Columbia River Project Water Use Plan

Monitoring Program Terms of Reference

CLBMON-49: Lower Columbia River Effects on Wintering Great Blue Herons

October 1. 2012

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Monitoring Program - CLBMON-49
Lower Columbia River Effects on Great Blue Herons

1.0 Monitoring Program Overview

1.1 Background

The Great Blue Heron (*Ardea herodias*) is a large colonial-nesting bird that lives throughout North and Central America. In British Columbia, there is a costal sub-species, *Ardea herodias fannini*, and an interior sub-species, *Ardea herodias herodias* (Campbell et al. 1990). Both sub-species are blue-listed by the province, and the provincial *Wildlife Act* provides year-round protection for herons and their nests (Gebauer and Moul 2001). Both sub-species and their nests also are protected under the federal *Migratory Birds Convention* Act, and the coastal sub-species is listed under Schedule 1 of the federal *Species at Risk Act* as a species of Special Concern.

In the Columbia Basin, the interior sub-species of the Great Blue Heron forages in wetlands and along the margins of lakes and slow-moving rivers (Machmer & Steeger 2004). The herons often nest in old deciduous forest stands, such as black cottonwood, but also use coniferous stands. Some interior Great Blue Herons migrate south during the winter; however, some herons stay in the Columbia Basin and forage where water remains open throughout the winter (Machmer, 2003).

From October through February, Great Blue Herons aggregate at Waldie Island downstream of the Hugh Keenleyside Dam near Castlegar (Machmer 2001, 2002, 2003)(Figure 1). Machmer (2003 p. p 18) suggested that Great Blue Herons likely aggregate at Waldie Island "*when shallow water foraging habitat and access to fish prey is limited elsewhere, because of high water elevations, freezing conditions, and human and other forms of disturbance*." The report provided six recommendations (Machmer, 2003 p. p 20):

i) BC Hydro maintain water elevations at or below approximately 421.0 m [420.7 m][1] elevation during November and December.

ii) BC Hydro maintain water elevations at or above 418.7 m [418.4 m][1] from March to July to discourage access and reduce disturbance from people and dogs during the nesting season.

[1]The elevation recommendations of 421.0 m and 418.7 m were based on elevations recorded at the Robson gauge. Using the Norns Creek discharge rating curve, the respective elevation constraints are 420.7 m and 418.4 m.

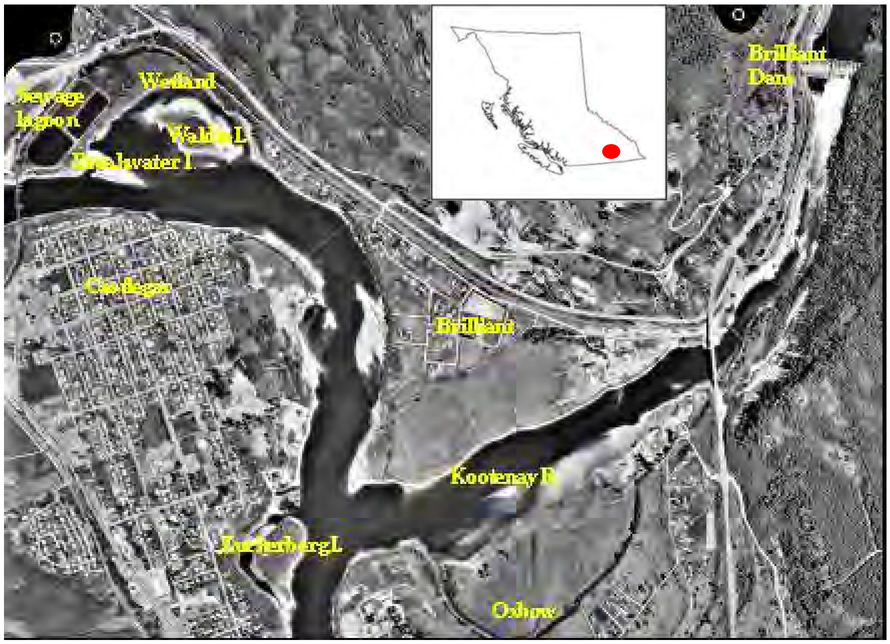

Figure 1 - Location of Waldie Island near Castlegar, B.C. on the lower Columbia River.

iii) Consider the purchase of Breakwater Island, the mainland foreshore and the adjacent wetland and manage the area to a) minimize disturbance to wintering heron aggregations, b) promote heron breeding activity, c) protect other wetland-dependent species, and d) replace signage and enforce trail regulations regarding leaching of pets.

iv) Develop regulations barring use of motorized watercraft near Waldie Island.

v) Initiate an awareness campaign about the breeding use of Waldie Island by herons to minimize disturbance during the incubation and chick-rearing periods and encourage heron viewing from a safe distance.

vi) Given the observed relationship between great blue herons and flows in the Columbia System, it is recommended that this issue be considered in the context of the Columbia Water Use Plan.

As per recommendations (i), (ii), and (vi), the BC Hydro's Columbia Water Use Plan considered the relationship between Great Blue Herons and the flows for whitefish (*Prosopium williamsoni*) (BC Hydro, 2005a). Each December, BC Hydro releases higher flows from the Lower Arrow Lake Reservoir for whitefish and the incubation of whitefish eggs while addressing requirements under the international Columbia River Treaty.

To address "*whether there was an operational link between the mountain whitefish flows and impacts to herons on Waldie Island*" (BC Hydro, 2005a pp. 7-120), the Consultative Committee developed a sub-objective to *"maximize winter refuge habitat for Great Blue Heron at Waldie Island.*" (BC Hydro, 2005a pp. p 4-23) and outlined two monitoring projects (BC Hydro, 2005b pp. p CC-16):

Monitoring Project 1 -	Monitoring of the effects of winter flows and river stage (November 15 to March 1) on Great Blue Heron use of the Waldie Island Area (replication of Pandion Study).
Monitoring Project 2 -	Mark and recapture study of Great Blue Herons (juveniles) nesting in colony adjacent to Revelstoke Reach to determine whether birds from this population winter at Waldie Island (November 15 to March 1).

For Monitoring Project 1, regarding winter flows, the Committee suggested three years of monitoring "*to assess the response of herons to flow and stage regime from the Hugh Keenleyside Dam during the winter period due to its potential effects on availability of shallow-water foraging and winter refuge habitats*" and to "*provide information on habitat use and feasible mitigative actions*."

For Monitoring Project 2, regarding the mark and recapture study, the Committee suggested five years of monitoring to "*address uncertainty related to the importance of Waldie Island as a wintering area for the Great Blue Herons that nest near Revelstoke*", and to "*address question around whether these represent the same individuals that may be susceptible to influences of both reservoir and downstream flow operations*."

1.2 Re-assessment of the Monitoring Program - CLBMON-49

The implementation of CLBMON-49 was deferred because of resource constraints. This deferral provided the opportunity to incorporate information gathered in the interim into the Terms of Reference for this monitoring program.

1.2.1 Monitoring Project 1 - Monitoring of the effects of winter flows on Great Blue Heron use of the Waldie Island Area

Monitoring Project 1 was intended to "*assess the response of heron to flow and stage regime from the Hugh Keenleyside Dam during the winter period due to its potential effects on availability of shallow water foraging and winter refuge habitats*." The monitoring also was intended to "*provide information on habitat use and feasible mitigative actions*" (BC Hydro, 2005b). As the Consultative Committee noted, this would be a replication of the Pandion Study (i.e., Machmer 2003).

Since 2005 when the Columbia Water Use Plan was released, the water-elevation data from the Norn Creek gauge from 2005 - 2012 reveal that recommendations (i) and (ii) from Machmer (2003) have been met. The data reveal that 99% of all days met the recommendation that

i) *BC Hydro maintain water elevations at or below 421.0 m* [420.7 m][2] *elevation during November and December (Figure 2).*

[2] The elevation recommendations of 421.0 m and 418.7 m were based on elevations recorded at the Robson gauge. Using the Norns Creek discharge rating curve, the respective elevation constraints are 420.7 m and 418.4 m.

The 2005 - 2012 water-elevation data also reveal that 83.7% of all days also met the recommendation that

ii) *BC Hydro maintain water elevations at or above 418.7 m* [418.4 m][2] *from March to July to discourage access and reduce disturbance from people and dogs during the nesting season (Figure 3).*

Although the water elevations from 2005 - 2012 were consistently below 421.0 m [420.7 m][2] elevation during November and December as recommended by Machmer (2003) and the Consultative Committee (Figure 2), the number of herons using Waldie Island of those years fluctuated widely (M. Machmer and N. Fields, pers. comm.). This indicates that changes in the number of herons using Waldie Island in the autumn and winter is not linked to water elevation at levels below 420.7 m.

Despite this lack of a link between water elevations and heron numbers, it might still be useful to implement Monitoring Project 1 to monitor the effects of winter flows on Great Blue Heron use of the Waldie Island and assess foraging areas. The number of herons wintering at Waldie Island might be affected if there were prolonged periods of the water elevation exceeding 420.7 m; although, this never occurred from 2005 - 2012. In addition, there were no systematic surveys of the Great Blue Herons from 2005 - 2012 under the Water-Use Plan, so the reports of wide fluctuations in heron numbers cannot be correlated to the water-elevation data. However, it is possible that local community groups have good surveys of the Great Blue Herons at Waldie Island from 2005 - 2012 that could be used to assess the relationship between heron numbers and water elevation. If so, the use of these existing data would suggest that the focus of Monitoring Project 1 should be re-assessed.

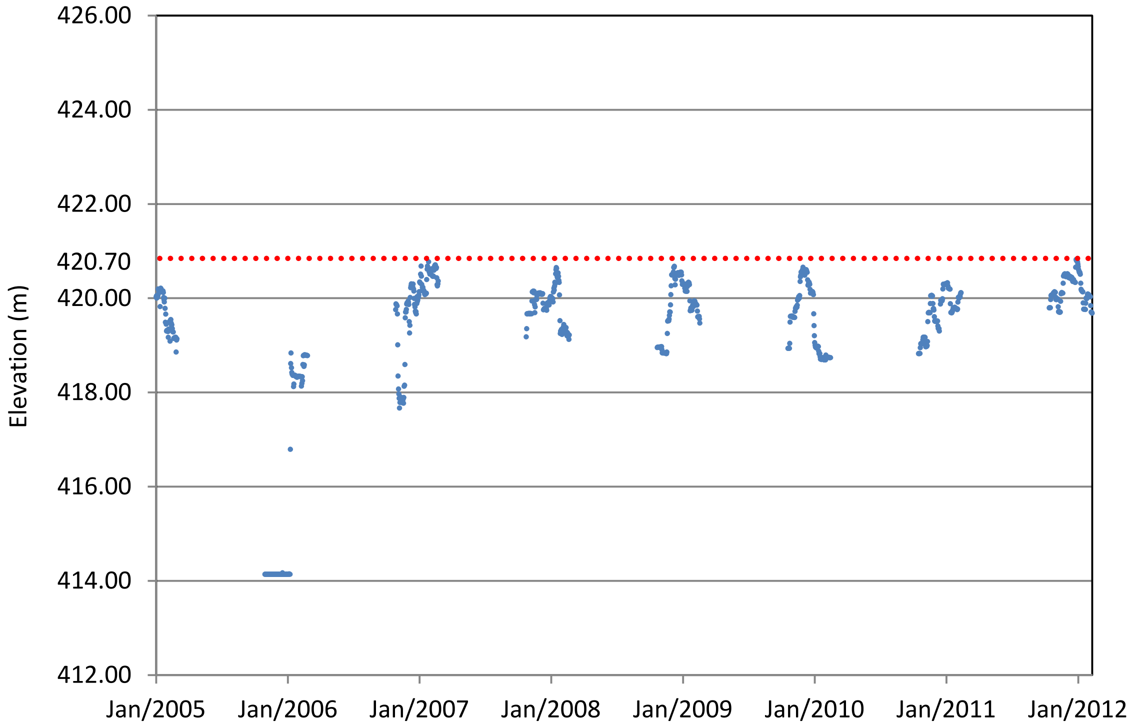

Figure 2 - Mean daily water elevations for autumn and winter (November 1 to February 28) from 2005 – 2012 at the Norns Creek gauge near Waldie Island. Of the total autumn and winter days (n = 898), 99% (n = 889) had water elevations that were lower than 420.7 m (red dotted line). The elevation recommendation of 421.0 m was based on elevations recorded at the Robson gauge. Using the Norns Creek discharge rating curve, the elevation constraint is 420.7 m.

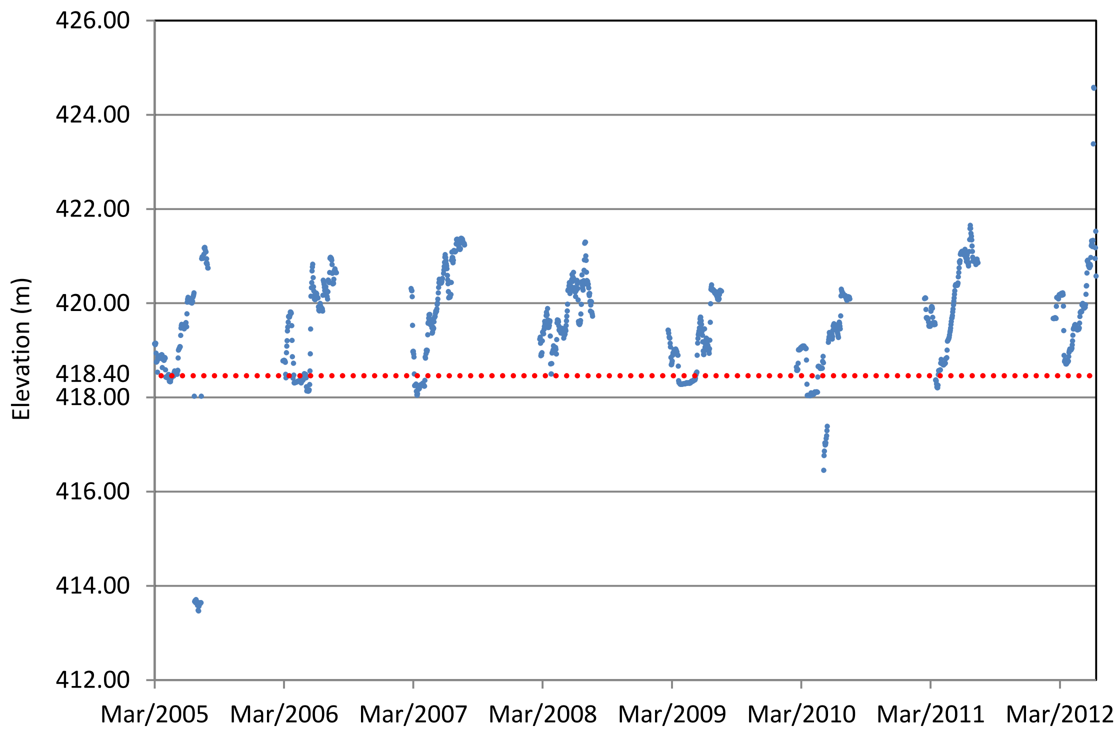

Figure 3 - Mean daily water elevations for spring and summer (March 1 to July 31) from 2005 - 2012 at the Norns Creek gauge near Waldie Island. Of the total number of days from March 1 to July 31 (n = 1188), 83.7% (n=994) had water elevations that were higher than the 418.4 m. The elevation recommendation of 418.7 m was based on elevations recorded at the Robson gauge. Using the Norns Creek discharge rating curve, the elevation constraint is 418.4 m.

1.2.2 Monitoring Project 2 - Mark and recapture study of Great Blue Herons (juveniles) nesting in colony adjacent to Revelstoke Reach to determine whether birds from this population winter at Waldie Island

Monitoring Project 2 was intended to address "*uncertainty related to the importance of Waldie Island as a wintering area for the Great Blue Herons that nest near Revelstoke*." The project also was intended to "*address question around whether these represent the same individuals that may be susceptible to influences of both reservoir and downstream flow operations*" (BC Hydro, 2005b).

Radio telemetry, using either Very High Frequency (V.H.F.) or Global Positioning Systems (G.P.S.), provides the most useful method for conducting an appropriate mark-recapture study for Monitoring Project 2. However, during the initial review by regulatory agencies, First Nations, and stakeholders of the proposed work, there were questions about the safety of the live-capture methods for Great Blue Herons. Relative to many other species, there have not been many studies that have captured and radio-tagged Great Blue Herons, so the live-capture methods are not well developed. Moreover, unlike most bird species, Great Blue Herons are very large and slender birds, and their long legs and wings are particularly susceptible to injury during handling. Accordingly, some reviewers of the initial proposal felt that the relatively low conservation benefit of capturing and radio-tagging herons did not warrant the risk to the birds.

From a study-design perspective, it would be logistically challenging to obtain adequate samples sizes of radio-tagged herons. Even if the live-capture methods were known to be safe and reliable, it would be challenging and costly to capture enough herons to enable statistically or ecologically meaningful conclusions. Even if all of the herons at Waldie Island were to be radio-tagged, it would be challenging and costly to obtain adequate sample sizes of relocation points in an area as vast as the Kootenay Region. Machmer and Steeger (2004) reported 16 known breeding colonies of Great Blue Herons and mapped more potential breeding sites and locations where adult and juvenile herons were observed (Figure 4).

Given the reviewers’ concerns about capture methods and the challenges for study design and logistics, it was recommended that Monitoring Project 2 be omitted from the monitoring program for CLBMON-49.

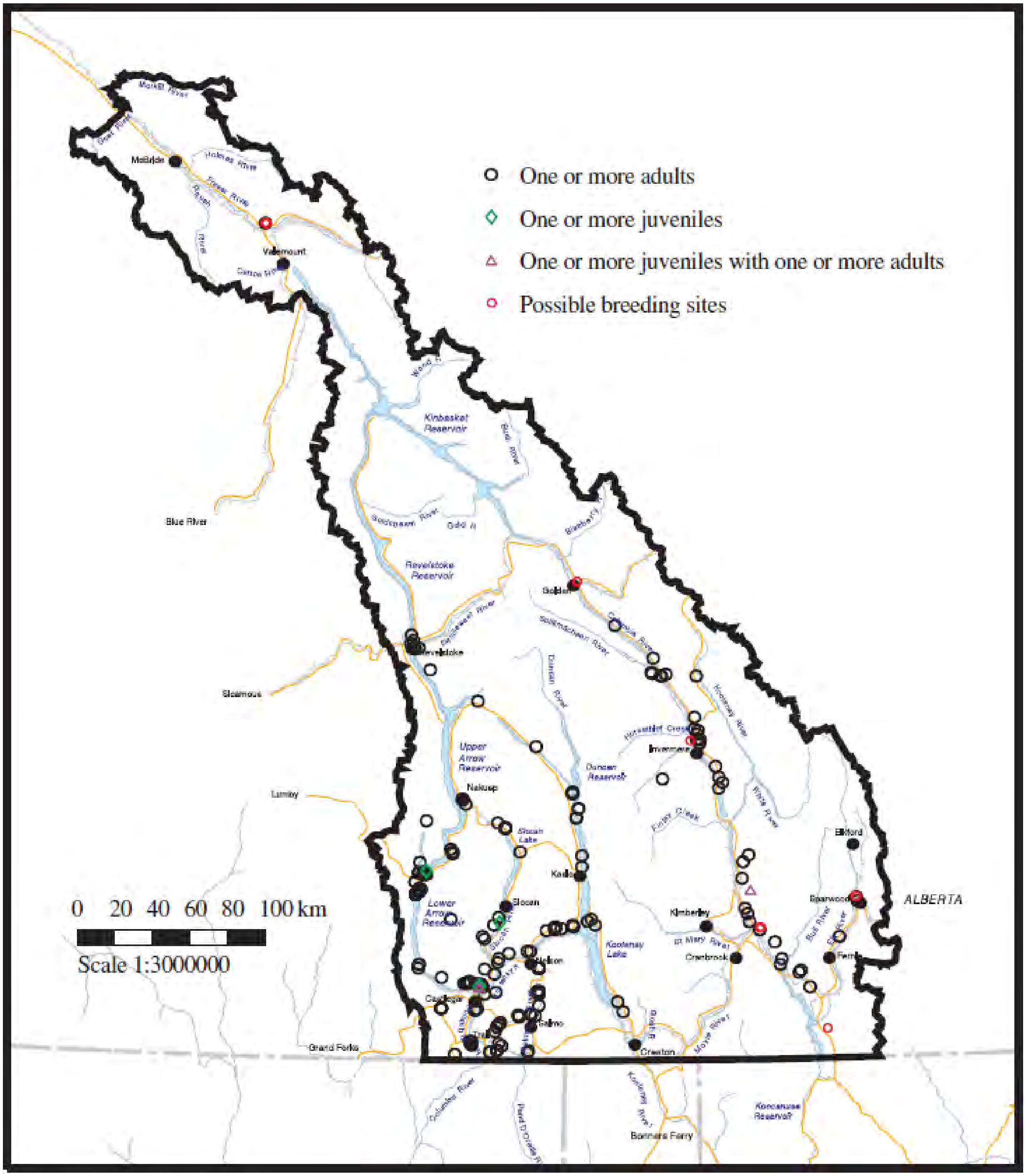

Figure 4 - Locations of potential breeding sites and observations of one or more adult and juvenile herons from Machmer and Steeger 2004.

1.3 Management Questions for CLBMON-49

The Management Questions address the intent of Monitoring Project 1 as outlined by the Consultative Committee to

- address "*whether there was an operational link between the mountain whitefish flows and impacts to herons on Waldie Island*",
- *"assess the response of herons to flow and stage regime from the Hugh Keenleyside Dam during the winter period due to its potential effects on availability of shallow-water foraging and winter refuge habitats*", and
- "*provide information on habitat use and feasible mitigative actions*."

The monitoring project for CLBMON-49 will address the following questions:

1) How does the flow regime in the lower Columbia River influence the number of Great Blue Herons that roost on Waldie Island between November 15 and March 1?
2) Are there operational changes that could improve Waldie Island as a roosting location for Great Blue Herons?
3) Where are the shoreline areas that are used by Great Blue Herons?
4) How does the flow regime affect the area, distribution, and attributes of shoreline areas?
5) How does the flow regime in the lower Columbia River influence the total number of Great Blue Herons that forage along the shoreline in the vicinity of Waldie Island?
6) How does the flow regime in the lower Columbia River influence the distance between Great Blue Herons that are foraging in shoreline areas (*i.e.*, the number of herons foraging/site)?
7) Are there operational changes that could improve the availability of suitable shoreline areas for the Great Blue Herons from Waldie Island?
8) Are there physical works that could improve the availability of shoreline areas for the Great Blue Herons from Waldie Island?

1.4 Management Hypotheses for CLBMON-49

Given the operating constraints outlined by the Consultative Committee (BC Hydro, 2005a), there are not opportunities for manipulative experiments to evaluate the effect of water elevations on the Great Blue Herons at Waldie Island. Instead, heron numbers and heron behaviour must be linked to water elevations opportunistically as water elevations change under other constraints.

For some questions, such as Question 1, it is valid to consider the analysis as a regression, rather than a correlation, because there is a clear independent X-variable (*i.e.*, water elevation) that might affect the dependent Y-variable (*i.e.*, heron numbers). With correlation, the analysis is unaffected if one switches the dependent and independent variables; however, that is not the case here because it is not logical to consider that heron numbers could be an independent factor that affected water elevation. Regardless of whether the analysis is a regression or a correlation, one is interested in how much of the variation in the number of herons can be explained by the water elevation; therefore, one should calculate the regression co-efficient of determination, r^2, which is equal to the correlation co-efficient, R, squared (*i.e.*, R^2).

For some questions, specific hypotheses are not appropriate. For example, it would not be realistic to expect that one could collect enough data to link the quality of shoreline areas to fishing success by herons because in two years of observations, Machmer (2003 p. Table 3) only recorded eight fish captures by herons. Instead, it is appropriate, as Machmer (2003 p. 9) did, to define "*actively foraging when the heron is standing alert or wading in shallow water with their necks extended*." and associate the number of herons actively foraging to the water elevation on that day.

The following one-tailed null hypotheses are to be tested by calculating the associated co-efficients of determination, r^2:

H_1: More than 60% of the variation in the number of Great Blue Herons that roost on Waldie Island between November 15 and March 1 can be explained by the water elevation measured at the Norns Creek Gauge on the lower Columbia River (*i.e.*, the co-efficient of determination, $r^2 > 0.60$).

H_2: More than 60% of the variation in the number of Great Blue Herons foraging along the shoreline in the vicinity of Waldie Island between November 15 and March 1 can be explained by the water elevation measured at the Norns Creek Gauge on the lower Columbia River (*i.e.*, the co-efficient of determination, $r^2 > 0.60$).

H_3: More than 60% of the variation in the distance between Great Blue Herons that are foraging in a shoreline area (i.e., the number of herons foraging/site) in the vicinity of Waldie Island between November 15 and March 1 can be explained by the water elevation measured at the Norns Creek Gauge on the lower Columbia River (*i.e.*, the co-efficient of determination, $r^2 > 0.60$).

1.5 Key Water Use Decision Affected

The key operating decisions that might be affected by this monitoring program are the following:

1) Should the early winter flow releases from Arrow Lakes Reservoir be altered to mitigate potential impacts of high river elevations on overwintering Great Blue Herons in the vicinity of Waldie Island?

   - The monitoring project will provide information on how the current flow regime in the lower Columbia River affects the foraging ecology and overwinter survival of Great Blue Herons.

- The monitoring project might suggest changes to the flow regime that would improve the availability of shoreline winter foraging areas for Great Blue Herons.

2) Are there physical-works projects that would enhance or creating suitable shallow-water foraging areas for the over-wintering Great Blue Herons?

2.0 Monitoring Program Proposal

2.1 Objectives and Scope

The objectives of this monitoring program are to address the Management Questions by conducting field observations at Waldie Island and surrounding areas. This monitoring program will be carried out over three years from 2013 to 2015.

2.2 Methods

2.2.1 Task 1: Project Co-ordination

Project co-ordination involves the general administration and technical oversight of the program, which will include, but may not be limited to the following:

i) budget management,

ii) management of project team,

iii) co-ordination of logistics,

iv) technical oversight of field work, data collection, and data analysis, and

v) facilitation of information transfer among other investigations associated with the Lower Columbia Water Use Plan.

2.2.2 Task 2: Sampling Program

2.2.2.1 Monitoring the Overwintering Heron Population

Surveys will be conducted during the winter Great Blue Heron aggregation to obtain observation information on Great Blue Heron use of Waldie Island and surrounding areas in relation to river flow and water elevation. Data collection should follow inventory procedures for Great Blue Herons of the provincial Resource Inventory Standards Committee (Ministry of Environment, 1998) supplemented with information from Machmer (2003). Surveys will be conducted from the sewage treatment facility near the north shore of the Columbia River to the Kinnaird area, including Waldie Island, Breakwater Island and surrounding areas near Castlegar, where Great Blue Heron activity has been consistently noted in the past (*e.g.*, Brilliant Dam, Kootenay Oxbow, Kootenay-Columbia confluence, Zuckerburg Island, Norns Creek, Genelle) (Figure 5). The surveys should occur from November 1 to March 1 to over-lap with the periods before, during, and after the whitefish flows. Access to this entire study area is possible from land, and a number of vantage points provide excellent visibility to large areas with a spotting scope.

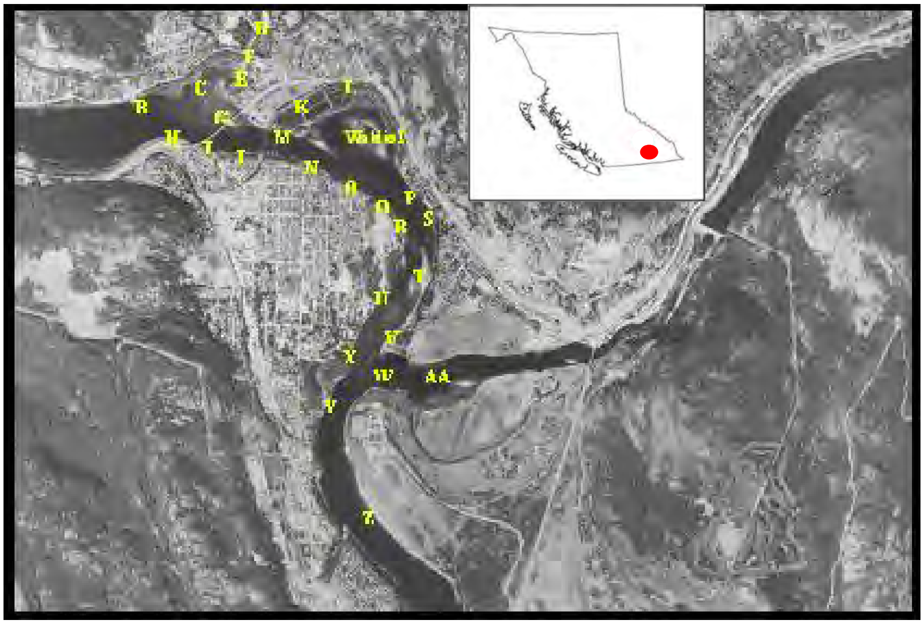

Figure 5 - Locations of off-island forage sites used by Waldie-Island Great Blue Herons near Castlegar, B.C. (from Machmer 2003).

2.2.2.2 Required Sample Sizes for H_1

The data from Figure 4 in Machmer (2003) for the period from October 21 to February 4 enabled an *a priori* estimation of the population parameters for the Great Blue Herons at Waldie Island (Figure 6). Using R (2012), the statistical test for normality for these data was rejected (Shapiro-Wilk W = 0.97, p = 0.001). Similarly, statistical tests for two other common distributions of ecological data, the Poisson distribution ($\chi^2_{0.05,28} = 868.3$, $p << 0.001$) and the negative binomial distribution ($\chi^2_{0.05,25} = 83.2$, $p << 0.001$), also were rejected.

The scatter plot of the heron count data (Figure 6) and the trend in the count data (blue line in Figure 6) are strongly suggestive of a normal distribution. The statistical test for normality likely was rejected because of the high variability in counts among years and because low values for the "*tails*" of the normal curve were not plotted (*i.e.*, low counts of herons during spring and summer when the herons are arriving, leaving, or are absent). Krebs (1999) addresses the implications of such apparent departures from normality:

> "What happens if the variable we are measuring does not have a normal, bell-shaped distribution? Fortunately, it does not matter much because of the Central Limit Theorem. The Central Limit Theorem states that, *as sample size increases, the means of samples drawn from a population with any shape of distribution will approach the normal distribution**. In practice this theorem means

that with large sample sizes (*n* > 30), we do not have to worry about the assumption of a normal distribution."

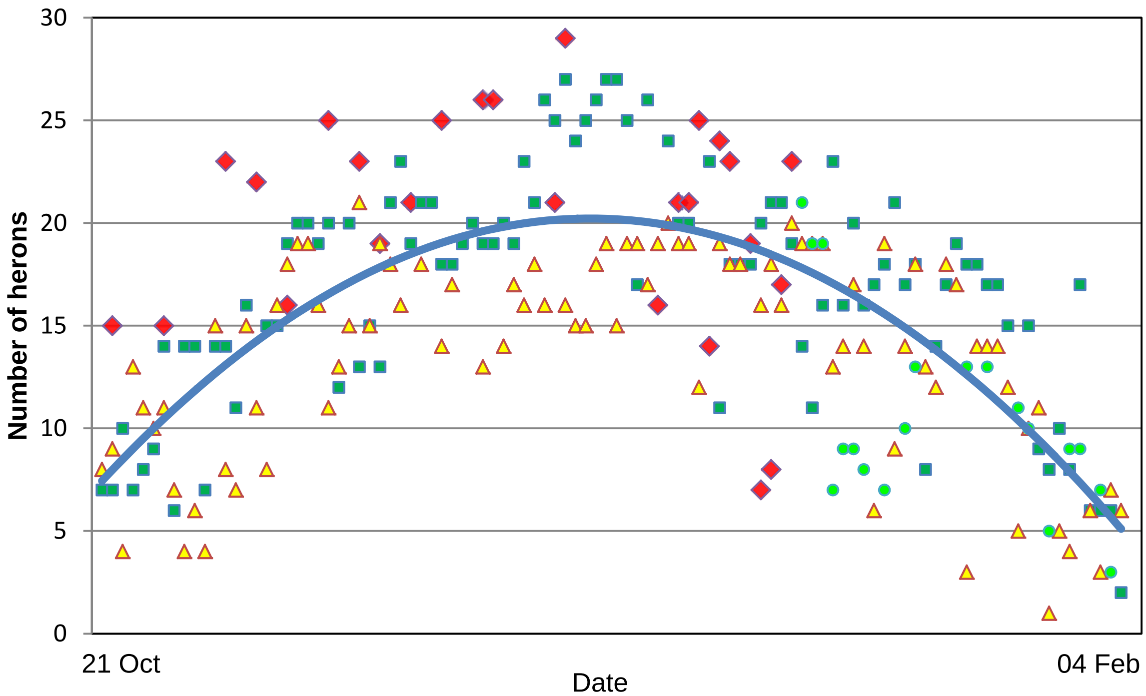

Figure 6 - Count data for Great Blue Herons from 21 October to 04 February for 2000(◊), 2001(■), 2002 (△), and 2003(●) with trend line in blue. Data from Figure 4 in Machmer 2003.

Considering the distribution of the sample population enables one to determine the necessary sample size required to achieve a desired level of confidence in population estimates. It was assuming that the data for the Great Blue Herons at Waldie Island (Figure 6) comes from a normal distribution with a calculated $\bar{x}$ = 15.4 and a coefficient of variation, C.V. = 0.4 (*i.e.*, the ratio of the standard deviation to the mean). Using software from Krebs (1999a), it is possible to calculate the number of randomly selected, independent samples (*e.g.*, days of counting) between October 21 and February 4 that are required for a desired level of confidence (*e.g.,* 95% confidence limit) and a desired width of the confidence interval (*i.e.*, the desired relative error level as a percentage of $\bar{x}$) (Table 1).

Table 1 - The number of randomly selected samples, *n*, required from a normal distribution with $\bar{x}$ = 15.4 and C.V. = 0.4 to obtain different confidence limits and different levels of precision. For example, one requires 428 independent counts of the heron population (*e.g.*, 428 days of counting) to calculate a sample mean, $\bar{x}$, that has a confidence interval with a range of values that, on average, will include the true population mean 99% of the time (*i.e.*, α = 0.01) and with a level of precision of ±5% (*i.e.*, the width of the 99% confidence interval around the sample mean will be within ±5% of the sample mean, $\bar{x}$).

	Desired relative error (% of $\bar{x}$)		
Confidence Limit	5%	10%	15%
90%	175	46	21
95%	248	64	30
99%	428	109	50

Using the example from the caption for Table 1, if one counted the heron population 428 independent times randomly selected between October 21 and February 4 and calculated a sample mean of $\bar{x}$ = 22.0 herons, then, as shown in Table 1, this estimate of the mean (*i.e.*, $\bar{x}$ = 22.0) will have a confidence interval with a range of values that, on average, will include the true population mean, μ, 99% of the time (*i.e.*, α = 0.01) and have a level of precision of ±5% (*i.e.*, the width of the 99% confidence interval around the sample mean will be within ±5% of the sample mean, $\bar{x}$,). Hence, one can say that they are 99% confident (*i.e.*, one can expect that 99 times out of 100) that the true population mean will be within 22.0 ± (5% of 22.0) herons (*i.e.*, 20.9 to 23.1 herons). Of course, there are not 428 days between October 21 and February 4, so, if one is considering "*days*" as independent samples, one must choose a sampling regime of fewer days (*i.e.*, fewer independent samples) and acknowledge the wider confidence limits and the lower level of precision associated with the fewer number of independent random samples.

2.2.2.3 Required Sample Sizes for H_2 and H_3

For H_2 and H_3, *a priori* power analyses will be conducted to determine the required sample sizes for the regression analyses. The results of the power analyses will be presented graphically to show the relationship between power and sample size.

2.2.2.4 Collection of River Flow Data

River flows and water elevations in the Waldie Island area fluctuate as a function of releases from Hugh Keenleyside Dam and backwatering effects created by releases from Brilliant Dam on the Kootenay River. BC Hydro can supply data on flow rates and water elevations from the Norns Creek Fan Gauge and supply air temperature, water temperature, and precipitation levels from the Hugh Keenleyside Dam site.

2.2.2.5 Monitoring Shoreline Areas

Shoreline surveys will be conducted to map the distribution and extent of areas with shallow-water suitable for potential foraging by herons along the lower Columbia River. The surveys will collect data on number of herons using the shoreline areas and will collect data on the physical attributes of the shoreline areas that could be ecologically relevant to heron foraging behaviour, such as water depth, water velocity, water turbidity, surrounding vegetation, substrate, and distance to sources of disturbance.

The shoreline surveys will record the use of shorelines by herons to enable assessment of potential effects of high water flows and elevations on the availability or use of these areas by herons.

The shoreline surveys will be conducted in areas described in Section 2.2.2.1. The first survey will be carried out during the early December when river flows are higher and more variable. The shoreline surveys should attempt to record data for a minimum of 2 surveys when water elevations are below *421.0 m* [420.7 m][3] and a minimum of 2 surveys when water elevations are above *421.0 m* [420.7 m]. A minimum of 2 shoreline surveys should be repeated when water flows are lower and more stable, usually in January. Access to this entire study area is possible from land, and a number of vantage points provide excellent visibility to large areas with a spotting scope.

2.2.3 Task 3: Data Analysis

2.2.3.1 Great Blue Heron Population

Count data for the Great Blue Heron population will be presented for Waldie Island, the whole study area, and for relevant geographic sub-sections within the study area related to the shoreline monitoring areas. Reports will provide plots, summary tables, and all raw data in either the main text or an appendix. The locations of herons will be recorded and mapped.

2.2.3.2 Use of Shoreline Areas

Data from the shoreline monitoring will be mapped for different water elevations to indicate the changes in the area available for herons to forage. The locations of herons should be linked to the shoreline maps.

2.2.4 Task 4: Reporting

In Year 1 (2013) and Year 2 (2014) of the project, an analysis-summary report will be submitted by March 15, and an annual-progress report will be submitted by August 15. The analysis-summary report will be a summary of the data collected during the recent field season. The annual-progress report will provide a comprehensive description and review of the work and analyses undertaken

[3] The elevation recommendations of 421.0 m and 418.7 m were based on elevations recorded at the Robson gauge. Using the Norns Creek discharge rating curve, the respective elevation constraints are 420.7 m and 418.4 m.

that year to monitor the Great Blue Heron population and the shoreline areas. The annual-progress reports will include summaries of the data collected to date.

In the final year of the project, Year 3 (2015), a comprehensive final report will be prepared that includes the following:

i) an executive summary,

ii) a description of the methods used,

iii) a comprehensive section of results including a comparison of results among years,

iv) a detailed summary of the findings as they relate to the management questions,

v) recommendations for

   a) modifying early winter operations to reduce impacts on the overwintering Great Blue Heron population at Waldie Island or

   b) a description of physical works (*e.g.*, enhancing or creating suitable shallow-water foraging areas, and

vi) a digital appendix with relevant data, including a database of heron count data, a database of map data, and text files of the computer code (*e.g*., R code) used for all statistical analyses.

Reports will follow the standard format for Water Use Plan monitoring projects. All reports will be provided as three hard-copies and as unlocked Microsoft Word and Adobe Acrobat (pdf) digital files.

2.3 Interpretation of Monitoring Program Results

Results of the monitoring program will be used to inform decisions regarding the early winter water flow regime in the lower Columbia River. The results will also inform decisions regarding opportunities for physical works to protection or enhance shoreline foraging areas.

2.4 Schedule

The monitoring project will be conducted over four consecutive years during the implementation of the Columbia River Water Use Plan (Table 2). Surveys of foraging HABITAT within the study area will be conducted once during the pre-whitefish flow period when flows are higher and more variable (early December) and again during the whitefish flow period when flows are lower and more stable (early January).

Table 2 - Project Schedule for CLBMON-49 Year 1 (2013) to Year 3 (2015)

Task	Sept - Oct	Nov - Dec	Jan - Feb	15 Mar	Apr - July	15 Aug
Project Co-ordination	●	●	●	●	●	●
Heron Monitoring		●	●			
Shoreline Mapping		●	●			
Analysis Summary				●		
Fiscal Year-end Summary				●		
Data Analysis					●	
Report Write-up					●	
Annual Report Due						●

2.5 Budget

Total revised program costs: $243,088.

3.0 Literature Cited

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