

Peace Project Water Use Plan

Williston Recreation Use

Reference: GSMON-20

**BC Hydro Williston Reservoir Recreation Use Monitoring
Program, Data Report Year 4 (2012)**

Study Period: May – October 2012

Synergy Applied Ecology

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BC HYDRO WILLISTON RESERVOIR RECREATION USE MONITORING PROGRAM, DATA REPORT YEAR 4 (2012)

ABSTRACT

BC Hydro is planning new boat launches and improvements to existing boat launches at several recreation sites along the Williston Reservoir. A 10-year reservoir recreation use monitoring program was initiated in 2009 to assess use of the boat launch sites before and after improvements. This is a summary report presenting the results of Year 4 (2012) pre-improvement use monitoring at 6 recreation sites, including Elizabeth Creek and Dunlevy in the Peace Reach, and Finlay Bay (76 Mile), Six Mile Bay, Cut Thumb Bay (38 Mile), and Alexander Mackenzie Landing in the Parsnip Reach. Boat launch condition varies among sites and no improvements to launch structures were made in Year 4 (2012). Vehicle counters and remote cameras were used concurrently to evaluate site use. Total use by site estimated from photo-corrected counter data varied from 296 visits at Finlay Bay to 878 visits at Alexander Mackenzie Landing between May 23 and October 31 2012. Consistent with Year 3 (2011), the proportion of photo-validated site users that brought boats varied from 17.5% at Alexander Mackenzie Landing to 79.1% at Elizabeth Creek. Reservoir elevation strongly influenced boat launch use at Six Mile, Cut Thumb and Dunlevy in Year 4 (2012).



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INTRODUCTION

BC Hydro is planning the construction of new boat launches or improvements to existing boat launches at several recreation sites along the Williston Reservoir as part of the Access, Navigation, and Safety Management Plan of the Peace Water Use Plan (WUP). Physical works are intended to facilitate improved boater access to the reservoir at all water elevations. To allocate future efforts relative to this objective appropriately, a 10-year site use monitoring program has been implemented to assess seasonal use of boat launches before and after improvements (BC Hydro 2008). Results of the monitoring program are expected to address 2 primary management questions:

- Does recreational use of the Williston Reservoir boat launches increase after boat access is improved?
- What is the frequency of use of newly constructed boat launches? Specifically, does seasonal use change with improved access to new areas of the reservoir, and improved access during low reservoir levels?

Six recreation sites scheduled for improvements were monitored in Year 4 (2012) and include 5 sites with existing boat launches and 1 site with no constructed boat launch. Remote vehicle counters installed at the access to each recreation site or boat launch provided an estimate of site-specific, temporal use patterns. However, inferences derived from vehicle counter data alone are limited in scope and may over estimate use, and relying on a single unit or technology for remote data collection has inherent risks. To account for these limitations motion-sensitive cameras were also employed. Photo-validated site use records increase confidence in the estimates resulting from counter data and provide insight to the following:

- The proportion of recreation site users with boats
- The duration of each site user's visit
- The number of repeat users at each site

Year 1 (2009), Year 2 (2010) and Year 3 (2011) results were reported by Cubberley and Hengeveld (2010, 2011, 2012). This is a summary report presenting the results of the fourth year of baseline (pre-improvement) recreation site use monitoring.

METHODS

Study area

Williston Reservoir

The Williston Reservoir is the largest man-made, hydroelectric reservoir in British Columbia with an area of 1,779 km² and a shoreline perimeter of 1,700 km (Figure 1). The reservoir offers considerable recreational fishing, hunting and wildlife viewing opportunities as boaters can access remote, undeveloped areas of the watershed with relative ease. The maximum licensed water elevation is 672 m asl and a minimum elevation of 640 m asl, with the lowest water elevation typically reached in April annually.



Figure 1. The Williston Reservoir and surrounding watershed boundary in northern British Columbia. The W.A.C. Bennett and Peace Canyon generation stations are located on the Peace River adjacent to the community of Hudson's Hope.

Six recreation sites that provide boater access to the Williston Reservoir were selected for monitoring (BC Hydro 2008). Two of these sites, Elizabeth Creek and Dunlevy, are in the Peace Reach while the other four sites, Finlay Bay (76 Mile), Six Mile Bay, Cut Thumb Bay (38 Mile), and Alexander Mackenzie Landing are in the Parsnip Reach (Figure 2). Boat launch conditions vary among sites and no improvements were made in 2009-2012 to any of the monitored launches (Table 1).

Table 1. Boat launch status at 6 Williston Reservoir recreation sites monitored in Year 4 (2012).

Site	Description
Cut Thumb	No formal boat launch
Six Mile Bay	Constructed gravel boat launch suitable for use at mid-high water levels Small boats can be walked in at low water levels
Finlay Bay	Constructed gravel boat launch suitable for use at mid-high water levels
Elizabeth Creek	Constructed concrete boat launch suitable for all water levels
Dunlevy	Constructed concrete boat launch suitable for high water levels only
Mackenzie Landing	Constructed concrete boat launch suitable for use at mid-high water levels

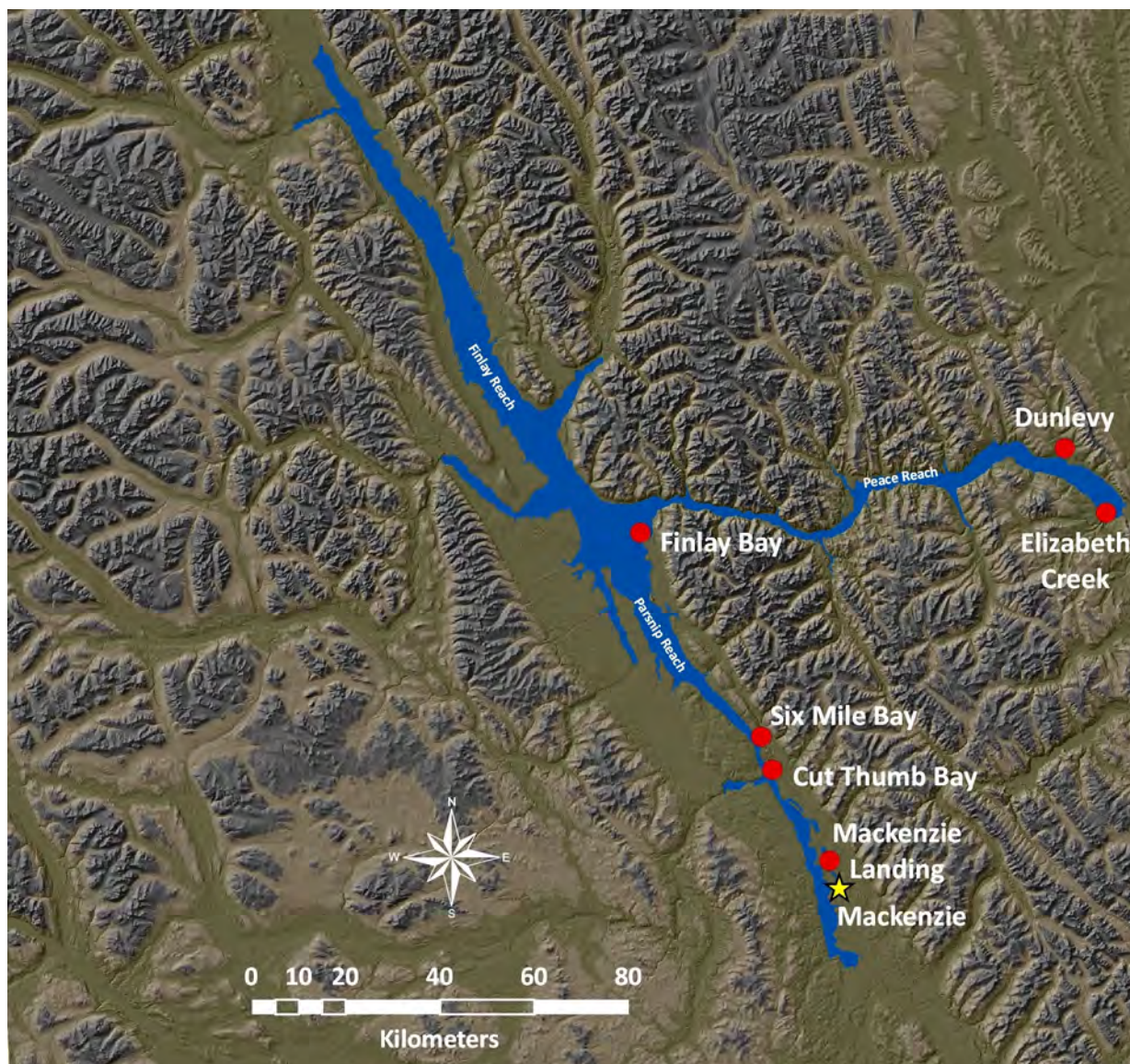


Figure 2. Williston Reservoir recreation sites monitored in Year 4 (2012).

Recreation Site Descriptions

Cut Thumb Bay recreation site is located approximately 35-40 minutes driving time from Mackenzie. Access is via the Parnip West Forest Service Road (FSR), a well-maintained, radio-assisted gravel mainline, turning west between the 33 and 34 km markers onto a 4 km long gravel spur road. The site consists of 9 camp stalls with picnic tables and 3 outhouses. During low reservoir elevation there is a large gravel bar where users can park, camp, and launch boats (Appendix A). The narrow road that leads to the gravel bar becomes the boat launch at highest water elevation. The reservoir water elevation dictates how much room users have to launch boats at this site.

Six Mile Bay recreation site is located approximately 45-50 minutes driving time from Mackenzie. Access is via the Parsnip West FSR, turning west at the 41 km marker onto an approximately 1 km long, dirt access road. There is one camping spot at high water, located right beside the top of the boat launch, with one outhouse available. At low reservoir elevation, an open, sandy area provides additional parking or camping space. Access to this sand bar is via the dirt road that also serves as the boat launch (Appendix A). At low water elevation, it may be difficult to launch boats as there is a steep drop off to the water and the sandy substrate may cause vehicles to become stuck. If the one camp spot is taken at high water elevation, it constrains the amount of room that visitors have to maneuver, and may deter use of the launch and limit parking.

Finlay Bay recreation site is located approximately 1.5-2 hours driving time from Mackenzie. Access is via the Parsnip West FSR. At the 96 km marker, the Parsnip terminates and there is a turn off onto a 1 km long, narrow (approx. 4 m wide) gravel road leading to the recreation site. The site is user maintained and consists of 11 camp stalls with picnic tables and 3 outhouses. There is also a large open field area where many users prefer to camp and where boat trailers are parked. The boat launch is a short gravel road that is approximately 4 m wide (Appendix A). There are remnants of old slabs of concrete and pieces of rebar laying off to the side, indicating that a concrete launch once existed. At low reservoir elevation, vehicles must drive over rocks and sand to reach the water.

Elizabeth Creek recreation site is located approximately 20 minutes driving time from Hudson's Hope. Access is via paved Highway 29, turning right (north) approximately 300 m after crossing the crest of the WAC Bennett Dam. The site is intended for day-use, as there are no defined camp stalls, but overnight parking is common. There are two outhouses on site and a modest gravel parking lot with sufficient area for large vehicles. The boat launch is approximately 6 m wide, constructed of concrete and in good condition (Appendix A). The boat launch has been constructed to allow all sizes of boats to access the reservoir at both low and high water elevation. Elizabeth Creek will not be improved and is the designated control site for the monitoring program.

Dunlevy recreation site is located approximately 40 minutes driving time from Hudson's Hope. Access is via Highway 29, turning north on 12 Mile Road and following this well-maintained gravel road to the site. There is a large open area for parking with 2 outhouses nearby. Although the site is intended as a day use site, there is evidence that the site is used for overnight camping. The boat launch is not usable during low reservoir elevation due to a steep sandy drop-off (Appendix A). As well, the launch is in disrepair, as the concrete slabs on one side of the launch have collapsed due to shoreline erosion, rendering only one side (3 m wide) of the launch usable. This site is part of Butler Ridge Provincial Park.

Alexander Mackenzie Landing recreation site is located approximately 10 minutes driving time from Mackenzie. Access is via the Parsnip West FSR for approximately 7 km with several signs that lead users to the site from Highway 39. The site is well-maintained and designated for day use with a picnic area, cooking shelter and amphitheater. There is a modest area for parking with 2 outhouses on site. Immediately adjacent to the day use site is the BC Hydro Alexander Mackenzie Landing campsite which contains 10 camp stalls suitable for all RVs. A maintained foot path joins the two sites. The boat launch

is approximately 6 m wide, constructed of concrete and in good condition (Appendix A). Users launch directly from the concrete slab at high reservoir elevation, but must travel further down foreshore area on a rudimentary, gravel road to access the reservoir at low elevation.

Data collection

General approach

Data collection repeated the methods established in Year 1 (2009) and refined in Year 2 (2010) and Year 3 (2011). Recreation site use monitoring was accomplished using remote vehicle counters and motion-sensitive remote cameras synchronized by date and time. While the counters provide baseline data for monitoring trends in site use, the primary purpose of camera data is to estimate percentage of visitors bringing boats to each site. Because access and boat launch layouts differed among sites, we placed the monitoring equipment along the access roads into each site, except at Elizabeth Creek and Mackenzie Landing, in order to keep data capture consistent between sites and among years. At Elizabeth Creek and Mackenzie Landing, remote monitoring equipment was installed directly adjacent to the constructed, concrete boat launch. Equipment was concealed to reduce the likelihood of changes in site user behavior reacting to the presence of monitoring equipment, and to lower the probability of theft or vandalism. No personal user information was collected as this was not relevant to our analysis. Vehicle counters and cameras were downloaded in the field approximately every 6 weeks and then re-deployed. All captured data was screened after download in the field to alert the field crew of potential problems, monitor battery voltage, and ensure data was transferred and secured without error. Upon return to the office each day, field data was imported to a secure project directory supported by a redundant back up protocol. Results are reported as total monthly frequencies of use per site for mid-May through October.

Vehicle counters

We installed Generation III (G3) vehicle counters manufactured by TRAFx Research Ltd., Canmore Alberta, pre-programmed to VEH-4d mode. The counters employ magnetometers that are capable of operating in temperature ranges of -40°C to 50°C with an expected battery life of approximately 7 - 14 months and enough storage to accommodate up to 14,000 data records. All counters were deployed with the same settings as previous years to ensure consistency in data interpretations among sites (Table 2). Counters were placed in waterproof, moisture controlled cases roadside at each site as per manufacturer's specifications, such that it would detect vehicle traffic traveling in both directions.

Table 2. Vehicle counter settings for monitoring Year 4 (2012). Settings are the same as previous years.

Parameter	Setting
Period	000
Delay	024
Threshold	012
Rate	Slow

Remote cameras

We installed ScoutGuard SG550 digital cameras that incorporate a passive infra-red motion sensor. The cameras operate with either 4 or 8 'AA' batteries or an external 6V DC power source. Eight batteries were used in each camera in order to prolong the battery life (approximately 80 days). All photos were stored on 2GB SD memory cards, allowing for over 2000 photos at 3MP resolution. The cameras operate in temperatures ranging from -20°C to 60°C and humidity of 5-90%. All cameras were programmed with the same settings (Table 3), mounted in steel lock boxes lightly concealed and installed in areas where the photo contained the largest field of view possible. In the event camera set-ups were discovered, lock boxes were labeled with a brief project description and a phone number to allow users to contact SAE project staff for more information.

Table 3. Remote camera settings for monitoring Year 4 (2012). Settings are the same as previous years.

Parameter	Setting
Mode	Camera
No. photos per event	1
Photo quality (MP)	3
Delay (sec.)	0
Sensitivity	High
Time stamp	On
Timer	Off

Data analyses

Vehicle counter and remote camera data cross-referenced by event date and time stamps were imported to an MS Access database. We used the equipment manufacturer's specifications as a guide to devise a protocol for identifying and removing duplicate events, which can occur when a vehicle travels slowly past the counter or parks near the counter. A series of counter events within 10 seconds of each other were deemed redundant to the first event of the series unless a second photo-validated event was logged during this interval. For events that could be photo-validated, 'false' events such as maintenance vehicles, ATVs and cyclists detected by the counter were excluded from the total count data unless they were using the boat ramp (e.g. RCMP, BC Hydro).

Counter data were photo-validated by assigning unique user vehicle IDs that allowed for an estimate of the minimum number of users who visited each site between mid-May and October, the proportion of site users with boats, the duration of stay, and whether they were a repeat visitor. In some instances we observed multiple counter events by the same vehicle(s) coming and going throughout the day(s), but only one photo of the vehicle either initially arriving or its final departure. So that these orphaned data could be included in our estimates, database code routines were written to calculate the minimum duration of stay under these conditions. As a result, mean site stay is slightly underestimated.

Year 4 (2012) estimates followed the Year 3 (2011) method (Cubberley and Hengeveld 2012). Given that counter units function at nearly 100% reliability while photo success varies among sites (Cubberley and Hengeveld 2011), we used the total proportion of photos, including blank photos, associated with counter events at each site as a correction factor. This correction factor was used to adjust the number of total unique photo-validated users to estimate site use at each location. This method also enables the calculation of upper and lower confidence limits around the estimate. The lower limit is photo-validated users while the upper limit is the total counter events divided by hypothetical site use patterns: dividing by 2 (arrival - exit) at Cut Thumb Bay (38 Mile), Six Mile Bay, Finlay Bay (76 Mile), and Dunlevy; dividing by 4 (down loaded - up empty - down empty - up loaded) at Elizabeth Creek and Alexander Mackenzie Landing.

We expect that future boat launch improvements will likely result in closures during some or all of the boating season at some sites. The Elizabeth Creek closure between June 26 - August 3 2012 provided an opportunity to test the compensatory response of boaters to opt for the next closest launch or choose not access the reservoir in the event of a closure. This information is useful for mitigation planning to reduce the inconvenience to the public during construction activities. Further, evidence of significant user increases at nearby recreation sites because of construction will need to be accounted for during final analysis. To do this, we compared the total number of boaters launching daily at Dunlevy in Year 4 (2012) with boater data for the same period in Year 3 (2011). As the number of boater visits per day were not normally distributed, pair-wise differences were evaluated with a two-sided Wilcoxon Signed Rank Test ($\alpha = 0.05$). We used the `wilcox.test` function from the package `STATS` in R statistical software (R Development Core Team 2012). The function transforms variables by combining each sampling period and ranking daily count data by employing continuity correction to account for tied ranks.

Lastly, because Williston Reservoir water elevation appears to affect the effort required to launch boats at each site, we used simple regression plots to examine trends in daily use by boaters as reservoir elevation increases throughout the monitoring period.

RESULTS

Total use by site estimated from photo-verified counter data varied from 296 visits at Finlay Bay to 878 visits at Mackenzie Landing between May 23 and October 31 2012 (Figure 3). Reservoir elevation was 661 m asl at the beginning of the monitoring season, 4.5 m higher than 2011. Spring freshet prompted reservoir elevation to rise quickly, particularly in June (Figure 3).

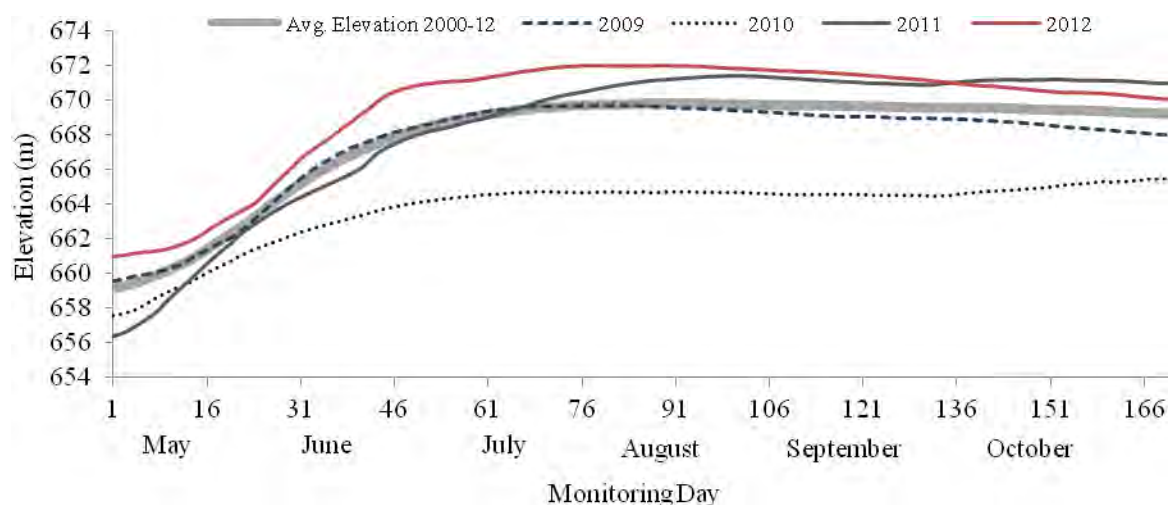


Figure 3. Williston Reservoir daily average elevation during recreation site monitoring period Year 1 (2009) - Year 4 (2012) compared to the mean of daily average reservoir elevation between 2000 and 2012. Monitoring day 1 corresponds to May 14 while monitoring day 171 corresponds to October 31.

Poor weather in the spring limited use at all sites except Mackenzie Landing which hosted 3 well attended community events June 8 - 9, June 10, and June 16 - 17 2012. Favourable weather in summer and fall compensated for the slow start to the season, ending with similar user visits as previous years (Figure 4). Due to poor ramp condition, low reservoir elevation restricted boat launching operations at Six Mile Bay and Dunlevy more than at other sites during May – mid-June until reservoir elevation approached 665 m asl. As reservoir elevation exceeded 671 m asl., boat launching at Cut Thumb was hindered due to the mobilization of previously piled woody debris along the shoreline blocking the boat launch area (Appendix A). This led to an increase in visits at Six Mile beginning in July. The debris in launching areas at Cut Thumb was removed in mid-August.

A large multi-year construction project at the WAC Bennett Dam continued and required those wishing to use the Elizabeth Creek boat launch to register with facility security and be escorted by a pilot vehicle through the construction zone. Construction traffic using the launch decreased from 4100 events the previous year to 1160 events during the Year 4 (2012) monitoring period. Construction activities were identified and excluded where possible, but likely elevated our site use estimate as unmarked construction vehicles were treated as unique visitors. Between June 26 - August 3 2012, high reservoir water elevation necessitated spilling at the W.A.C. Bennett Dam and BC Hydro closed the Elizabeth Creek boat launch for safety reasons as the spillway intake is nearby. Because the closure occurred during a popular month for boating, the number of site users was lower than previous years.

Space limitations arising from high reservoir elevation are deterring boaters from using the Six Mile Bay launch. High reservoir elevation in Year 4 (2012) restricted parking and movement of vehicles particularly if the one campsite was occupied. Several vehicles with boats and RVs, unable to turn around, were observed backing out of the site over the entire length (>1 km) of the access spur road.

Vehicle counters

Vehicle counters were deployed at all sites May 23 - 24 2012 and operated continuously at Cut Thumb, Six Mile, Finlay Bay and Mackenzie Landing until the end of the monitoring period, October 31 2012 (161 days). Counters at Dunlevy and Elizabeth Creek. were removed October 29 2012 (159 days). A total of 16,257 new counter event data were added to the site use database. After we implemented data validation routines 11,099 event data were used to estimate monthly site use in Year 4 (Table 4).

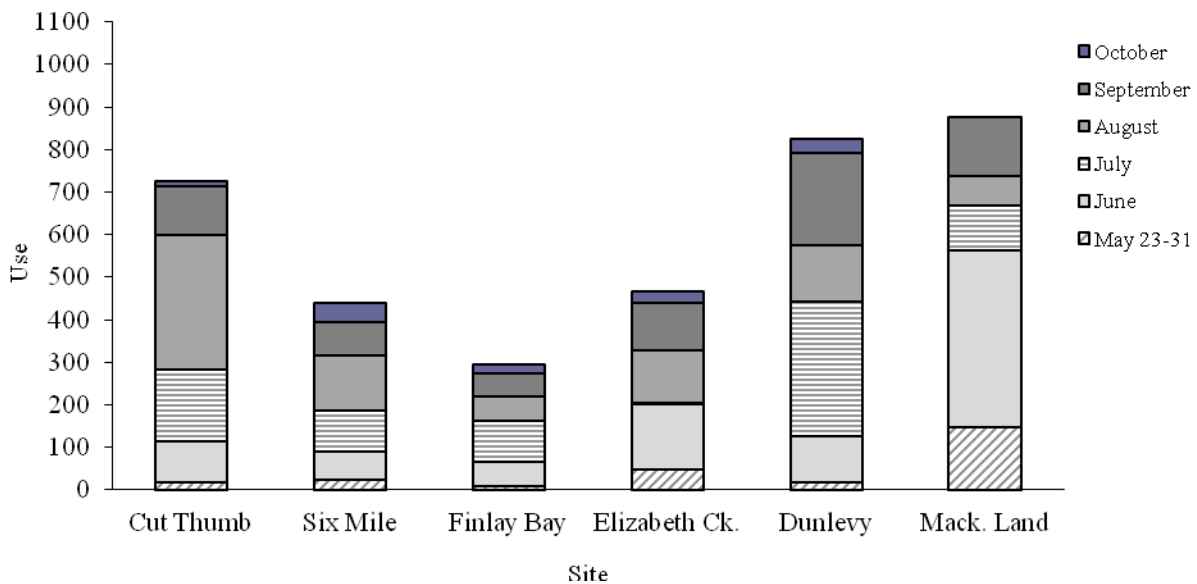


Figure 4. Monthly use by site estimated from photo-validated counter data corrected using photo success between May 23 and October 31 2012. Elizabeth Creek was closed to the public from June 26 - Aug 3 2012 while the W.A.C. Bennett Dam spillway was operating. No photo data were recorded at Mackenzie Landing in October due to full camera storage capacity.

Table 4. Total use by site estimated for monitoring Year 3 (2011) and Year 4 (2012). Estimates include both boaters and non-boaters. Parentheses indicate lower and upper confidence limits among sites.

Site	2011	2012
Cut Thumb Bay	699 (499-1180)	725 (541-1606)
Six Mile Bay	386 (295-524)	439 (330-578)
Finlay Bay	272 (162-440)	296 (185-384)
Elizabeth Creek	473 (468-2585 ¹)	468 (306-735 ²)
Dunlevy	727 (475-983)	824 (525-1063)
Mackenzie Landing	1097 (899-1092 ²)	878 (570-1224)
Total visits	2,557	2,752

Monitoring periods: May 17 – October 31 2011 and May 23 – October 31 2012.

¹Includes Construction vehicles using boat launch

²Counter events excluded while launch closed. Includes construction vehicles using boat launch

Remote cameras

Remote cameras operated continuously at Cut Thumb, Six Mile, and Finlay Bay for the duration of the monitoring period, May 23 – October 31 2012 (161 days). High volumes of pedestrian site user activity filled the camera storage capacity at Mackenzie Landing rendering it inoperable between July 11 - 26, August 9 – 30, and September 23 - October 29 2012. Camera storage capacity at Elizabeth Creek was filled July 8 - August 1 2012 but the launch was closed during this interval and excluded (Appendix A). Most cameras have been discovered by site users; however, no phone queries, theft or vandalism occurred during the Year 4 (2012) monitoring period.

A total of 19,836 photos were collected with 8,027 corresponding to vehicle counter events. The proportion of photo-validated site users that brought boats varied from 17.5% at Mackenzie Landing to 79.1% at Elizabeth Creek (Figure 5, Table 5). Mean photo success was 52% and ranged from 40% at Finlay Bay to 67% at Cut Thumb and Six Mile Bay. Boaters visited all sites throughout the monitoring period (Table 6). On average, visitors with boats stayed longer than 8 hours at all sites (Table 7). The number of easily recognized repeat visitors per site ranged from 13 (Finlay Bay) to 120 (Mackenzie Landing; Table 8). Cameras were removed at the end of season but camera lock boxes were left on site to facilitate re-deployment of monitoring equipment next spring.

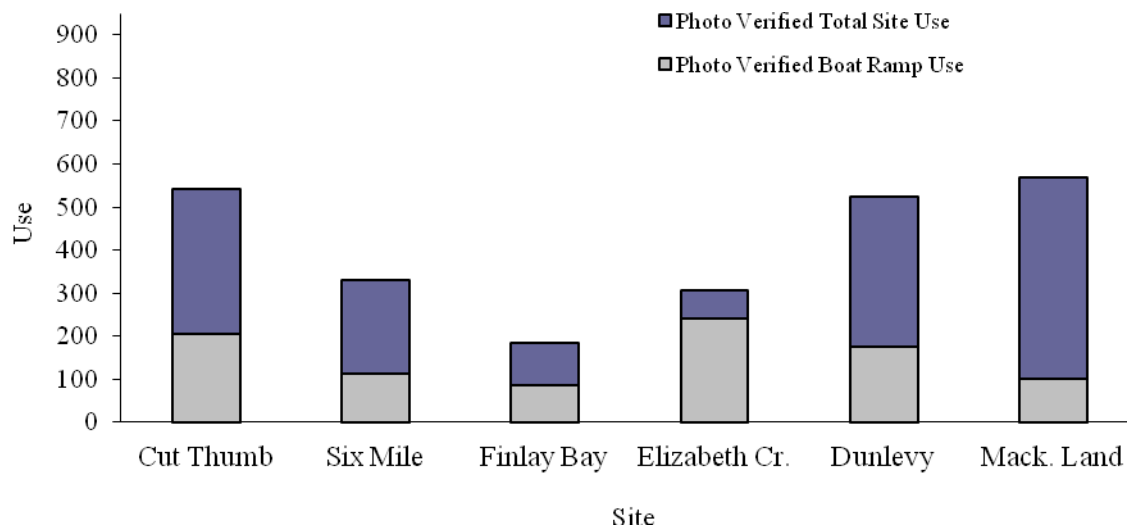


Figure 5. Proportion of photo-validated vehicles bringing boats to the recreation sites between May 23 and October 31 2012.

Table 5. Proportion (%) of photo-validated vehicles bringing boats to recreation sites during the Year 2 (2010), Year 3 (2011), and Year 4 (2012) monitoring periods. Parentheses indicate total number of photo-verified site users.

Site	2010	2011	2012
Cut Thumb Bay	46.2 (383)	37.7 (499)	37.9 (541)
Six Mile Bay	28.4 (218)	31.5 (295)	33.9 (330)
Finlay Bay	28.7 (188)	37.7(162)	46.5 (185)
Elizabeth Creek	56.8 (472)	55.8 (468)	79.1 (306)
Dunlevy	21.0 (443)	29.5 (475)	33.5 (525)
Mackenzie Landing	Not monitored	18.7 (899)	17.5 (570)

Monitoring periods: June 16 – October 31 2010, May 17 - October 31 2011, and May 23 - October 31 2012.

Table 6. Dates of the first and last photo-verified boater visits during the Year 4 monitoring period, May 23 – October 31 2012. Not all visitors photographed arriving with boats launched due to site conditions.

Site	First occurrence	Last occurrence
Cut Thumb Bay	May 26	Oct 8
Six Mile Bay	May 25 ¹	Oct 10
Finlay Bay	May 28	Oct 4
Elizabeth Creek	May 25	Oct 31
Dunlevy	May 26	Oct 9
Mackenzie Landing	May 25	Unk ²

¹Users with larger boats are not launching, and leaving the site within ½ hour.

²Camera storage capacity filled September 23 2012.

Table 7. Average duration of stay for site users identified as boaters or non-boaters in Year 4 (2012). Duration is a minimum biased estimate of hours per visit based on a subset of photo-validated counter data; see text for explanation of method.

Site	Boaters			Non-boaters		
	n	mean	range	n	mean	range
Cut Thumb Bay	29	15.1	0.11 – 95.6	30	33.6	0.10 - 118.9
Six Mile Bay	56	26.8	0.07 – 262.5	94	17.9	0.02 – 335.7
Finlay Bay	11	107.7	19.1 – 343.9	11	34.2	0.16 – 159.1
Elizabeth Creek	173	25.6	0.06 – 436.4	41	0.4	0.002 – 4.6
Dunlevy	57	41.0	0.001 – 262.8	52	6.5	0.02 – 95.8
Mackenzie Landing	79	12.0	0.001 - 67.5	301	0.4	0.001 - 23.8

Table 8. Number of easily recognized repeat visitors per site during the Year 4 (2012) monitoring period, May 23 – October 31 2012.

Site	Repeat visitors
Cut Thumb Bay	59
Six Mile Bay	59
Finlay Bay	13
Elizabeth Creek	71
Dunlevy	56
Mack. Landing	120

User response to boat launch closure

The closure of Elizabeth Creek in July left Finlay Bay and Dunlevy as the only boat launches directly accessing the Peace Reach of the Williston Reservoir. Boater use increased slightly at Finlay Bay ($n=22$) and significantly at Dunlevy ($n=47$; $P = 0.005$; Figure 6) in Year 4 (2012) compared to the same period in Year 3 (2011). The number of repeat visitors doubled ($n=16$) during this period from Year 3 (2011) and contributed to the increase. Boater visits at Elizabeth Creek during the closure period in Year 3 (2011) was 43. Six users compromised the barricades and launched boats during the closure.

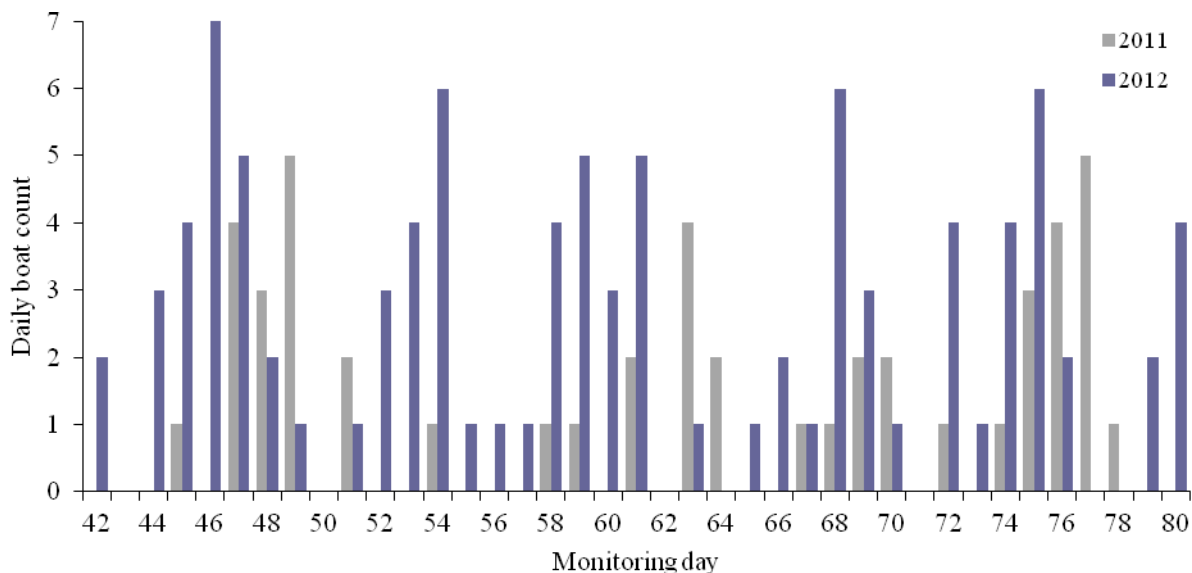


Figure 6. The number of photo-validated vehicles bringing boats to Dunlevy between June 26 and August 3 2011 and 2012. Monitoring day 1 corresponds to May 14 while monitoring day 171 corresponds to October 31.

Effects of reservoir elevation on boat launch use

Site use by boaters appears spread throughout the monitoring period at Cut Thumb Bay, Finlay Bay, and Mackenzie Landing, regardless of reservoir elevation (Figure 7). Elizabeth Creek was the only site to show a negative trend in boater use as the reservoir elevation increased. This was mostly due to the July closure but still emphasizes its value to boaters early in the season as a reliable access point to the reservoir. Six Mile Bay and Dunlevy were seldom used early in the season but increased in appeal to boaters as the reservoir elevation increased above 665 m asl.

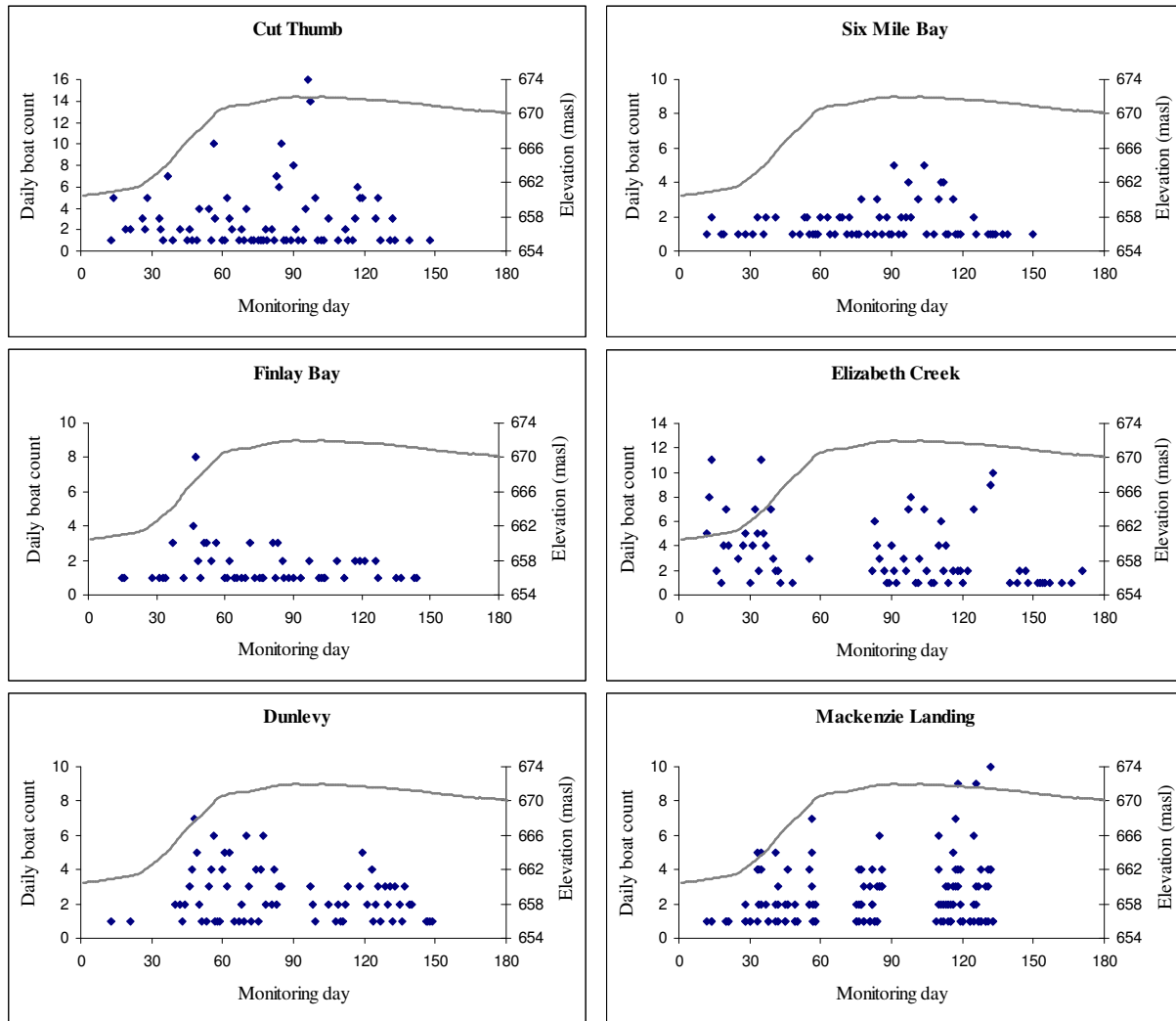


Figure 7. Daily boater use count (points) as a function of reservoir elevation (line) for each recreation site through the Year 4 (2012) monitoring period. Monitoring day 1 corresponds to May 14 while monitoring day 171 corresponds to October 31. Data are incomplete at Mackenzie Landing and Elizabeth Creek.

DISCUSSION

Remote vehicle counters continue to be an effective monitoring tool. Given their data capacity and battery life, they can be installed in mid - May and left to operate continuously until the end of October with little maintenance. Remote cameras function less reliably than counters, and are more labour-intensive to set-up and maintain. However, because fewer than 50% of the photo-validated users had boats at most sites in Year 4 (2012), it is possible to observe as much as a 50% increase in the number of boaters using a site, with no increase in the total number of site visits recorded by the vehicle counters. A monitoring program relying on the counter data alone would not detect this change because the counters alone can only provide an index of site use that may or may not reflect use by boaters.

Because site layouts differ, ensuring consistency in the location of monitoring equipment among sites and among years reduces bias in data interpretations. While establishing the counters directly at the head of the boat launches may better approximate site use by boaters before and after ramp improvements, we feel this would compromise comparisons made among sites with and without boat launches that also offer multiple access points to launching areas. Given that continuous data throughout the annual monitoring periods and throughout the proposed 10 year term is important, site visits spaced approximately 4 - 6 weeks apart have reduced the risk of significant data losses.

Post-hoc analysis conducted in Year 1 (2009) indicates the data collected in concert by remote equipment can detect attainable changes in effect size with an acceptable statistical power (Cubberley and Hengeveld 2010). Multi-year data has increased sample sizes and enabled the detection of smaller differences (<50%) between samples. Including the standardizing parameter *monitoring day* will reduce variance created by day of the week and statutory holidays in statistical models. Four years of reasonably consistent sampling intensity suggest the specific questions that this monitoring program is intended to address can be answered, but they are entirely dependent on whether boat launch facilities are improved. To date, no improvements have been made.

Patterns of use suggest that recreation sites are valued for community and family events, often without intending to launch boats. It is clear there is an expectation by the public that improvements to the launches will materialize given the awareness of this project through community presentations undertaken by BC Hydro. In anticipation of the advertised improvements, site users have been exceptionally tolerant of the monitoring equipment.

Boater increase at Dunlevy in response to the Elizabeth Creek closure may reflect the appeal of launches closer to population centres, even if the facilities are significantly degraded, as in the instance of Dunlevy. This is supported by the high number of repeat visitors at Cut Thumb, Elizabeth Creek, and Mackenzie Landing. Interestingly, the number of boaters launching at Elizabeth Creek during the same period in Year 3 (2011) was equivalent to the increase observed at Dunlevy in Year 4 (2012). This suggests that the surrounding population density influences the number of site users. If this is true, then a meaningful increase in total site use by new users may only be attained from a corresponding increase in local population or disposable income.

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APPENDIX A. SITE PHOTOS



Cut Thumb May 23 2012



Cut Thumb alternate launch May 23 2012



Cut Thumb July 20 2012



Cut Thumb alternate launch July 20 2012



Cut Thumb August 30 2012



Cut Thumb alternate launch August 30 2012



Six Mile Bay May 23 2012



Six Mile Bay May 23 2012



Six Mile Bay May 23 2012



Six Mile Bay May 23 2012



Six Mile Bay July 10 2012



Six Mile Bay August 30 2012



Finlay Bay May 23 2012



Finlay Bay July 24 2012



Finlay Bay August 31 2012



Finlay Bay August 31 2012



Elizabeth Creek May 24 2012



Elizabeth Creek August 1 2012



Elizabeth Creek August 1 2012



Elizabeth Creek August 29 2012



Dunlevy May 24 2012



Dunlevy May 24 2012



Dunlevy May 24 2012



Dunlevy May 24 2012



Dunlevy August 1 2012



Dunlevy August 29 2012



Mackenzie Landing May 12 2012



Mackenzie Landing May 12 2012



Mackenzie Landing May 23 2012



Mackenzie Landing June 17 2012



Mackenzie Landing July 27 2011



Mackenzie Landing August 30 2012