

# Waterbirds of the Revelstoke Reach Wetlands Upper Arrow Reservoir, Revelstoke, British Columbia, Canada

June 2001



*Photo courtesy of Wendy Beauchamp*

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Evaluation of the Ancillary Benefits of Upper Arrow  
Reservoir Drawdown Zone Revegetation Project

# Waterbirds of the Revelstoke Reach Wetlands

## Upper Arrow Reservoir, Revelstoke, British Columbia, Canada

### A report prepared for BC Hydro, June 2001

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### Abstract

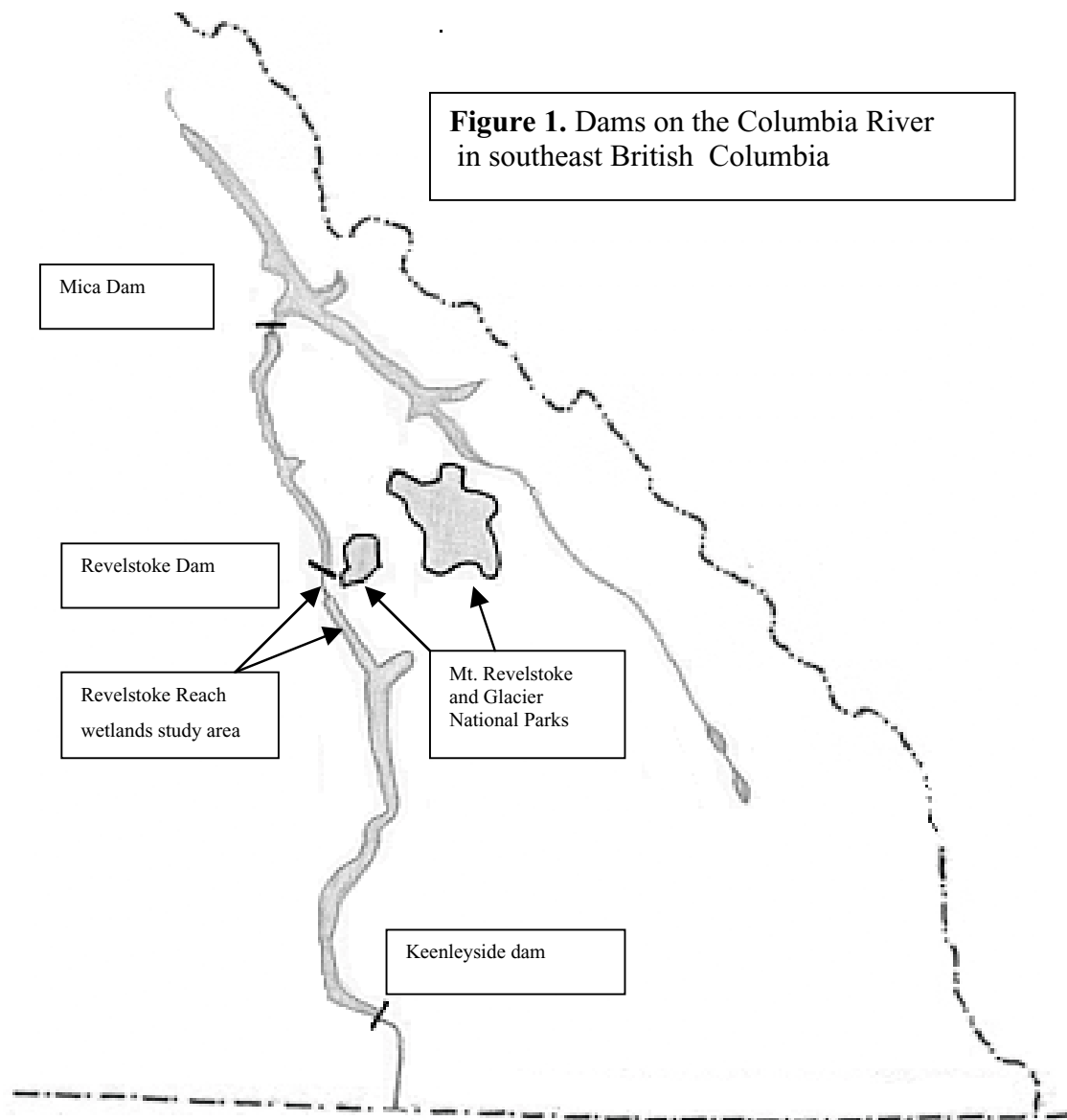
From January 1991 to March 2001 waterbirds were surveyed from fixed points along 12 kilometers of the eastern shoreline of the northern portion of Upper Arrow Reservoir, in a portion of the area known as the Revelstoke Reach wetlands. These surveys documented 65 species of waterbirds with large variations in species richness and abundance by month and zone. The area with the greatest species richness and individual abundance had the most stable water regime. The greatest species richness and individual abundance occurred during the spring and the least during the winter and summer. Several species appeared to be regular breeders but summer flooding may limit reproduction opportunities. There were large month-to-month variations in water levels on the Reach and flooding patterns and timing varied from year-to-year. Within the Columbia River hydro-electric reservoir system, the Revelstoke Reach wetlands appear to be unique in terms of amount of persistent vegetation below the maximum reservoir level. An ACCESS database has been prepared to facilitate further analysis.

### Introduction

The Upper Arrow Reservoir immediately downstream from Revelstoke, British Columbia, Canada is unique within the reservoir system along the main stem of the former Columbia River (Figure 1). In most areas of these reservoirs, long-periods of inundation (Figure 2) and steep shoreline (Figure 3) gradients have resulted in very little persistent vegetation below the high-water level (Bonar 1978, WUP). However, in the Revelstoke Reach wetlands (Revelstoke to Shelter Bay, Figure 4) a relatively flat floodplain at the highest elevations of the reservoir supports a riparian vegetation and marshland complex. In turn, this wetland complex attracts considerable use by waterbirds<sup>1</sup> (Bonar 1978, Tremblay 1992).

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<sup>1</sup> The term “waterbirds” is used to include all wetland bird families (e.g. Ramsar Convention). Waterbirds is used here to include all “wildfowl”, covering divers, grebes, cormorants, Anatidae (swans, geese, ducks), coots, and rails; “shorebirds” (synonymous with waders); and other wetlands bird families notably gulls, terns, herons; (Davidson & Delany 2000) and water-dependent birds of prey.



In response to a growing interest in bird life at Revelstoke and the recognition of the importance of the Revelstoke wetlands to a variety of recreational and water-use interests (Waters 2000, RLL 2000) the Friends of Mount Revelstoke and Glacier initiated the ‘Revelstoke Waterfowl Survey’ in 1991 (Tremblay 1992). The area has become an area of interest for numerous organizations and there have been a number of suggestions on potential future uses of the area (Waters 2000). Given the diversity of these interests, it is important to understand how waterbirds use the area. The goal of this report is to present the results of systematic bird surveys and to make these data available to all interested users.





**Figure 2.** Arrow Reservoir near Drimmie Creek. Lower portion of Revelstoke Reach cannot sustain vegetation cover due to prolonged flooding. Michael Morris photo, April 2001



**Figure 3.** Revelstoke Reservoir near Downie Loop. Steep, rocky shoreline precludes any wetlands. Michael Morris photo, March 1995



**Figure 4.** Revelstoke Reach, Arrow Reservoir. Bright green area is under water at high pond. Michael Morris photo, June 2001

Since the completion of the Hugh Keenleyside Dam near Castlegar and formation of the Arrow Lakes Reservoir in 1968, the Revelstoke wetlands have been seasonally inundated as part of BC Hydro's water-use requirements. With the completion of Mica Dam in 1973 and the Revelstoke Dam in 1984 (135 km and 5 km upstream respectively) the water levels at the Revelstoke Reach wetlands have become a complex function of downstream storage and upstream regulation in order to fulfill power and flood control requirements for the province of British Columbia and to meet the terms of the Columbia River Treaty (RL & L 2001). Prior to impoundment, the elevation of the Upper and Lower Arrow Lakes fluctuated between 420 and 427m (RL&L 2001).

The Arrow Lakes Reservoir is licensed to operate between 420.0–440.1m . Any surcharge above the normal full pool requires approval by the B.C. Comptroller of Water Rights, where a maximum allowable level is 440.75m . The normal operating range typically creates an annual drawdown of 15–20m (RL&L 2001).

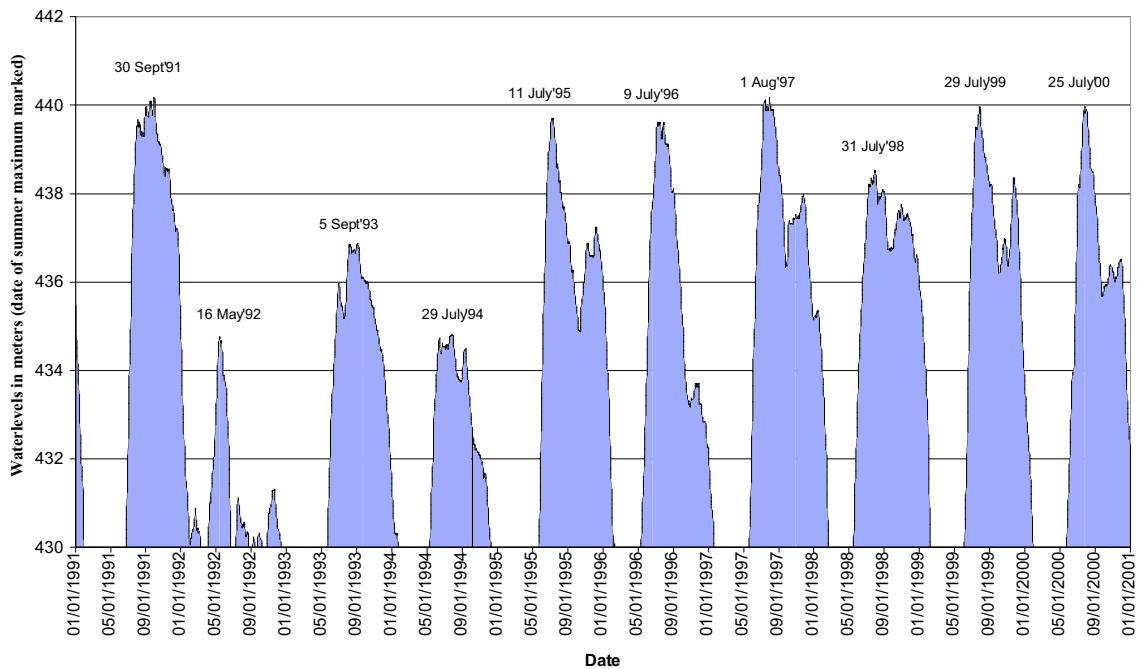
Since 1968, the 'typical' operating regime in the Arrow Lakes Reservoir has been one of minimum water levels during the winter and early spring. The Revelstoke Reach at Drimmie Creek starts flooding at 430 m and rising water levels throughout late spring and summer usually result in the water spreading over all or part of the Columbia's former floodplain (e.g. 440 m maximum at the Trans Canada Highway bridge). The water level then typically drops through the late summer and autumn to a winter minimum. Because of the location of the Revelstoke wetlands at the top end of the Arrow Lakes Reservoir storage system, relatively minor variations in maximum water levels from year-to-year can have dramatically different effects on the wetlands (Figure 5). For example, during the mid-1990's, extensive areas of the wetlands were not flooded at all.

While the timing and extent of flooding during 1968-2000 have produced the pattern of vegetation and waterbird use we see today, this pattern cannot be assumed into the future for several reasons. First, the operating regime is dynamic and will respond to future conditions and priorities set out in the Columbia River Treaty and the future Water Use Plan (RL & L 2000). Secondly, there is now active vegetation management of the area for dust control and this may alter the vegetation pattern.

Lastly, erosion of the former floodplain may result in reducing the elevation of the former floodplain and thus increasing the area subject to longer periods of flooding. As Tremblay (1992) observed, the timing and extent of flooding affected waterbird use of the area from year-to-year and suggested that water levels above 439.5 m resulted in greatly reduced use by waterbirds.

In this report we address the questions of what species of waterbirds use the Reach and how this use varies by species, month, and year. In addition, we present some preliminary observations on the implications to waterbird use, vegetation management, and changing human use of the area.

**Figure 5.** Water Levels: Revelstoke Reach wetlands, Upper Arrow Reservoir, British Columbia, Canada 1991-2001  
(average daily levels measured at Nakusp)



## Study Area

We surveyed waterbirds in that portion of the Revelstoke Reach wetlands within the operational zone of the Upper Arrow Reservoir between the Trans-Canada Highway bridge over the Columbia River at Revelstoke (51° 01' north, 118° degrees 26' west; UTM 04 1600 5000) and a point immediately south of Drimmie Creek (50° 64' north, 118° 12' west; UTM 04 2280 3460). This area has a maximum water level fluctuation of 430–440m. Immediately pre-flooding the area was largely under agricultural development (Nobbs 1998). The original natural vegetation (e.g., pre 1885) in this area is not documented but was likely a mosaic of sloughs, cottonwood-willow riparian forest, and cedar-hemlock forest, part of the Northern Columbia Mountains ecosection (Campbell et al. 1990).

## Acknowledgements

Volunteers from the Friends of Mount Revelstoke and Glacier National Parks staffed this project from the start and provided funding for private vehicle mileage. Without this support from the Friends organization and membership, this project would not have been completed. In particular, we would like to acknowledge the extraordinary volunteer support of Ellen Tremblay (principal observer 1991-1992), Hilary Gordon (driver and recorder 1991-1992, Weldon Jarvis (driver 1993-2001), and Wanda Jarvis (driver 1993-

2001). Parks Canada staff provided advice, encouragement and expertise throughout the project. We appreciate the assistance of Michael Morris in editing the final report. We also would like to express our appreciation to BC Hydro for funding the data input and reporting writing time for the senior author.

## Methods

The area on the east side of the Revelstoke Reach wetlands was divided into 7 zones and fixed vantage points established in each Zone (Figures 6a, 6b). Surveys were conducted on or about the 1<sup>st</sup> and 15<sup>th</sup> of each month from 1 January 1991 to 1 March 2001. The field team including 1 experienced observer and 1 recorder. Principal observers included Ellen Tremblay (1991-1992) and Janice Jarvis (1992-2001). All waterbirds seen from the road using 20x-25x spotting scope and binoculars were counted. Each survey took approximately 3 hours to complete. While an attempt was made to identify all birds to species, it was frequently necessary to list waterfowl at great distance as unidentified. Due to the nature of the landscape of the wetlands, uneven areas with numerous dips and ponds, it may be assumed at differing water levels that not all waterbirds in a zone were visible from the count points. In addition, the survey team recorded any bird species that were seen along the route onto a standard data form.

Weather was recorded at the start of survey (wind, rain, snow, visibility) and a notation was made if the weather changed during the survey. Reservoir water levels at the time of the survey were obtained from BC Hydro Keenleyside and added later to the survey form. If visibility was < 100 m, the count was abandoned. When possible, the survey was rescheduled to the next day (not usually feasible for volunteers). A specific sequence of driving (Appendix 1) and observing was followed in order to maximize survey team safety and viewing of the wetlands. The data were then transcribed into an Access database.

## Results

Water levels varied dramatically throughout the year and from year-to-year (Figure 5). Timing of maximum summer water elevations varied within the limits specified in the Water License. The large flats near the Revelstoke Airport (432–436 m) did not flood at all from 1992-94.

From January 1, 1991 to March 1, 2001 there were 248 waterfowl surveys. Sixty-two species of waterbirds were recorded (Appendix 2) along with 1 hybrid. A total of 135,272 individual birds were seen including: waterfowl 118,128; grebes & loons 482; birds of prey 418; gulls, shorebirds, and coot 16,244. The most numerous birds were Canada Goose, Mallard, American Wigeon, and American Coot and the most frequently seen species were Canada Goose, Mallard, American Wigeon and Great Blue Heron. (Table 1). Bird use varied greatly from zone-to-zone (Table 2). Waterbird use varied greatly from month-to-month (Table 3). Nine species of waterbirds were observed on nests, with newly fledged young, or throughout the breeding season in the count area

most years (Table 4). Waterbird use in terms of species richness and abundance varied greatly from year-to-year (Table 5).

**Table 1.** Most abundant and frequently seen species of waterbirds on the study area portion of the Revelstoke Reach wetlands - January 1991 to March 2001.

Species	Scientific Name	Total seen	Total times seen ( max = 248 )
Canada Goose	<i>Branta canadensis</i>	59,822	191
Mallard	<i>Anas platyrhynchos</i>	27,106	186
American Wigeon	<i>Anas americana</i>	13,755	161
Great Blue Heron	<i>Ardea herodias</i>	974	123
Common Merganser	<i>Mergus merganser</i>	2,115	121
Ring-necked Duck	<i>Aythya collaris</i>	1,478	99
Killdeer	<i>Charadrius vociferous</i>	359	82
American Green-winged Teal	<i>Anas crecca</i>	2053	82
Bald Eagle	<i>Haliaeetus leucocephalus</i>	220	80
American Coot	<i>Fulica americana</i>	13,365	75
Pied-billed Grebe	<i>Podilymbus podiceps</i>	258	71
Common Goldeneye	<i>Bucephala clangula</i>	330	57

**Table 2.** Numbers of individuals and species using observation zones within the study area of the Revelstoke Reach wetlands - January 1991 to March 2001.

Zone Name and Location	Number Individuals	Number Species
A – Railway Point	7,985	33
B – Horse Coral	5,014	26
C – Cartier Bay	24,454	56
D – Montana Slough	17,599	53
E – Outside Runway	25,713	57
F – Flying Club	51,007	63
G – Downie Street Substation	3,624	46

**Table 3.** Numbers of individuals and species by year, within the study area of the Revelstoke Reach wetlands January 1991 to December 2000.

Month	Number of Individuals	Number of Species
January	2,682	11
February	2,218	15
March	16,589	35
April	19,110	54
May	13,289	62
June	3,735	39
July	4,039	40



August	10,393	46
September	10,277	38
October	17,164	44
November	18,199	41
December	13,143	29

**Table 4.** Waterbird species confirmed or suspected of breeding in the Revelstoke Reach wetlands, 1991-2001.

Species	Notes
Canada Goose	Regular breeder, nests with eggs, many observations of young with parents
Mallard	Regular breeder, nest with eggs, many observations of young with parents
Wood Duck	Regular breeder, many observations of young with parents
Pied-billed Grebe	Regular breeder, many observations of young with parents
Great Blue Heron	Regular breeder, know location of rookery, observations of young
Spotted Sandpiper	Regular breeder, many observations of young with parents
Killdeer	Regular breeder, many observations of young with parents
Bald Eagle	Regular breeder, know nest locations, many observations of young with adults
Osprey	Regular breeder, know nest locations, many observations of young with adults
Northern Harrier	Frequent breeder, numerous observations of young
Red-necked Grebe	Occasional breeder, observations of young with adults
American Wigeon	Frequent breeder, observations of young with adults
Belted Kingfisher	Frequent breeder, observations of young with adults
Gadwall	Occasional breeder, observations of young with adults
Northern Pintail	Occasional breeder, observations of young with adults
American Coot	Occasional breeder, observations of young with adults

Wilson's Phalarope	Rare breeder, observation of nest, young with adults
Short-eared Owl	Possible breeder during this study, many breeding season displays observed, confirmed breeder in 2001 (J. Jarvis unpublished data)

**Table 5.** Numbers of individuals and species by year, study area portion of the Revelstoke Reach wetlands, January 1991 to December 2000.

Year	Number of Individuals	Number of Species
1991	21,239	56
1992	20,846	58
1993	13,824	44
1994	10,596	43
1995	12,759	48
1996	12,844	54
1997	7,279	41
1998	12,140	49
1999	11,507	45
2000	11,829	41

## Discussion

The northern portion of the Revelstoke Reach wetlands is unique. The authors know of no other major areas within the impounded areas of the Columbia River that support a quasi-natural wetland vegetation community or consistently attract the numbers and variety of waterbirds described in this report.

Within the Reach, differences in elevation, natural vegetation, and water levels within each zone (see Figures 6a and 6b) has had an effect on the way that waterbirds use specific areas throughout the year. Zones A and B contain no water source beyond a fast moving stream or a small pond for most of the year and are mainly natural grasslands. In these zones, waterbird use is mainly throughout migration periods in the autumn when water levels are typically highest and most of the zone is flooded. Zones C, D, E, and G all contain ponds and natural grasslands on various elevations that provide habitat throughout the year during high and low water levels for breeding, migration, and over-wintering. Zone F contained the most marsh-like habitat and had the highest number of individuals and species recorded in the surveys.

Species richness was least during the winter (December – February) and greatest during the spring (April-May). Individual abundance was least during the winter and summer (December-February, June - July) and greatest during the spring, autumn, and early winter (March-May, August-November). The greatest use is during spring migration when water levels are typically below flood elevations.

Differences in numbers of individuals seen appeared to depend on the migration season for individual species (Table 3). Spring migration happened from mid-March to the end

of May while fall migration happened through August to as late as the first of December, depending on the weather. The wetlands had more species diversity in the spring migration (62 species) than in fall migration (46 species). This difference in numbers could be linked to the lack of available habitat for species that require shallow waters (e.g. waders, shorebirds) during fall migration when water levels were often high.

Although this survey was not designed to detect breeding, incidental observations documented breeding or suspected breeding for several waterbird species. The obvious problem for ground nesters is flooding. However, several species such as Canada Goose, Mallard, American Wigeon, Killdeer, and Spotted Sandpiper arrive early and may avoid high water levels by nesting early. Several other species nest in trees and forage in the Reach. Examples of this group are Great Blue Heron, Wood Duck, Osprey, and Bald Eagle. There have been several breeding season observations of Short-eared Owls and this species may occasionally breed on the Reach. Winter use of the Reach by waterbirds is highly variable and likely dependent on the combination of water level and freezing temperatures.

The hydroelectric operating regime \ has left large areas of the Upper Arrow Reservoir barren of vegetation due to long periods of flooding, especially below 430 m. Areas without vegetation, exposed by the annual hydrological cycle, for dust storms. In response to this problem BC Hydro began a seeding program downstream in the mid-1980s. An annual seeding programme with fall rye treating over 1000 ha of potential dust source area has been in place since. This planting programme may have caused changes in the waterbird use of the area (e.g., more feeding and hiding cover). In particular, it may have attracted some species out of the observational points used in this study thereby affecting the total birds observed.

Reservoir water levels are highly variable from year-to-year depending on requirements for power generation and flood control interacting with snow pack melt and weather. Although there is a general pattern from year-to-year (winter minimums, summer maximums), timing and duration of flooding is variable and have a year-to-year impact on waterbird use.

Other factors that also play a role in the way that waterfowl use the area include the weather and human activities. The temperatures during winter months affect the species and the number of birds in the area. A cold winter will see little to no use in the area beyond that of Bald Eagles, while a warm winter may see waterfowl such as Canada Goose and Mallards holding over here instead of migrating further south. A late summer may affect the numbers and length of time a bird uses this area for rest during migration.

The other major factor affecting the way waterfowl use this area is human activity. The Reach is a major recreational area for Revelstoke residents. On any given day during high or low water, people use the area for dog walking, horseback riding, riding mountain bikes or dirt bikes, skiing, or boating. Most of boating activity until 1999 was of the slow variety, mainly for fishing. In 1999 there was an increase in high speed powerboat use during high water, including the use of jet-skis (J. Jarvis, personal observation). This

may have had effects on nesting birds by large wakes being created and general disturbance to migrating birds. Human use patterns during 2000 were reported in the “Revelstoke Wetlands Conservation Area Feasibility Study” by L. Waters Ltd. The study was commissioned by the Illecillewaet Greenbelt Society to consider the development of a conservation area.

Over the past century, the Revelstoke Reach of the Columbia River has seen dramatic ecological changes. Pre-settlement, the area was likely a mosaic of riparian cottonwood, willow thickets, cedar-hemlock forest, and a network of small-scale sloughs. Located on the main Columbia River trench, it probably served as both a migration corridor for both waterbirds and landbirds (Jarvis and Woods, 1998, 1999, 2000). During the nesting season, a relatively stable water regime would have made the Reach a secure nesting site for several waterbirds. With settlement, some of this area was converted to farm fields, but remnant forests on wet sites would have remained and most of the sloughs were likely unchanged. Field-dwelling species of landbirds such as Savannah Sparrow and Western Meadowlark would have increased and waterfowl may have been attracted to fields of recently harvested crops. Creation of a reservoir in 1968 eliminated all forest habitat below 440 m and reduced the suitability of the area for waterbird nesting. However as this study illustrates, because of its unique situation within the Columbia River impoundments, the Reach retained considerable value for migrating waterbirds and some value to migrating landbirds in fringe grass/willow/cottonwood habitat. This is in contrast to the dramatic reduction in these values north and south of the Reach where prolonged flooding eliminates almost all vegetation in the impounded area.

Active manipulation of the wetlands for dust control and changes in the water regime for hydro-electric generation, recreation, or enhancement of fish and wildlife have the potential to alter the current situation and ways that may be both positive and negative for bird life. A unique opportunity exists on the Reach to study the ecology of this quasi-wetland system and to potentially use this information to enhance ecological values in other areas of the Columbia River reservoir system.

## **Conclusions and Recommendations**

1. The Revelstoke Reach wetlands are unique in the Columbia River system from Donald to the Pacific Ocean and are the only known major area used by waterbirds within the Columbia River system of impounded waters. Increased understanding of the interplay of flooding regimes, vegetation, wildlife, and fish in this area would enhance our ability to predict changes under different management regimes in the future. This database has been developed as a tool to facilitate resource understanding in the upper portions of the Upper Arrow Reservoir.
2. Within the Reach, the wetlands inside the Revelstoke Airport runway are the most significant in terms of waterbird use, both in terms of species richness and individual abundance. Opportunities to create similar ‘pocket’ wetlands may exist elsewhere on the reservoir system..

3. Waterbird and use of the Reach must co-exist with reservoir operations and recreational use of the area. The maintenance of an accessible data base on this resource will assist water-use and land-use planners. We recommend that steps be taken to ensure that long-term monitoring continue and that the resulting data be widely accessible.

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## **Appendix 1. Detailed Description of the Survey Route** (see Figures 6a, 6b)

### **Start: Zone G. *Downie St. BC Hydro Sub-station***

Park at the Downie St. Sawmill log scale if the site is active, if not, park at the gate to the sub-station .

- **Point # 17.** Looking directly at the Downie St. Sub- Station sign, walk to your right and go to the far corner where the paved walkway meets the dirt road. This is the first vantage point. From here, survey from where the trail cuts off the view to the right, next to the log yard, to over the pond and then left to the base of the power lines. Use binoculars to scan the area for Ospreys and Northern Harriers along the power lines and adjacent shorelines. While moving to the next view spot, check the grasslands on both sides of the walkway as Killdeer and Spotted Sandpipers nest in and around the sub-station.
- **Point # 18.** Walk to the left from stop #17 to the next corner of the sub-station and view the area. Scan the wetlands surrounding this area as well as the confluence of the Illecillewaet and Columbia rivers. The sandbar on the south side of the Illecillewaet River often has gulls and geese during migration.

The rest of the survey is conducted in the following order to make use of the safest parking and vantage points.

### **Zone E. *Outside the Airport Runway***

- **Point #14.** At the Revelstoke Airport's second driveway, pull in close to the fence. Scan with the scope from the outside of the runway to where the bushes cut off the view to the right. This is a difficult area to count due to its size and numerous dips in the landscape, so look for landmarks while counting. From the vehicle, continue slowly along this area until stop #13. Stop and count anything seen on this stretch.
- **Point # 13.** Drive along the route until a stream that flows out to the river or just before the field that is being used for agriculture on the right side of the road. Scan along the edge of the field and the stream that runs out to the river. Scan any anywhere that you have not viewed between the stops #13 and #14.

### **Zone D. *Montana Slough***

- **Point # 12.** Beyond Zone E, drive by the field and a small patch of trees on your right. Once past those trees, there is a house on the left (corner of Catherwood Rd.), stop just before their fence.
- **Point # 11.** The next stop is at the 'speed' sign. Scan the flats with the scope. Most of the ponds should be visible. This view this area again from the next stop.
- **Point # 10.** View the slough area from the pullout. Scan over areas you may have missed some due to screening vegetation.
- **Point # 9.,** As the road curves near a tall Douglas fir, there is an outhouse and runway for the model plane club. This area and the stream that runs out to the river at low water are the southern boundaries of Zone D. Scan to the right to complete Zone D.

### **Zone C. *Cartier Bay***

- **Point # 8.** Zone C begins a bit farther along this same curve. A small clearing near another large Douglas fir allows a view out to the river, At low water a pond is visible. This is a large area to scan and there are many dips that shelter birds.
- **Point # 7.** Proceed around the curves until an open area is reached. Past a small outcrop of rock to your right, pull off and count all the way back covering bay. To avoid duplication, view the other stops from here to separate what will be counted in each spot.
- **Point # 6.** This site views this area best. You should view back to stop #7 and towards #5, this area is not only the large pond that is present most of the year but all the flats to the river in low water. In high water this area is one complete bay of water.
- **Point # 5.** This stop is small clearing in the trees where the bushes start to mix with the trees and before the trees become too dense. This area is used to monitor the far end (left side) of the bay and can be difficult, so be patient. View the far end of bay using the point of land as reference. Typically you will see clearly as far as the second road.

### **Zone B. *Horse Coral***

- **Point # 4.** Stop before the cement guardrails. A fenced pasture is below the road. Many trees interfere with the view.

### **Zone A. *Railway Point***

- **Point # 3.** Stop and scan just after passing the first clump of trees.
- **Point # 2.** Continue on to the corner before the clump of trees and stop at #2 and scan out into the pond at all times of the year.
- **Point # 1.** Continue past the clump of trees along the road to the field. Stop #1 should be looking out onto the field with a clear view of the whole field. Drive to the end of pavement and turn around and head back to the Flying Club for Zone F.

### **Zone F. *Flying Club***

- **Point #15.** The Flying Club is the driveway north of the Revelstoke Airport on the west side of the road. Drive in and park by the second building. Scan the ponds on the inside of the runway and count everything in the area. Scan left to right. View out as far as \_ of the way down the island that is in middle of this area. Look for eagles and ospreys often sitting in the trees. Continue back towards town and park at the mail boxes above Red-Devil.
- **Point #16.** Stop at the middle of Red-Devil Hill and count this area from here as well. Take a moment to look at what can be viewed from here before you begin. Half way down the hill there is an opening in the trees. Stay on the pavement walkway as turtles nest in the gravel here and view out onto the area once again. Pick up where you left off from your count at the Flying Club. Walk 2/3 the way up the hill to another opening in the trees in which you can view out onto the wetlands. This is the last stop of the survey.

**Appendix 2.** Most abundant and frequently seen species of waterfowl and water-dependent birds on the Revelstoke Reach wetlands - January 1991 to March 2001

Scientific Name	Species	Total seen	Total times seen (max = 238)
1. <i>Gavia immer</i>	Common Loon	60	35
2. <i>Podilymbus podiceps</i>	Pied-billed Grebe	258	73
3. <i>Podiceps auritus</i>	Horned Grebe	12	3
4. <i>Podiceps grisegena</i>	Red-necked Grebe	57	28
5. <i>Aechmophorus occidentalis</i>	Western Grebe	89	27
	Unidentified Grebe	6	3
6. <i>Phalacrocorax auritus</i>	Double-crested Cormorant	2	2
7. <i>Anser albifrons</i>	Greater-white Fronted Goose	27	5
8. <i>Chen caerulescens</i>	Snow Goose	1	1
9. <i>Chen rossii</i>	Ross's Goose	1	1
10. <i>Branta canadensis</i>	Canada Goose	59,822	192
11. <i>Cygnus buccinator</i>	Trumpeter Swan	139	27
12. <i>Cygnus columbianus</i>	Whistling (Tundra) Swan	131	14
	Unidentified Swan	145	21
13. <i>Aix sponsa</i>	Wood Duck	222	44
14. <i>Anas strepera</i>	Gadwall	93	17
15. <i>Anas penelope</i>	Eurasian Wigeon	35	15
16. <i>Anas americana</i>	American Wigeon	13,755	162
17. <i>Anas platyrhynchos</i>	Mallard	27,106	186
	Mallard x Black Duck Hybrid	1	1
18. <i>Anas discors</i>	Blue-winged Teal	204	32
19. <i>Anas cyanoptera</i>	Cinnamon Teal	385	47
	Unidentified Teal	1	1
20. <i>Anas clypeata</i>	Northern Shoveler	368	48
21. <i>Anas acuta</i>	Northern Pintail	1260	55
22. <i>Anas crecca</i>	American Green-winged Teal	2053	83
23. <i>Aythya valisineria</i>	Canvasback Duck	30	14
24. <i>Aythya americana</i>	Redhead	37	15

**Appendix 2 continued.** Most abundant and frequently seen species of waterfowl and water-dependent birds on the Revelstoke Reach wetlands - January 1991 to March 2001

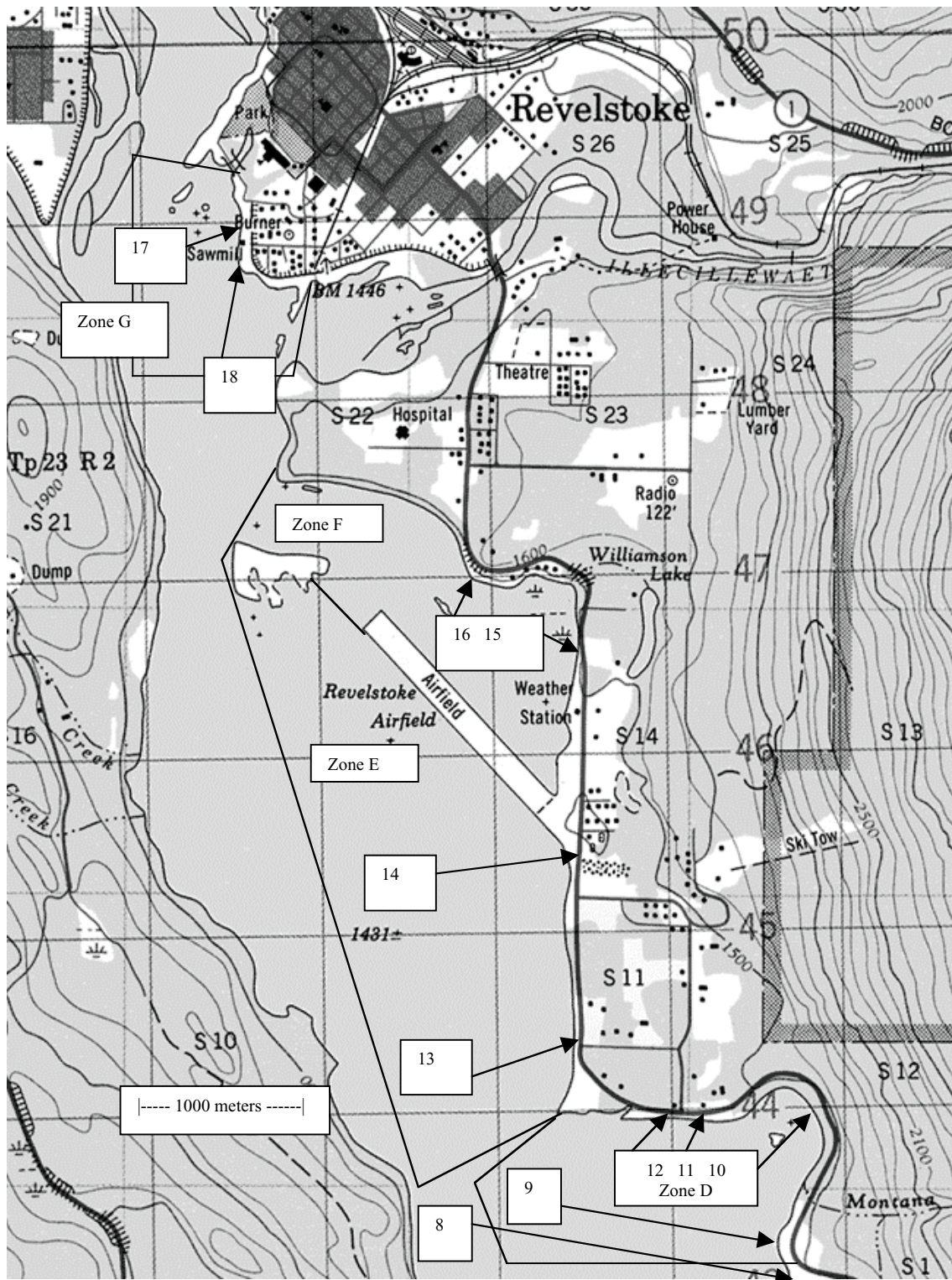
25. <i>Aythya collaris</i>	Ring-necked Duck	1478	90
26. <i>Aythya marila</i>	Greater Scaup	24	4
27. <i>Aythya affinis</i>	Lesser Scaup	336	36
	Unidentified Scaup	256	25
28. <i>Melanitta perspicillata</i>	Surf Scoter	2	1
29. <i>Melanitta fusca</i>	White-winged Scoter	8	1
30. <i>Bucephala albeola</i>	Bufflehead	899	75
31. <i>Bucephala clangula</i>	Common Goldeneye	330	57
32. <i>Bucephala islandica</i>	Barrow's Goldeneye	51	33
	Unidentified Goldeneye	90	18
33. <i>Lophodytes cucullatus</i>	Hooded Merganser	168	40
34. <i>Mergus merganser</i>	Common Merganser	2115	123
35. <i>Mergus serrator</i>	Red-breasted Merganser	3	1
36. <i>Oxyura jamaicensis</i>	Ruddy Duck	156	14
	Unidentified Waterbird	6,394	129
37. <i>Pandion haliaetus</i>	Osprey	98	53
38. <i>Haliaeetus leucocephalus</i>	Bald Eagle	220	80
39. <i>Circus cyaneus</i>	Northern Harrier	87	55
40. <i>Buteo lagopus</i>	Rough-legged Hawk	8	7
41. <i>Parzana carolina</i>	Sora	32	19
42. <i>Fulicia americana</i>	American Coot	13,365	75
43. <i>Grus canadensis</i>	Sandhill Crane	4	2
44. <i>Charadrius vociferus</i>	Killdeer	359	82
45. <i>Recurvirostra americana</i>	American Avocet	1	1
46. <i>Tringa melanoleuca</i>	Greater Yellowlegs	38	10
47. <i>Tringa flavipes</i>	Lesser Yellowlegs	24	7
	Unknown Yellowlegs	7	4
48. <i>Tringia solitaria</i>	Solitary Sandpiper	5	3
49. <i>Actitis macularia</i>	Spotted Sandpiper	143	30

**Appendix 2 continued.** Most abundant and frequently seen species of waterfowl and water-dependent birds on the Revelstoke Reach wetlands - January 1991 to March 2001

50. <i>Calidris mauri</i>	Western Sandpiper	4	1
51. <i>Calidris melanotos</i>	Pectoral Sandpiper	17	2
52. <i>Limnodromus griseus</i>	Short-billed Dowitcher	1	1
53. <i>Limnodromus scolopaceus</i>	Long-billed Dowitcher	37	4
	Unidentified Dowitcher	181	7
54. <i>Gallinago gallinago</i>	Common Snipe	78	38
55. <i>Phalaropus tricolor</i>	Wilson's Phalarope	56	8
56. <i>Phalaropus lobatus</i>	Red-necked Phalarope	5	1
	Unidentified Shorebirds	239	23
57. <i>Larus delawarensis</i>	Ring-billed Gull	23	12
58. <i>Larus californicus</i>	California Gull	23	2
59. <i>Larus argentatus</i>	Herring Gull	8	6
	Unidentified Gull	564	66
60. <i>Sterna hirundo</i>	Common Tern	1	1
61. <i>Asio flammeus</i>	Short-eared Owl	4	1
62. <i>Ceryle alcyon</i>	Belted Kingfisher	51	33



**Figure 6a.** Zones and Survey Points, Revelstoke Reach (north), Arrow Reservoir, British Columbia





**Figure 6b.** Zones and Survey Points, Revelstoke Reach (south), Arrow Reservoir, British Columbia

