable suitable habitat available to shorebirds during the spring migration period.

The broad distribution of suitable habitat in the delta was evident in the corresponding dispersal of shorebirds across these sites. Although shorebirds were noted on most wetlands, some areas showed higher levels of use including the perched basins of the Sweetgrass, Prairie River, Deep Point Complex, Lynx Stand Bay and Mamawi - East areas. Four large lakes, including Mamawi and Welstead (both spring surveys) and Otter and Frog Lake (second spring survey), accounted for a large proportion of shorebird totals. High levels of shorebird use were recorded for the lake basins of the Birch River delta.

Limon, Richardson and Galoot Lakes and the Athabasca River delta basin had only small numbers of shorebirds, with the exception of the single large flock of phalaropes on Galoot Lake. Although the habitat appeared suitable, there may be something missing which is attractive or important to shorebirds.

The sheltered bays of Lake Claire had good numbers of shorebirds during this period, in contrast to the exposed shoreline of the west and northwest side of Lake Claire which had virtually no shorebird use. This reaffirms an earlier impression (Kevin Timoney, pers. comm.) that the habitat on the west and northwest side of the lake was not very suitable for shorebirds. The Athabasca lakeshore on the Athabasca River delta had few shorebirds yet appeared to be good habitat. Either it was too exposed to provide shelter to resting shorebirds, or food resources were limited in the silt and sand of the delta.

Habitat and shorebird distribution - fall

A number of factors affected fall shorebird habitat condition on the delta. Seasonal precipitation was below evaporation rates, resulting in water level recession on lakes and perched basins and in the exposure of new mudflats along the water edge during the summer period. Mudflats exposed in the early spring were quickly colonized by germinating seeds and carpets of vegetation covered areas that were once bare soil. The greatest changes came about as a result of the summer flood of the Athabasca River. All delta lakes and basins, in this open drainage system, connected to the Athabasca River were flooded. Water levels remained high until early August.

The effects of the flood waters of the Athabasca River were especially noted on two of the major lakes which had high shorebird use during the spring. Mamawi and Otter Lakes are directly connected to the Athabasca River through the Embarras River, Mamawi Creek and inter-connecting tributaries. The remaining lakes (Richardson, Limon, Galoot and the Athabasca River delta basins) affected by the floods did not have high spring shorebird use but the cumulative effects of habitat loss was noticeable in the concentration of shorebird use on the remaining shorebird habitat.

The rapid colonization and growth of vegetation on exposed mudflats was especially noticeable along the west shoreline of Lake Claire. These vast expanses of shoreline, bare in the spring, were covered with lush green growth during the late July surveys. Additionally, the edge of the high water levels was visible well up into the shoreline vegetation and there was a distinct lack of shorebirds in these areas.

Although Lake Claire's eastern shallow bays were reduced in size as a result of encroaching vegetation and higher water levels, shorebird use was comparable between the last spring and first fall survey. A number of perched basins with low spring water levels were dry in late July and overgrown with vegetation, but the remaining perched basins had considerable exposed shoreline mudflats and shallow water habitat to support large numbers of shorebirds during both fall surveys.

Key wetland areas or lakes identified during the 1999 surveys with high levels of shorebird use throughout the seasons included Welstead, Frog and Hilda (East and West) Lakes and the lake basins of the Birch River delta (Figure 1). They appear to be part of a restricted drainage system and thus were not subject to the dramatic influences of the Athabasca River summer flood. Water levels appeared normal or slightly high as a result of spring runoff of the snow melt from the surrounding landscape but habitat conditions improved as evapo-transpiration caused water levels to drop. The reduction and elimination of habitat in other parts of the delta coupled with the improved conditions on these sites was highlighted by the dramatic increase in shorebird use of these wetlands. These sites accounted for the majority of bird use during both fall surveys.

Species identified on the delta

The majority of the flocks encountered in the spring fitted the SHSM category. During two spring ground trips to Mamawi Lake, where large flocks of small shorebirds had been observed, three species were identified (Semipalmated Sandpiper, White-rumped Sandpiper and Sanderling), all arctic migrants. Small shorebirds, observed during fall aerial counts and also from ground counts were primarily arctic migrants, including Semipalmated Sandpiper, Baird's Sandpiper, Semipalmated Plover and Red-necked Phalarope. Medium sized shorebirds observed during fall surveys made up a greater proportion of the total counts, and included arctic migrant species such as Pectoral Sandpiper and Stilt Sandpiper as well as several local breeding species (Lesser Yellowlegs, Greater Yellowlegs and dowitchers).

The normal breeding range of about ten species of shorebirds overlap the delta (Lesser Yellowlegs, Greater Yellowlegs, Killdeer, Solitary Sandpiper, Spotted Sandpiper, Semipalmated Plover, Upland Sandpiper (*Bartramia longicauda*), Wilson's Snipe (*Gallinago delicata*), Short-billed Dowitcher (*Limnodromus griseus*) and Wilson's Phalarope (*Phalaropus tricolor*) and observations of these species could be expected throughout the season (Soper, 1942; Hohn, 1971; Hohn, 1972; Kuyt and Johnson, 1975, Wayland and Arnold, 1993; Godfrey, 1986). Low numbers of local nesting species were observed during the spring surveys presumably because they were dispersed in nesting territories. Lesser Yellowlegs and Spotted Sandpipers were primarily observed as single birds along the shoreline of the lakes and tributaries of the delta during spring ground surveys.

The Birch River delta and Welstead Lake fall ground trip observations of medium sized category shorebirds included two species of yellowlegs, potentially two dowitcher species and two arctic migrants (Pectoral Sandpiper and Stilt Sandpiper). A local nesting species, the Lesser Yellowlegs was the most common medium sized shorebird seen accounting for 50.5% and 57.4% of the shorebirds identified at each of the sites, respectively. This may indicate that some delta wetlands provide important habitat for pre-migration staging in the fall.

Potential factors influencing shorebird use

Habitat availability did not appear to be a limiting factor in this year as the number of shorebirds observed on the delta was relatively low in comparison to some prairie wetlands where one day totals can range from 50,000 to 100,000 shorebirds (Morrison *et al.*, 1995). Shorebird observations provided a snapshot of specific wetland use during the spring and fall survey periods but no detailed ground observations were made identifying shorebird activity or type of use of a wetland site.

Habitat conditions along the migration route may influence the number of stops required by these birds and dictate whether the delta is used or not. If habitat conditions are good further south and shorebirds have ample opportunity to feed and build fat (energy) reserves for the long flights then the delta may not be used on spring migration even if suitable habitat is available.

Shorebirds are annually observed in the spring on Canadian prairie wetlands in large concentrations actively feeding prior to continuation of their northern migration. It is about 500 kilometres to the delta from the edge of the prairies at 53 degrees latitude and many species of shorebirds are capable of flights of 2200 to 3400 kilometres (McNeil and Cadieux, 1972; Gudmundsson *et al.*, 1991; Harrington *et al.*, 1991). Therefore most shorebirds would be capable of flying non-stop to their arctic mainland nesting areas, a distance of under 2000 km without needing to stop at the delta if they had sufficient energy reserves. However, if shorebirds departed the prairies with insufficient reserves, they would be required or rather forced to make more frequent stops including sites such as the PAD to rest and feed in order to be able to continue their migration flights.

Skagen and Oman (1996) examined studies of shorebird diets throughout the western hemisphere and found that shorebirds consumed a wide variety of invertebrate taxa. No studies have currently been conducted on the delta wetlands in regards to shorebird feeding, specific invertebrate resources or levels of abundance of these food resources. Such studies would be required to identify if this is a factor in defining use of this area by shorebirds.

Wind conditions play a major role in shorebird migration (Butler *et al.*, 1997) with respect to energy demands. Favourable tail winds would reduce demand for large energy reserves while strong or unsuitable head winds and severe storms may force birds to seek shelter until more favourable conditions prevail. Large flocks of Black-bellied Plovers have been observed resting on the shores of Little Quill Lake, Saskatchewan as a result of severe weather conditions and left the next day after the storm had passed. Shorebirds are regularly observed taking advantage of favourable winds to depart staging sites on the prairies with a tail wind. Weather patterns, including wind speed and direction, therefore may influence use of the delta for shorebirds, especially for shorebirds with low energy resources.

At the Quill Lakes, Saskatchewan, Alexander and Gratto-Trevor (1997) found that length of stay was shorter in the spring than fall. The observation of higher numbers of shorebirds in the fall on the PAD may be a result of birds staying longer in the fall therefore increasing the likelihood of observation.

Alternately, juveniles of northern nesting species as well as local breeding species of shorebirds would need to build energy reserves to continue or commence migration. Therefore larger numbers of shorebirds are likely to be present in the fall.

American Avocet- northern limit extension

The American Avocet, considered a prairie breeding species, appears to have extended the northern edge of its range to include the delta lakes. Avocets were observed during all aerial surveys and 91 birds were noted in the late July flights. This is a minimum estimate: aerial surveys of Welstead Lake recorded only one avocet, while five were observed there during ground checks the same day. Successful nesting in the PAD was confirmed through observations of adults with flightless young at Lynx Stand Bay during 1999 field studies (L. Carbyn, pers. comm.). The sighting of avocets during spring 2000 waterfowl surveys (M. Gendron, pers. comm.) confirms continued use of the delta.

Historically, some avocets were found at northern locations. Specimens were taken in the nineteenth century at Rae and Fort Resolution, Mackenzie and at Fort Chipewyan, Alberta (Godfrey 1986). Observations in 1988 of a flock of 12 birds were made on a wetland complex called Fox Holes northwest of Ft. Smith (Kuyt, 1989).

In the past, movement into the area may have been a response to drought conditions on the prairies Kuyt (1989). However, given the current number of birds and the regularity of observations combined with breeding activity, it is likely that there is now an established population of American Avocets in the Peace-Athabasca Delta.

SUMMARY

Observations during aerial surveys showed that the amount of habitat available did not appear to be a limiting factor in shorebird use. Aerial survey results in conjunction with restricted ground checks for species identification showed that arctic migrant shorebirds do use the wetlands of the Peace-Athabasca Delta during both migration periods.

Local breeding species numbers were quite low in the spring as a result of dispersal during the breeding season. The rise in numbers of at least one of these species in the fall, the Lesser Yellowlegs, was likely due to emigration to and pre-migration staging on specific wetlands in the delta.

Survey results provided a snapshot of the presence of migrant shorebirds but information indicating whether these birds used the site merely as a resting site, or actively fed and replenished energy reserves was outside the scope of this study.

The fluctuating water levels on the open drainage system lakes such as Mamawi Lake are critical for maintaining the dynamic nature of the near shore and through time would sporadically provide

suitable habitat during different seasons for migrant or local breeding shorebirds. However, stable wetland habitats as observed at Welstead Lake and the Birch River delta this year provide shorebirds with suitable habitat on the PAD when numerous delta wetlands were flooded.

RECOMMENDATIONS

Periodic surveys of the key wetlands identified within the delta should be conducted during various migration periods to provide an insight of future shorebird use. Spot checks of key sites by parks staff or researchers would be beneficial in identifying level of use.

Research studies focused on food resources and feeding habits of shorebirds on the delta would provide some insight into whether the PAD provides suitable food resources for migrating shorebirds or whether it is merely suitable for use by local breeding birds. Initial studies should be conducted on those wetlands which showed consistent high use during all the surveys this year.

The number of shorebirds observed during the surveys indicates that the Peace-Athabasca Delta meets the requirements for a WHSRN site in the Regional category. It is likely that the number of birds using the site is much higher given that “turn-over” of a number of species would increase the total number observed. Efforts should be undertaken with the appropriate partners to put forward the nomination of this site to the WHSRN council for inclusion in the chain of sites across the hemisphere.

In studies which use moving map software and GPS linkage, the methodology section should incorporate the following procedural consideration: Daily synchronization of all clocks prior to the aerial survey flight is required for the Laptop computer, GPS unit and digital clocks to ensure accurate plotting of data-points.

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Consultation with local parks staff and researchers previously working in the Peace-Athabasca Delta provided the ground work for development of aerial surveys. Traditional Ecological Knowledge was received from Fort Chipewyan residents: Willie Courtorielle (park warden), Reggie McKay and Jumbo Fraser. The surveys would not have been completed without the competence of Air Mikisew pilot Shawn Kennedy.

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APPENDICES

Appendix 1. Scientific names, species alpha-codes and size categories for shorebirds observed on the Peace-Athabasca Delta.

Common Name	Scientific Name	Alpha-code	Size Category
American Avocet	<i>Recurvirostra americana</i>	AMAV	Large
American Golden Plover	<i>Pluvialis dominica</i>	LEGP	Medium
Black-bellied Plover	<i>Pluvialis squatarola</i>	BBPL	Medium
Baird's Sandpiper	<i>Calidris bairdii</i>	BASA	Small
Greater Yellowlegs	<i>Tringa melanoleuca</i>	GRYE	Medium
Killdeer	<i>Charadrius vociferus</i>	KILL	Medium
Least Sandpiper	<i>Calidris minutilla</i>	LESA	Small
Lesser Yellowlegs	<i>Tringa flavipes</i>	LEYE	Medium
Pectoral Sandpiper	<i>Calidris melanotos</i>	PESA	Medium
Red-necked Phalarope	<i>Phalaropus lobatus</i>	RNPH	Small
Sanderling	<i>Calidris alba</i>	SAND	Small
Semipalmated Plover	<i>Charadrius semipalmatus</i>	SEPL	Small
Semipalmated Sandpiper	<i>Calidris pusilla</i>	SESA	Small
Solitary Sandpiper	<i>Tringa solitaria</i>	SOSA	Small
Spotted Sandpiper	<i>Actitis macularia</i>	SPSA	Small
Stilt Sandpiper	<i>Calidris himantopus</i>	STSA	Medium
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	WRSA	Small
Dowitcher spp.		DOWI	Medium
Small Shorebirds		SHSM	
Medium Shorebirds		SHME	
Large Shorebirds		SHLA	
Other Shorebirds (small & medium)		SHOT	
Yellowleg spp.		YELL	Medium

Appendix 2. *Field data form for audio cassette tape recordings of shorebird observations.*

PEACE- ATHABASCA DELTA SHOREBIRD SURVEYS Page ____ of ____.

Survey Date : _____. Observer : _____. Wind : _____. Cloud : _____.

Comments : _____.

Time 2400	Waypoint #	Species	Number of Birds	Comments

Appendix 3. Shorebird survey flight schedule / personnel.

Spring Migration

Survey Date	Navigator / Observer	Observer
May 24 - 25, 1999	Gerry Beyersbergen, Canadian Wildlife Service	Bruce Pollard, Ducks Unlimited Canada
May 30 - 31, 1999	Gerry Beyersbergen	Jennifer Bailey, Parks Canada

Fall Migration

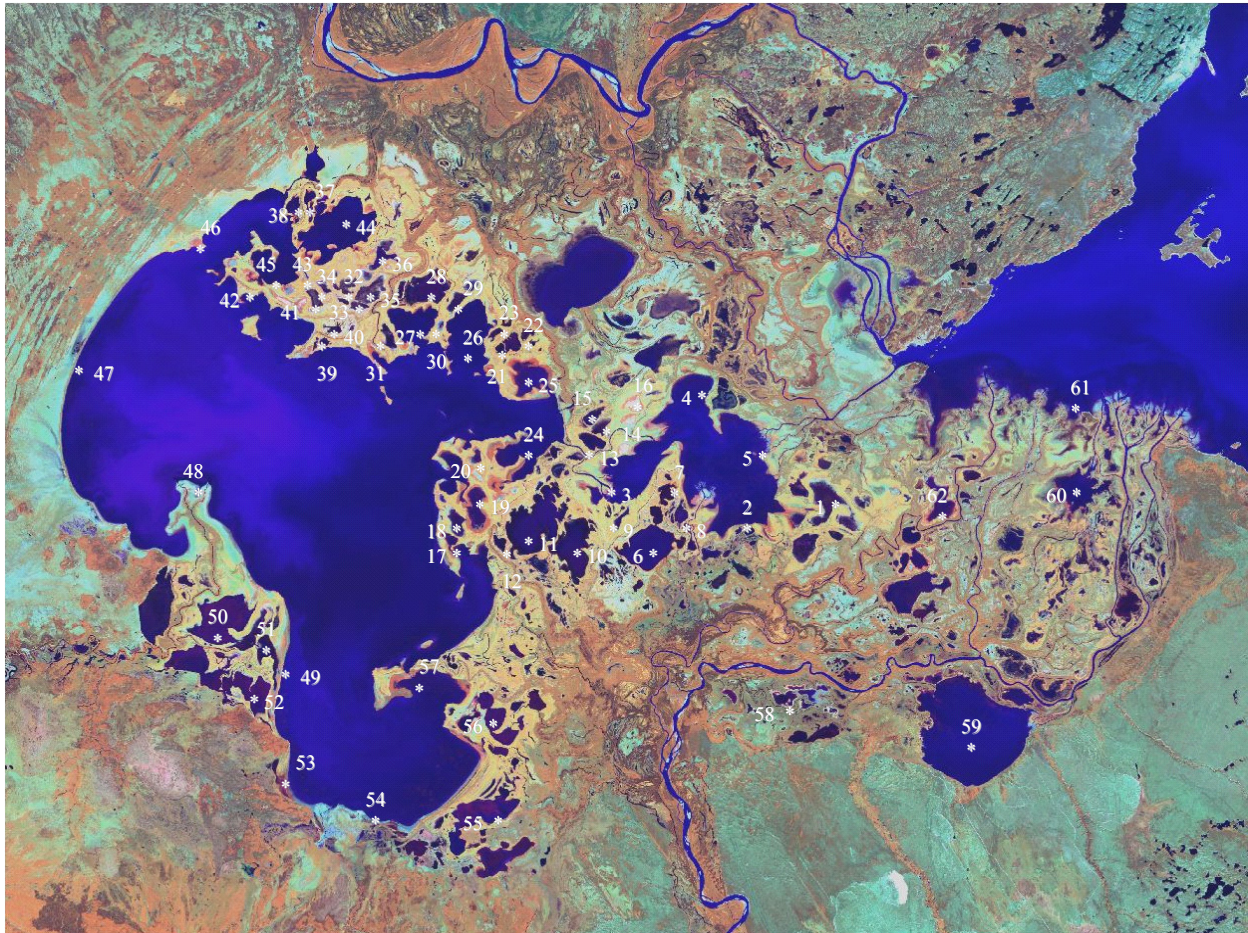
Survey Date	Navigator / Observer	Observer
July 24 - 25, 1999	Gerry Beyersbergen	Loney Dickson, Canadian Wildlife Service
August 10 -11, 1999	Gerry Beyersbergen	Frank Letchford, Canadian Wildlife Service

Appendix 4. Map reference locations (latitude, longitude) for all lakes/ wetlands/ perched basins with shorebird records for all aerial surveys of the Peace-Athabasca Delta in 1999.

Map Ref.	Site Name	Latitude	Longitude	Map Ref.	Site Name	Latitude	Longitude
1*	Mamawi Lake - East - Perched Basins	58.58360	111.29178	32	Sweetgrass Area - Perched Basin 1	58.75889	112.04199
2	- South Shore (with Mamawi Creek delta)	58.56845	111.42673	33	- Perched Basin 2	58.74228	112.02104
3	- West Shore	58.59621	111.63284	34	- Perched Basin 3	58.75195	112.07503
4	- North Shore	58.68622	111.48931	35	- Perched Basin 4	58.74963	112.01699
5	- East Shore	58.62740	111.39173	36	- Perched Basin 5	58.78157	111.98527
6	Otter Lake	58.54798	111.56444	37	- Perched Basin 6	58.82698	112.09628
7	Otter Lake - North Bays	58.58382	111.54728	38	- Perched Basin 7	58.82038	112.12247
8	- Perched Basin 1	58.57056	111.51800	39	- Perched Basin 8	58.70755	112.07299
9	- Perched Basin 2	58.57142	111.60924	40	- Perched Basin 9	58.71737	112.05749
10	Hilda Lake - East	58.54701	111.67912	41	- Perched Basin 10	58.73628	112.10824
11	- West	58.56594	111.73524	42	- Perched Basin 11	58.76168	112.19179
12	- Perched Basin	58.54474	111.79526	43	- Perched Basin 12	58.76995	112.10444
13	Prairie River - Perched Basin 1	58.62933	111.65751	44	- Bay 1	58.80175	112.05168
14	- Perched Basin 2	58.64294	111.64272	45	- Bay 2	58.76661	112.14734
15	- Perched Basin 3	58.65155	111.65672	46	Lake Claire - Northwest Shore	58.78861	112.27543
16	- Perched Basin 4	58.65842	111.59522	47	- West Shore	58.63711	112.47687
17	Lake Claire - Deep Point Complex - Perched Basin 1	58.54990	111.87294	48	- Birch River delta	58.59519	112.27190
18	- Deep Point Complex - Perched Basin 2	58.56268	111.86508	49	- Southwest Shore	58.43000	112.12404
19	- Deep Point Complex - Perched Basin 3	58.57211	111.83504	50	Birch River delta - Lake 1	58.47730	112.23071
20	- Deep Point Complex - Perched Basin 4	58.61655	111.83444	51	- Lake 2	58.45427	112.14170
21	- Deep Point Complex - Perched Basin 5	58.71070	111.78154	52	- Lake 3	58.41714	112.16520
22	- Deep Point Complex - Perched Basin 6	58.72046	111.75670	53	Pointe Des Roche - Basin	58.35834	112.13767
23	- Deep Point Complex - Perched Basin 7	58.72000	111.80478	54	Lake Claire - South Shore	58.32554	112.01904
24	- East Bay 1	58.61855	111.75230	55	Welstead Lake	58.32412	111.83856
25	- East Bay 2	58.68757	111.75248	56	Frog Lake	58.40144	111.80289
26	- East Bay 3	58.72196	111.84608	57	Buffalo Point Bay	58.43142	111.93423
27	- East Bay 4	58.72265	111.93162	58	Limon Lake	58.42358	111.31622
28	Lynx Stand Bay	58.75453	111.91840	59	Richardson Lake	58.39428	111.07505
29	Lynx Stand - Perched Basin 1	58.74677	111.86461	60	Athabasca River delta - Wetland 1	58.59202	110.91093
30	- Perched Basin 2	58.72587	111.89052	61	- lakeshore	58.67863	110.99122
31	- Perched Basin 3	58.71348	111.97170	62	Galoot Lake	58.58332	111.11689

* Corresponding map references points are plotted on Appendix 5, PAD LANDSAT TM 7 satellite imagery - 17 August, 1999.

Appendix 5. *Satellite image showing plotted map reference locations (Appendix 4) of shorebird observations during aerial surveys of the Peace-Athabasca Delta in 1999.*



Appendix 6. *Water monitoring level readings (metres) at select sites on the Peace-Athabasca Delta in 1999.*

Water Gauge Location	May 6	May 31 - June 8	June 25 - July 7	July 23 - Aug. 4	Aug. 10 - 18	Sept. 14 - 21
Mamawi Lake Channel - Old Dog Camp	208.532	208.526	208.626		208.643	208.296
- Change in level		-0.006	+0.100		+0.017	-0.347
Lake Claire - outlet to Prairie River	209.082	209.011	209.006	209.041		209.008
- Change in level		-0.071	-0.005	+0.035		-0.033
Athabasca River - above Jackfish Creek	209.936	209.757	210.231	210.644	209.749	209.160
- Change in level		-0.179	+0.474	+0.413	-0.895	-0.589
Embarras River - break into Mamawi Creek		210.262	210.997	210.941	210.259	209.811
- Change in level			+0.735	-0.056	-0.682	-0.448

Water level data provided by Alberta Environmental Protection and Wood Buffalo National Park staff in Fort Chipewyan.

Appendix 7. *Map reference locations with total shorebirds observed during each aerial survey of the Peace-Athabasca Delta in 1999.*

Map Reference	Site Name	May 24 - 25	May 30 - 31	July 24 - 25	August 10 - 11
1	Mamawi Lake - East Perched Basins	338	451	1028	52
2	- South shore	194	960	27	39
3	- West shore	322	74	12	113
4	- North shore	63	50	10	1
5	- East shore	149	11	8	0
6	Otter Lake	179	1477	502	6
7	Otter Lake - North Bays	62	109	98	6
8	- Perched Basin 1	35	0	418	47
9	- Perched Basin 2	108	45	230	41
10	Hilda Lake - East	228	170	1908	445
11	- West	374	330	516	414
12	- Perched Basin	0	55	171	218
13	Prairie River - Perched Basin 1	172	1	314	118
14	- Perched Basin 2	4	0	211	12
15	- Perched Basin 3	0	0	209	72
16	- Perched Basin 4	339	463	0	0
17	Lake Claire - Deep Point Complex - Perched Basin 1	0	131	218	73
18	- Deep Point Complex - Perched Basin 2	95	0	230	250
19	- Deep Point Complex - Perched Basin 3	111	48	386	296
20	- Deep Point Complex - Perched Basin 4	26	7	300	172
21	- Deep Point Complex - Perched Basin 5	0	0	1	3
22	- Deep Point Complex - Perched Basin 6	0	0	41	0
23	- Deep Point Complex - Perched Basin 7	4	5	26	141
24	Lake Claire - East Bay 1	43	340	6	78
25	- East Bay 2	102	678	93	74
26	- East Bay 3	42	0	424	0
27	- East Bay 4	30	111	143	0
28	Lynx Stand Bay	93	112	314	74
29	Lynx Stand - Perched Basin 1	0	0	150	227
30	- Perched Basin 2	111	0	0	220
31	- Perched Basin 3	229	45	415	88
32	Sweetgrass Area - Perched Basin 1	0	0	20	0
33	- Perched Basin 2	0	0	20	0
34	- Perched Basin 3	0	0	36	20
35	- Perched Basin 4	0	0	53	0
36	- Perched Basin 5	103	1	170	79
37	- Perched Basin 6	1	16	78	104
38	- Perched Basin 7	0	0	39	17
39	- Perched Basin 8	137	255	78	50
40	- Perched Basin 9	126	158	0	185
41	- Perched Basin 10	380	175	0	0
42	- Perched Basin 11	406	0	0	30
43	- Perched Basin 12	4	0	0	85
44	- Bay 1	5	4	377	5
45	- Bay 2	1	353	103	7
46	Lake Claire - Northwest shore	0	93	0	3
47	- West shore	5	3	47	79
48	- Southwest shore	107	120	53	0
49	- Birch River delta	20	26	0	5
50	Birch River delta - Lake 1	655	2169	4726	3040
51	- Lake 2	621	235	1327	678
52	- Lake 3	0	0	1923	2792
53	Pointe Des Roche - Basin	5	7	78	25
54	Lake Claire - South shore	141	0	5	75
55	Welstead Lake	741	2228	3742	1583
56	Frog Lake	122	2513	1405	953
57	Buffalo Point Bay	73	136	124	0
58	Limon Lake	2	0	0	160
59	Richardson Lake	145	128	1	98
60	Athabasca River delta - Wetland 1	142	100	4	9
61	- Lake Athabasca shore	119	0	0	71
62	Galoot Lake	54	3525	0	7
Total Shorebirds		7568	17918	22818	13440

Appendix 8. *Shorebird observations by species or size category for each map reference location for each aerial survey of the Peace-Athabasca Delta in 1999.*

Map Reference	Site Name	Date	Species	Number
1	Mamawi East Basins	24-May-99	SHSM	302
		24-May-99	SHME	28
		24-May-99	YELL	8
		30-May-99	SHSM	389
		30-May-99	SHME	21
		30-May-99	SHOT	32
		30-May-99	BBPL	2
		30-May-99	SOSA/SPSA	7
		24-Jul-99	SHME	171
		24-Jul-99	SHOT	843
		24-Jul-99	YELL	14
		10-Aug-99	SHSM	20
		10-Aug-99	SHME	19
		10-Aug-99	YELL	12
		10-Aug-99	SOSA/SPSA	1
2	Mamawi Lake - South Shore	24-May-99	SHSM	185
		24-May-99	YELL	4
		24-May-99	SHME	5
		30-May-99	SHSM	847
		30-May-99	SHME	5
		30-May-99	SHOT	96
		30-May-99	BBPL	12
		24-Jul-99	SHME	7
		24-Jul-99	SHOT	20
		10-Aug-99	SHME	35
		10-Aug-99	SHOT	2
		10-Aug-99	YELL	2
3	Mamawi Lake - West Shore	24-May-99	SHSM	271
		24-May-99	SHME	49
		24-May-99	YELL	2
		30-May-99	SHSM	32
		30-May-99	SHOT	14
		30-May-99	BBPL	28
		24-Jul-99	SHME	2
		24-Jul-99	SHOT	2
		24-Jul-99	YELL	8
		10-Aug-99	SHME	95
		10-Aug-99	SHOT	8
		10-Aug-99	YELL	10
4	Mamawi Lake - North Shore	24-May-99	SHSM	47
		24-May-99	SHME	5
		24-May-99	SHLA	6
		24-May-99	YELL	3
		24-May-99	SOSA/SPSA	2
		30-May-99	SHSM	50
		24-Jul-99	SHME	1
		24-Jul-99	YELL	9
		10-Aug-99		0

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
5	Mamawi Lake - East Shore	24-May-99	SHSM	118
		24-May-99	SHME	31
		30-May-99	SHSM	11
		24-Jul-99	SHME	2
		24-Jul-99	SHLA	1
		24-Jul-99	YELL	5
		10-Aug-99	YELL	1
6	Otter Lake	24-May-99	SHSM	132
		24-May-99	SHME	21
		24-May-99	DOWI	15
		24-May-99	KILL	2
		24-May-99	YELL	9
		30-May-99	SHSM	1247
		30-May-99	SHME	100
		30-May-99	SHOT	98
		30-May-99	BBPL	28
		30-May-99	YELL	3
		30-May-99	SOSA/SPSA	1
		24-Jul-99	SHME	169
		24-Jul-99	SHOT	287
		24-Jul-99	YELL	46
		10-Aug-99	SHOT	4
		10-Aug-99	YELL	2
7	Otter Lake - north bays	24-May-99	SHSM	57
		24-May-99	SHME	3
		24-May-99	KILL	1
		24-May-99	YELL	1
		30-May-99	SHSM	65
		30-May-99	SHME	8
		30-May-99	SHOT	36
		24-Jul-99	SHME	54
		24-Jul-99	SHOT	37
		24-Jul-99	SHLA	1
		24-Jul-99	YELL	6
		10-Aug-99	SHOT	4
		10-Aug-99	YELL	2
8	Otter Lake - Perched Basin 1	24-May-99	SHSM	35
		30-May-99		0
		24-Jul-99	SHME	272
		24-Jul-99	SHOT	100
		24-Jul-99	YELL	46
		10-Aug-99	SHME	45
		10-Aug-99	YELL	2
9	Otter Lake - Perched Basin 2	24-May-99	SHSM	103
		24-May-99	SHLA	1
		24-May-99	KILL	1
		24-May-99	YELL	3
		30-May-99	SHSM	42
		30-May-99	SHOT	3
		24-Jul-99	SHME	76
		24-Jul-99	SHOT	150
		24-Jul-99	AMAV	1
		24-Jul-99	YELL	3
		10-Aug-99	SHSM	20
10-Aug-99	YELL	21		

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
10	Hilda Lake - East	24-May-99	SHSM	189
		24-May-99	SHME	23
		24-May-99	SHLA	2
		24-May-99	SOSA/SPSA	12
		24-May-99	YELL	2
		30-May-99	SHSM	90
		30-May-99	SHM	37
		30-May-99	SHOT	38
		30-May-99	KILL	1
		30-May-99	YELL	1
		30-May-99	SOSA/SPSA	3
		24-Jul-99	SHSM	610
		24-Jul-99	SHME	45
		24-Jul-99	SHOT	1185
		24-Jul-99	YELL	68
		10-Aug-99	SHSM	88
		10-Aug-99	SHME	333
		10-Aug-99	SHOT	23
10-Aug-99	YELL	1		
11	Hilda Lake - West	24-May-99	SHSM	361
		24-May-99	SHME	4
		24-May-99	KILL	4
		24-May-99	YELL	5
		30-May-99	SHSM	262
		30-May-99	SHME	6
		30-May-99	SHOT	57
		30-May-99	YELL	1
		30-May-99	BBPL	4
		24-Jul-99	SHME	148
		24-Jul-99	SHOT	357
		24-Jul-99	YELL	6
		24-Jul-99	SOSA/SPSA	5
		10-Aug-99	SHSM	15
		10-Aug-99	SHME	327
		10-Aug-99	SHOT	20
		10-Aug-99	YELL	52
		12	Hilda Lake - Perched Basin	24-May-99
30-May-99	SHSM			55
24-Jul-99	SHME			8
24-Jul-99	SHOT			156
24-Jul-99	YELL			7
10-Aug-99	SHSM			20
10-Aug-99	SHME			184
10-Aug-99	YELL	14		
13	Prairie River - Perched Basin 1	24-May-99	SHSM	168
		24-May-99	SHME	2
		24-May-99	YELL	2
		30-May-99	SOSA/SPSA	1
		24-Jul-99	SHME	14
		24-Jul-99	SHOT	300
		10-Aug-99	SHSM	15
		10-Aug-99	SHME	90
10-Aug-99	YELL	13		

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
14	Prairie River - Perched Basin 2	24-May-99	SHME	4
		30-May-99		0
		24-Jul-99	SHME	32
		24-Jul-99	SHOT	177
		24-Jul-99	YELL	2
		10-Aug-99	SHME	10
		10-Aug-99	YELL	2
15	Prairie River - Perched Basin 3	24-May-99		0
		30-May-99		0
		24-Jul-99	SHME	10
		24-Jul-99	SHOT	197
		24-Jul-99	YELL	2
		10-Aug-99	SHME	55
		10-Aug-99	YELL	17
16	Prairie River - Perched Basin 4	24-May-99	SHSM	328
		24-May-99	SHME	11
		30-May-99	SHSM	423
		30-May-99	SHME	38
		30-May-99	SOSA/SPSA	1
		30-May-99	BBPL	1
		24-Jul-99		0
		10-Aug-99		0
		17	Lake Claire - Deep Point Complex - Perched Basin 1	24-May-99
30-May-99	SHSM			131
24-Jul-99	SHME			21
24-Jul-99	SHOT			190
24-Jul-99	YELL			7
10-Aug-99	SHME			69
10-Aug-99	YELL			4
18	Lake Claire - Deep Point Complex - Perched Basin 2	24-May-99	SHSM	95
		30-May-99		0
		24-Jul-99	SHME	35
		24-Jul-99	SHOT	190
		24-Jul-99	YELL	5
		10-Aug-99	SHSM	80
		10-Aug-99	SHME	170
19	Lake Claire - Deep Point Complex - Perched Basin 3	24-May-99	SHSM	111
		30-May-99	SHSM	34
		30-May-99	SHME	14
		24-Jul-99	SHSM	15
		24-Jul-99	SHME	16
		24-Jul-99	SHOT	343
		24-Jul-99	YELL	12
		10-Aug-99	SHSM	160
		10-Aug-99	SHME	134
		10-Aug-99	YELL	2
20	Lake Claire - Deep Point Complex - Perched Basin 4	24-May-99	SHME	26
		30-May-99	SHSM	7
		24-Jul-99	SHME	7
		24-Jul-99	SHOT	293
		10-Aug-99	SHSM	71
		10-Aug-99	SHME	84
		10-Aug-99	YELL	17

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
21	Lake Claire - Deep Point Complex - Perched Basin 5	24-May-99		0
		30-May-99		0
		24-Jul-99	SHME	1
		11-Aug-99		0
22	Lake Claire - Deep Point Complex - Perched Basin 6	24-May-99		0
		30-May-99		0
		24-Jul-99	SHME	41
		11-Aug-99		0
23	Lake Claire - Deep Point Complex - Perched Basin 7	24-May-99	SHSM	3
		24-May-99	YELL	1
		30-May-99	SHSM	1
		30-May-99	SHME	2
		30-May-99	SOSA/SPSA	2
		24-Jul-99	SHME	2
		24-Jul-99	SHOT	24
		10-Aug-99	SHME	125
		10-Aug-99	SHOT	6
		10-Aug-99	YELL	10
24	Lake Claire - East Bay 1	24-May-99	SHSM	20
		24-May-99	SHME	22
		24-May-99	YELL	1
		30-May-99	SHSM	315
		30-May-99	BBPL	25
		24-Jul-99	YELL	6
		10-Aug-99	SHME	77
		10-Aug-99	YELL	4
25	Lake Claire - East Bay 2	24-May-99	SHSM	57
		24-May-99	SHME	45
		30-May-99	SHSM	645
		30-May-99	SHME	3
		30-May-99	BBPL	30
		24-Jul-99	SHME	45
		24-Jul-99	SHOT	47
		24-Jul-99	YELL	1
		10-Aug-99	SHME	50
		10-Aug-99	SHOT	4
26	Lake Claire - East Bay 3	24-May-99	SHSM	23
		24-May-99	SHME	16
		24-May-99	YELL	3
		30-May-99		0
		24-Jul-99	SHOT	420
		24-Jul-99	YELL	4
		10-Aug-99		0
27	Lake Claire - East Bay 4	24-May-99	SHSM	15
		24-May-99	SHME	15
		30-May-99	SHSM	100
		30-May-99	BBPL	11
		24-Jul-99	SHME	15
		24-Jul-99	SHOT	127
		24-Jul-99	AMAV	1
		10-Aug-99		0

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
28	Lynx Stand Bay	24-May-99	SHSM	60
		24-May-99	SHME	2
		24-May-99	AMAV	24
		24-May-99	YELL	5
		24-May-99	KILL	2
		30-May-99	SHSM	65
		30-May-99	SHME	22
		30-May-99	AMAV	14
		30-May-99	BBPL	10
		30-May-99	SOSA/SPSA	1
		24-Jul-99	SHME	108
		24-Jul-99	SHOT	195
		24-Jul-99	AMAV	6
		24-Jul-99	YELL	5
		10-Aug-99	SHME	63
10-Aug-99	YELL	11		
29	Lynx Stand - Perched Basin 1	24-May-99		0
		30-May-99		0
		24-Jul-99	SHSM	3
		24-Jul-99	SHME	9
		24-Jul-99	SHOT	136
		24-Jul-99	YELL	2
		10-Aug-99	SHSM	50
		10-Aug-99	SHME	10
		10-Aug-99	SHOT	165
		10-Aug-99	YELL	2
30	Lynx Stand - Perched Basin 2	24-May-99	SHSM	110
		24-May-99	YELL	1
		30-May-99		0
		24-Jul-99		0
		10-Aug-99	SHSM	155
10-Aug-99	SHME	65		
31	Lynx Stand - Perched Basin 3	25-May-99	SHSM	228
		25-May-99	SHLA	1
		30-May-99	SHSM	33
		30-May-99	SHME	12
		24-Jul-99	SHSM	20
		24-Jul-99	SHME	370
		24-Jul-99	SHOT	25
		10-Aug-99	SHME	80
		10-Aug-99	YELL	8
32	Sweetgrass Area - Perched Basin 1	25-May-99		0
		31-May-99		0
		25-Jul-99	SHOT	20
		11-Aug-99		0
33	Sweetgrass Area - Perched Basin 2	25-May-99		0
		31-May-99		0
		25-Jul-99	SHME	10
		25-Jul-99	LEYE	10
		11-Aug-99		0
34	Sweetgrass Area - Perched Basin 3	25-May-99		0
		31-May-99		0
		25-Jul-99	SHME	21
		25-Jul-99	YELL	15

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
34 (cont'd)	Sweetgrass Area - Perched Basin 3	10-Aug-99	SHME	12
		10-Aug-99	YELL	8
35	Sweetgrass Area - Perched Basin 4	25-May-99		0
		31-May-99		0
		25-Jul-99	SHME	6
		25-Jul-99	SHOT	42
		25-Jul-99	YELL	5
		11-Aug-99		0
36	Sweetgrass Area - Perched Basin 5	25-May-99	SHSM	100
		25-May-99	SHLA	3
		31-May-99	SOSA/SPSA	1
		25-Jul-99	SHSM	95
		25-Jul-99	SHME	19
		25-Jul-99	SHOT	32
		25-Jul-99	YELL	24
		11-Aug-99	SHME	48
		11-Aug-99	SHOT	3
		11-Aug-99	YELL	28
37	Sweetgrass Area - Perched Basin 6	25-May-99	SHSM	1
		31-May-99	SHME	14
		31-May-99	YELL	2
		25-Jul-99	SHME	60
		25-Jul-99	YELL	18
		11-Aug-99	SHSM	7
		11-Aug-99	SHME	92
		11-Aug-99	YELL	5
38	Sweetgrass Area - Perched Basin 7	25-May-99		0
		31-May-99		0
		25-Jul-99	SHME	39
		11-Aug-99	SHME	13
		11-Aug-99	YELL	4
39	Sweetgrass Area - Perched Basin 8	25-May-99	SHSM	94
		25-May-99	SHME	29
		25-May-99	YELL	4
		25-May-99	BBPL	5
		25-May-99	SOSA/SPSA	5
		30-May-99	SHSM	250
		30-May-99	KILL	1
		30-May-99	SOSA/SPSA	4
		24-Jul-99	SHME	74
		24-Jul-99	SHOT	1
		24-Jul-99	YELL	3
		10-Aug-99	SHME	46
		10-Aug-99	YELL	4
40	Sweetgrass Area - Perched Basin 9	25-May-99	SHSM	116
		25-May-99	SHME	10
		30-May-99	SHSM	155
		30-May-99	BBPL	3
		25-Jul-99		0
		10-Aug-99	SHME	175
		10-Aug-99	YELL	10

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
41	Sweetgrass Area - Perched Basin 10	25-May-99	SHSM	228
		25-May-99	SHME	100
		25-May-99	SHLA	1
		25-May-99	BBPL	50
		25-May-99	KILL	1
		30-May-99	SHSM	140
		30-May-99	SHME	25
		30-May-99	BBPL	10
		25-Jul-99		0
		11-Aug-99		0
42	Sweetgrass Area- Perched Basin 11	25-May-99	SHSM	379
		25-May-99	SHME	27
		31-May-99		0
		25-Jul-99		0
		10-Aug-99	SHME	25
10-Aug-99	YELL	5		
43	Sweetgrass Area - Perched Basin 12	25-May-99	SHSM	4
		31-May-99		0
		25-Jul-99		0
		10-Aug-99	SHME	85
44	Sweetgrass Area - Bay 1	25-May-99	SHSM	4
		25-May-99	YELL	1
		31-May-99	BBPL	4
		25-Jul-99	SHSM	187
		25-Jul-99	SHME	95
		25-Jul-99	SHOT	77
		25-Jul-99	YELL	18
		11-Aug-99	SHOT	5
45	Sweetgrass Area - Bay 2	25-May-99	SHSM	1
		30-May-99	SHSM	338
		30-May-99	SHME	15
		24-Jul-99	SHSM	20
		24-Jul-99	SHOT	83
		10-Aug-99	SHME	1
		10-Aug-99	YELL	6
46	Lake Claire - Northwest Shore	25-May-99		0
		31-May-99	SHSM	92
		31-May-99	YELL	1
		25-Jul-99		0
		11-Aug-99	SHOT	3
47	Lake Claire - West Shore	25-May-99	SHSM	5
		31-May-99	SHSM	1
		31-May-99	BBPL	1
		31-May-99	YELL	1
		25-Jul-99	SHME	47
		11-Aug-99	SHSM	32
		11-Aug-99	SHME	42
11-Aug-99	YELL	5		
48	Lake Claire - Southwest Shore	25-May-99	SHSM	90
		25-May-99	SHME	6
		25-May-99	BBPL	11

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
48 (cont'd)	Lake Claire - Southwest Shore	31-May-99	SHSM	120
		25-Jul-99	SHSM	53
		11-Aug-99		0
49	Lake Claire - Birch River delta	25-May-99	SHSM	20
		31-May-99	SHSM	26
		25-Jul-99		0
		11-Aug-99	SHME	4
		11-Aug-99	SHOT	1
50	Birch River delta - Lake 1	25-May-99	SHSM	603
		25-May-99	SHME	21
		25-May-99	SHLA	12
		25-May-99	AMAV	2
		25-May-99	BBPL	15
		25-May-99	SOSA/SPSA	2
		31-May-99	SHSM	2135
		31-May-99	SHME	2
		31-May-99	AMAV	8
		31-May-99	BBPL	8
		31-May-99	YELL	13
		31-May-99	SOSA/SPSA	3
		25-Jul-99	SHSM	1065
		25-Jul-99	SHME	1570
		25-Jul-99	SHOT	1977
		25-Jul-99	YELL	114
		11-Aug-99	SHSM	1488
		11-Aug-99	SHME	852
		11-Aug-99	SHOT	599
		11-Aug-99	AMAV	1
11-Aug-99	YELL	100		
51	Birch River delta - Lake 2	25-May-99	SHSM	598
		25-May-99	SHME	8
		25-May-99	BBPL	15
		31-May-99	SHSM	212
		31-May-99	SHME	22
		31-May-99	SOSA/SPSA	1
		25-Jul-99	SHSM	50
		25-Jul-99	SHME	650
		25-Jul-99	SHOT	620
		25-Jul-99	YELL	7
		11-Aug-99	SHSM	82
		11-Aug-99	SHME	250
		11-Aug-99	SHOT	317
52	Birch River delta - Lake 3	25-May-99		0
		31-May-99		0
		25-Jul-99	SHSM	698
		25-Jul-99	SHME	429
		25-Jul-99	SHOT	650
		25-Jul-99	AMAV	65
		25-Jul-99	YELL	81
		11-Aug-99	SHSM	340
		11-Aug-99	SHME	425
		11-Aug-99	SHOT	1940
11-Aug-99	YELL	87		

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
53	Pointe Des Roche - Basin	25-May-99	SHME	4
		25-May-99	YELL	1
		31-May-99	SHME	5
		31-May-99	YELL	2
		25-Jul-99	SHME	75
		25-Jul-99	SHOT	1
		25-Jul-99	YELL	2
		11-Aug-99	SHSM	25
54	Lake Claire - South Shore	25-May-99	SHSM	140
		25-May-99	YELL	1
		31-May-99		0
		25-Jul-99	SHME	4
		25-Jul-99	YELL	1
		11-Aug-99	SHSM	75
55	Welstead Lake	25-May-99	SHSM	694
		25-May-99	SHME	20
		25-May-99	AMAV	25
		25-May-99	YELL	1
		25-May-99	SOSA/SPSA	1
		31-May-99	SHSM	2075
		31-May-99	SHME	139
		31-May-99	AMAV	3
		31-May-99	KILL	1
		31-May-99	YELL	3
		31-May-99	SOSA/SPSA	7
		25-Jul-99	SHSM	699
		25-Jul-99	SHME	1237
		25-Jul-99	SHOT	1772
		25-Jul-99	AMAV	1
		25-Jul-99	YELL	33
		11-Aug-99	SHSM	346
		11-Aug-99	SHME	623
		11-Aug-99	SHOT	550
		11-Aug-99	YELL	64
56	Frog Lake	25-May-99	SHSM	40
		25-May-99	SOSA/SPSA	1
		25-May-99	KILL	1
		25-May-99	RNPH	80
		31-May-99	SHSM	2313
		31-May-99	SHME	195
		31-May-99	AMAV	2
		31-May-99	KILL	1
		31-May-99	BBPL	2
		25-Jul-99	SHSM	262
		25-Jul-99	SHME	598
		25-Jul-99	SHOT	465
		25-Jul-99	AMAV	17
		25-Jul-99	SOSA/SPSA	2
		25-Jul-99	YELL	61
		11-Aug-99	SHSM	285
		11-Aug-99	SHME	435
11-Aug-99	SHOT	177		
11-Aug-99	YELL	56		

Appendix 8. (cont'd)

Map Reference	Site Name	Date	Species	Number
57	Buffalo Point Bay	25-May-99	SHSM	12
		25-May-99	SHME	61
		31-May-99	SHSM	129
		31-May-99	BBPL	7
		25-Jul-99	SHSM	10
		25-Jul-99	SHME	33
		25-Jul-99	SHOT	70
		25-Jul-99	YELL	11
		11-Aug-99		0
58	Limon Lake	25-May-99	SHSM	1
		25-May-99	KILL	1
		31-May-99		0
		25-Jul-99		0
		11-Aug-99	SHSM	60
		11-Aug-99	SHME	40
		11-Aug-99	SHOT	50
		11-Aug-99	YELL	10
59	Richardson Lake	25-May-99	SHSM	139
		25-May-99	SHME	3
		25-May-99	KILL	1
		25-May-99	YELL	1
		25-May-99	SOSA/SPSA	1
		31-May-99	SHSM	125
		31-May-99	SOSA/SPSA	2
		31-May-99	YELL	1
		25-Jul-99	SHSM	1
		11-Aug-99	SHSM	5
		11-Aug-99	SHME	81
		11-Aug-99	SHOT	10
		11-Aug-99	YELL	2
60	Athabasca River delta - Basin 1	25-May-99	SHSM	101
		25-May-99	SHME	40
		25-May-99	SOSA/SPSA	1
		31-May-99	SHSM	100
		25-Jul-99	SHOT	4
		11-Aug-99	YELL	9
61	Athabasca River delta / Lake Athabasca shoreline	25-May-99	SHSM	109
		25-May-99	SHME	10
		31-May-99		0
		25-Jul-99		0
		11-Aug-99	SHSM	70
		11-Aug-99	YELL	1
62	Galoot Lake	25-May-99	SHSM	44
		25-May-99	SHME	10
		31-May-99	SHSM	500
		31-May-99	BBPL	25
		31-May-99	RNPH	3000
		25-Jul-99		0
		11-Aug-99	YELL	7

Appendix 9. *Ground visits to select sites in the Peace-Athabasca Delta in 1999 with species number shown as percentage of total shorebird observations at each site.*

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Semipalmated Sandpiper	68.2	83.7	87.5			7.8	3.6
Sanderling	17.7	14.0					
White-rumped Sandpiper	14.1	2.3	12.5				
Pectoral Sandpiper						24.5	7.2
Stilt Sandpiper						20.9	7.2
Baird's Sandpiper					1.6	0.5	
Semipalmated Plover					2.5		3.0
American Avocet						0.9	2.4
American Golden Plover				100.0			
Lesser Yellowlegs					92.7	41.4	57.4
Greater Yellowlegs					1.6	1.8	1.2
Red-necked Phalarope							13.2
Dowitcher species					1.6	2.2	4.8
Total shorebirds	283	215	200	45	121	554	167

Site 1 : Mamawi (Cree) Creek Delta on Mamawi Lake [58.57583°N, 111.49383°W]- 31 May, 1999

Site 2 : Peninsula on north /central shore of Mamawi Lake [58.65217°N, 111.48067°W]- 1 June, 1999

Site 3 : Lake Claire East Bay 1, due south of west end Prairie River [58.60667°N, 111.76800°W] - 1 June, 1999

Site 4 : Prairie River - Perched Basin 4, just off the junction of the Charles River and the Prairie River [58.64133°N, 111.59617°W] - 1 June, 1999

Site 5 : Birch River Delta lake 1 [58.46483°N, 112.16467°W] - 25 July, 1999

Site 6 : Birch River Delta lake 2 [58.46233°N, 112.25833°W] - 25 July, 1999

Site 7 : Welstead Lake proper and long perched basins to northwest of lake [58.33533°N, 111.82833°W] - 25 July, 1999

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